Buick

REFERENCE BOOK

1916 MODELS

BUICK REFERENCE BOOK

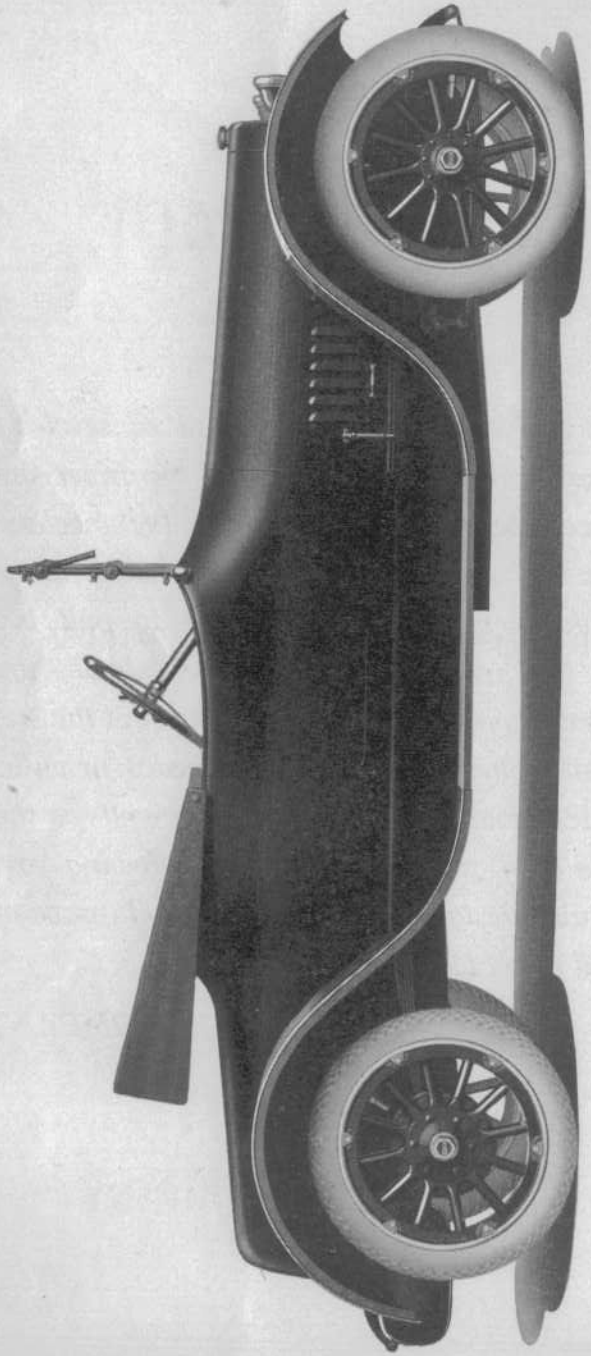
Containing
INSTRUCTIONS FOR THE OPERATION MAINTENANCE AND REPAIR OF

MODELS

D44-D45-D46-D47, DR44-DR45, D54-D55

SEASON OF
1916

BUICK MOTOR COMPANY
FLINT, MICHIGAN, U. S. A.



Buick Model D44 Roadster
(Buick Model DR44 same except right hand drive)

FOREWORD

To derive the greatest amount of service and satisfaction from the use of his truck the driver should have a complete understanding of the mechanical principles underlying its operation. Merely knowing which pedal to press or which lever to pull is not enough. The really competent driver should understand what happens in the various parts of the truck's mechanism when he presses the pedal or pulls the lever. He should know the cause as well as the result. We trust, therefore, that the following exposition of Buick design and construction will prove of interest and value to every Buick owner.

BUICK MOTOR COMPANY.

Flint, Michigan, U, S. A. November 1, 1915

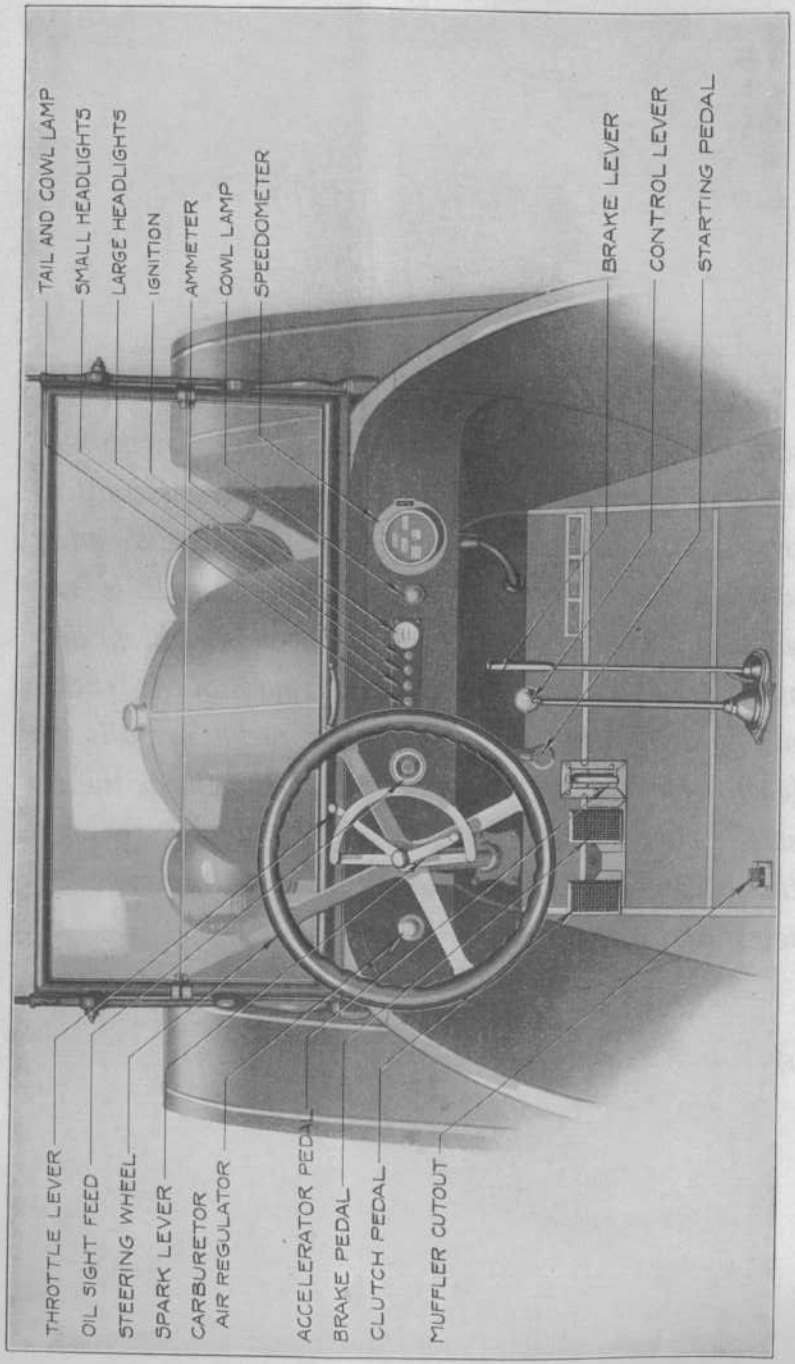


Plate 1
Driving Compartment, Showing Location of Control Levers, Pedals and Instruments.

PART I.

OPERATION

Before attempting to drive the car, make sure that it is ready for the road. See that there is gasoline in the tank at the rear; that the radiator is filled to the level of the overflow with clean water—or with an anti-freezing mixture in winter; that the motor crank case is filled with oil to the level of the petcock; that the storage battery is properly connected; that the gasoline shut-off cock between the vacuum tank and the carburetor is fully open; and that the car is provided with a driving license. If the car has been standing idle for several days, it may also be necessary to prime the vacuum tank by removing the pipe plug in the cover and introducing a pint or so of gasoline. Be sure to screw the plug in tight when replacing it.

TO START THE MOTOR

See that the ball-topped control lever stands in the neutral position, where it is free to move sideways. Set spark and throttle levers on the steering wheel about one-third of the way down the sector. Unlock the switch board and pull out the button marked "IGN," (Ignition). Pull out the air regulator button, and press the starting pedal.

Pressing the starting pedal sets the electric starter in motion and meshes the gears on its shaft with the teetlr in the fly wheel to spin the motor.

If the motor does not start within thirty seconds, release the starting pedal, examine all controls to see that they are properly set, and try again. In winter, or when the motor is very cold, it will require more cranking, but in ordinary weather the motor should start on the first few turns. Never hold the starting pedal down for any length of time without stopping to examine the position of the switch, levers, etc., as failure to start is generally an indication that somethng is wrong and a prompt investigation should be made.

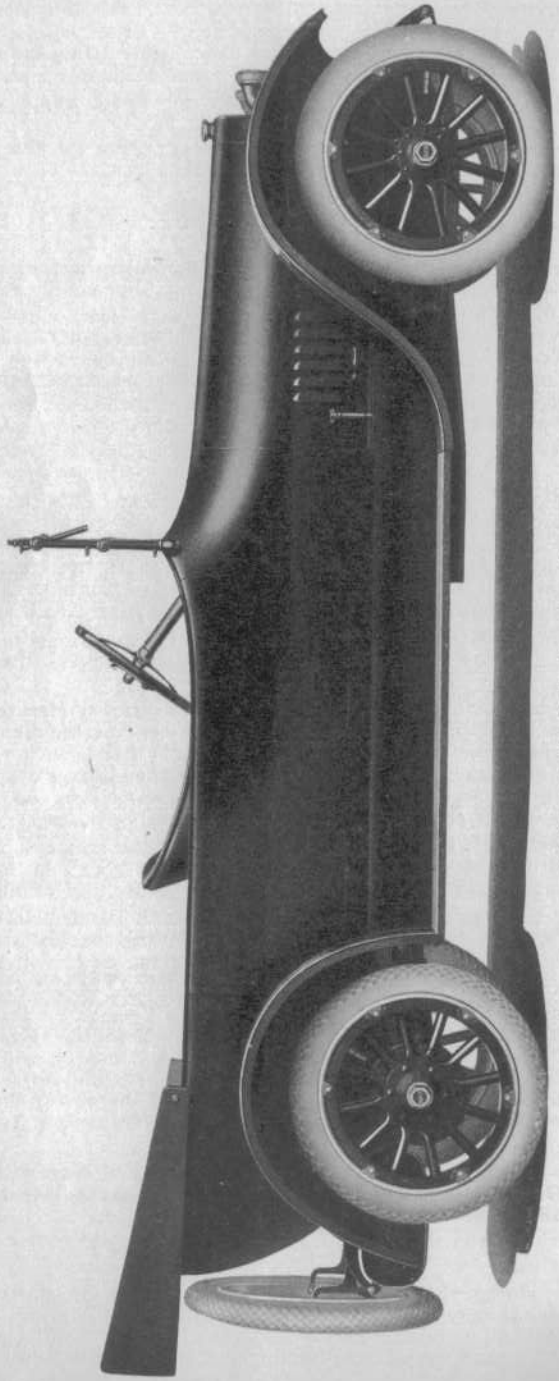
RUNNING POSITIONS

As soon as the motor starts, push the air regulator button half way in, until motor is thoroughly warmed up, close the throttle lever on steering wheel until the motor runs slowly and evenly, and advance the spark by moving the spark lever down as far as it will go on the sector. The automatic spark advance will now take care of the spark position for all ordinary driving. The foot accelerator can be used to control the speed of the motor.

Never allow the motor to run for any length of time with the air regulator button pulled clear out, as this gives an excessively rich mixture and uses an abnormal amount of gasoline.

HAND CRANKING

If the storage battery should be run down or the starter out of order, the motor may be started by hand cranking. To crank by hand, set switch, and air regulator button as before. Bring throttle lever one-third of the way down on the sector and move spark lever slightly



Buick Model D45 Touring Car
(Buick Model DR45 same except right hand drive)

away from its topmost position. Remove cap from starting crank below radiator in front of car and attach hand crank. Push in on crank until starting clutch is engaged, and turn motor over by pulling up sharply on the crank.

Never try to start a motor by pushing down on the starting crank. A back-fire is likely to result in a broken arm.

TO START THE CAR.

To start the car, select a quiet street or level road which has but little traffic on it. With the motor running slowly and evenly, take position in seat behind steering wheel, grasping the wheel firmly with the left hand. With the right hand, release the emergency brake lever, by pressing the thumb button on top, and push it as far forward as it will go. Place the left foot on the clutch pedal, and press it down firmly, holding it in this position. Now, with the right hand, shift the ball-topped control lever first to the right, then back, (See position marked "1," on control lever floor plate).

LOW SPEED

The gearset is now in the first, or "low speed" position. Now, gently release the pressure of the left foot on the clutch pedal, and at the same time press down lightly on the accelerator pedal with the right foot, to increase the speed of the motor. As the clutch takes hold, the car will commence to move forward. Continue to press down on the accelerator pedal until the car gains some headway before attempting to change to second speed

SECOND SPEED

When the car has gained good headway, quickly disengage the clutch, at the same time releasing the pressure on the accelerator pedal to prevent the motor racing, and, with the right hand, shift the ball-topped control lever forward, to the left, and then forward again, as far as it will go. (See position marked "2," on control lever floor plate). Immediately engage the clutch, at the same time accelerating the motor. The car is now in second or intermediate speed.

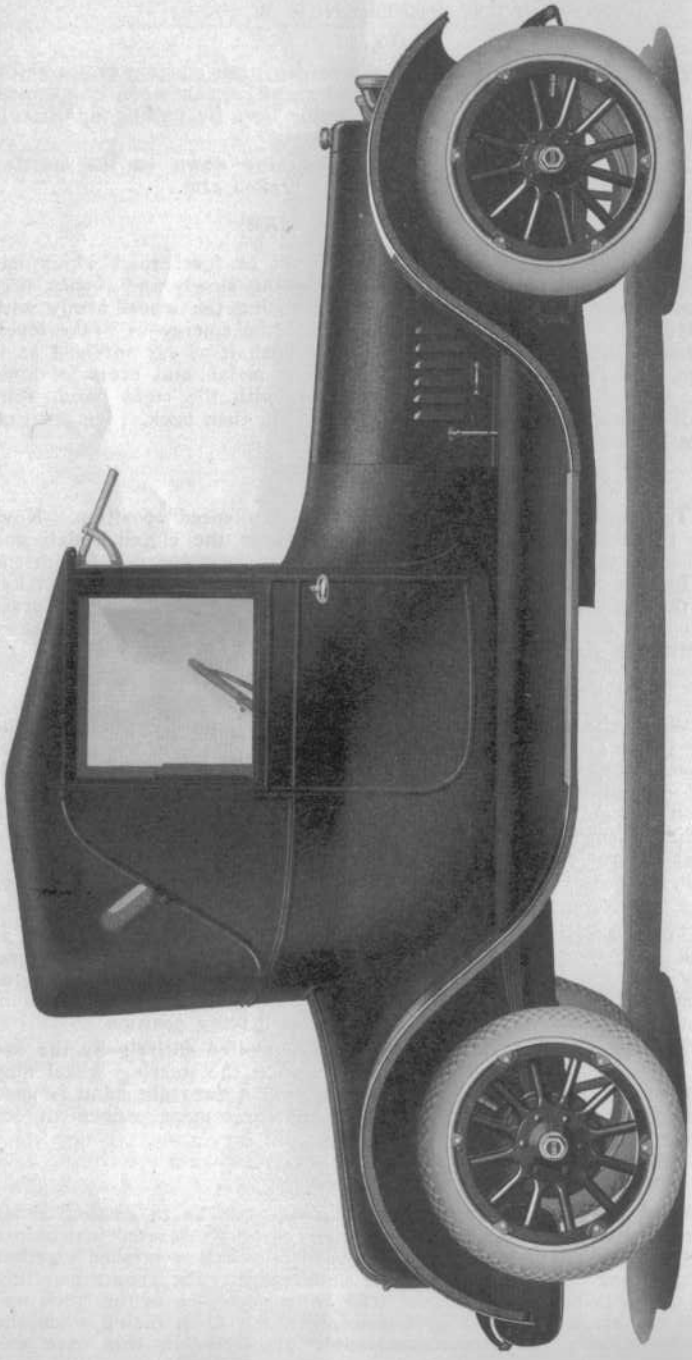
HIGH SPEED

Again accelerate the motor until the car is moving forward at a brisk gait, then operating clutch and accelerator pedals as before, quickly shift the control lever straight back as far as it will go. (see position marked "3," on control lever floor plate). The car is now in third, or "high speed," which is the normal driving position.

The speed of the car may now be controlled entirely by the use of the accelerator pedal. The throttle lever on the steering wheel may be used for the same purpose, if desired, but as the right hand is used to shift gears, the foot will generally be found more convenient for operating the throttle.

SHIFTING GEARS.

In shifting from a lower to a higher gear, as in getting under way, it is important that the speed of the car be accelerated just before making the change, so that the two gears that are to be meshed together will be running at approximately the same speed. The proper handling of the clutch pedal and accelerator, so as to make the motor "pick up" its load quickly and at the same time prevent it from racing when the clutch is released, requires considerable practice. In this case ex-



Buick Model D46 Cabriolet

perience is the only teacher and the driver soon acquires the knack of it.

In changing gears, and especially when starting from a standstill, always let the clutch pedal come back gently. Never remove the foot from the pedal suddenly, as this will let the clutch in with a jerk and throw an enormous strain on the entire driving mechanism.

In shifting gears from one speed to another, the motion should be made firmly and without hesitation. The different positions of the lever for the different speeds are marked on the control lever floor plate. If the gears fail to mesh exactly the first time, do not continue to pull or push on the lever, as this only grinds away the teeth. It is better to release the pressure on the clutch pedal for a moment and try again, as this will give the gears a chance to shift their relative positions and mesh without trouble.

SHIFTING DOWN

Shifting from a higher to a lower gear, or "shifting down," is accomplished in the same way as shifting up; that is, by releasing the clutch, moving the control lever quickly to the proper position, and re-engaging the clutch. It will be found much easier to shift gears from higher to lower speeds if clutch pedal is pressed down only enough to release clutch. When pressed clear down, the clutch brake is applied, making it difficult to mesh the gears.

DRIVING

Ordinarily the car is always driven in "high" or third speed, and first and second speeds are used only for starting. Occasionally, however, a steep hill or a muddy or sandy road will be encountered which requires more power, and since it is for this purpose that the lower speeds are provided, the driver should not hesitate to use them.

A Buick car will climb any hill "on high" that any car will climb, but after the driver has demonstrated this to his satisfaction, it is suggested that he make use of a lower gear which will not cause quite so great a strain on his motor.

STEERING

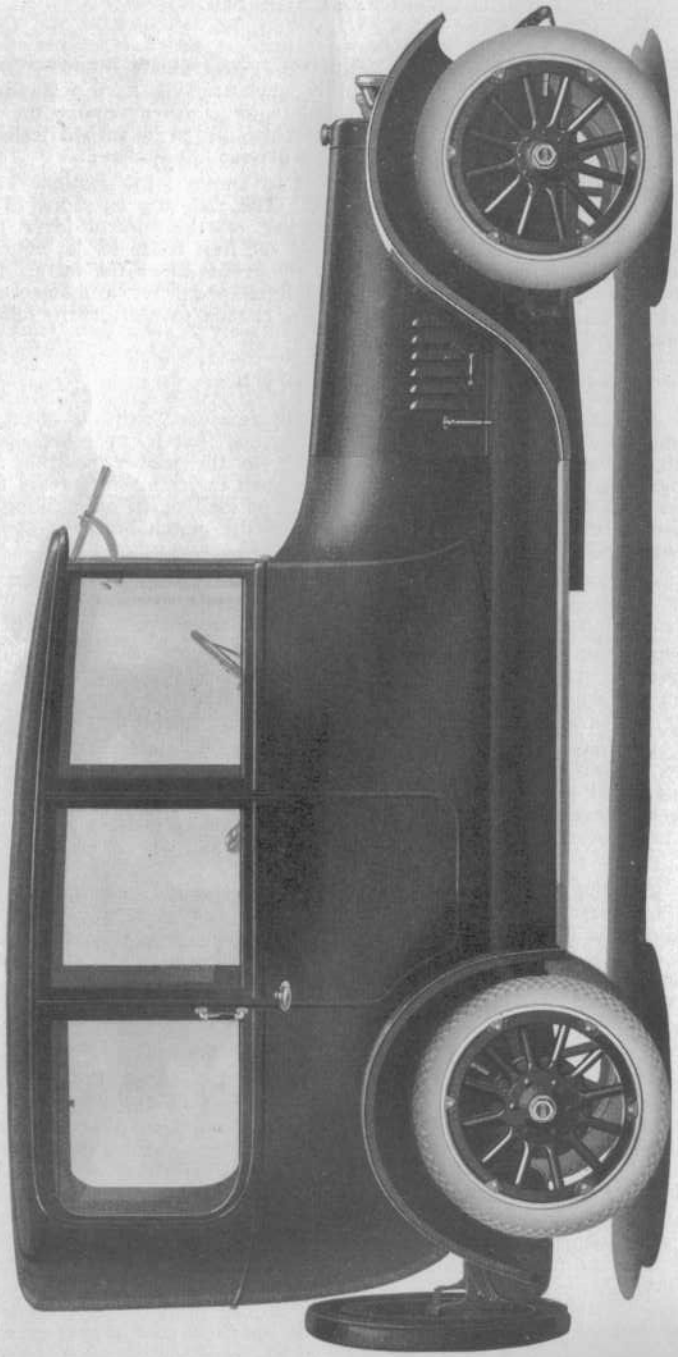
Steering is a matter of practice more than anything else. Drive slowly at first. Do not try to turn corners too sharply or too quickly. Always slow down or stop before crossing railroad and car tracks. In a short time the driver gets the "feel" of the car, and then steering becomes almost an involuntary action, so that all the attention can be concentrated on the road.

WATCH THE ROAD.

When driving, learn to keep the eyes on the road from 100 to 300 feet ahead of the car, depending on the speed at which it is running. Do not attempt to keep watch of the road just ahead of the wheels, as there would not be time to avoid a bump or a stone if one should appear at that range. Learn to watch the road some distance ahead of the car and to prepare for obstacles before the car reaches them.

HANDLING THE SPARK.

For all ordinary driving, the automatic spark advance, which is incorporated in the ignition system, will control the spark position without further attention on the part of the driver. It is arranged to automatically advance or retard the spark to the proper position,



Buick Model D47 Sedan

depending on the speed of the motor, but as the car slows down, as in ascending a steep hill or negotiating a heavy road, it is necessary to retard the spark by hand until the motor runs smoothly and without knocking.

Never allow the motor to run for any length of time with the spark retarded, as such practice only consumes an abnormal amount of gasoline and has a tendency to overheat the motor.

TO STOP THE CAR.

To stop the car, first slow down the motor by removing the foot from the accelerator pedal, then release the clutch by pressing the pedal with the left foot. If the car retains too much headway, apply the service brake by pressing the right pedal. After the car has come to rest, and while still holding the clutch out with the left foot, shift the control lever into the neutral position. The foot may now be removed from the clutch pedal.

TO REVERSE.

To reverse the motion of the car, or drive backwards, first come to a full stop. Release clutch and shift control lever to the right and forward. (See position marked "R," on control lever floot plate). Engage clutch and accelerate motor as before.

Never attempt to reverse the motion of the car before it has come to a dead stop. The car cannot move in two directions at once and the result is certain to be serious if this is attempted.

EMERGENCY STOPS.

If for any reason it should become necessary to stop the car suddenly, press both pedals and at the same time pull back on the emergency brake lever with the right hand. The car should not be stopped suddenly except in an emergency, as such stopping is extremely hard on the tires and strains the entire mechanism. A good rule is to use brakes and clutch as little as possible and endeavor to control the car with the throttle.

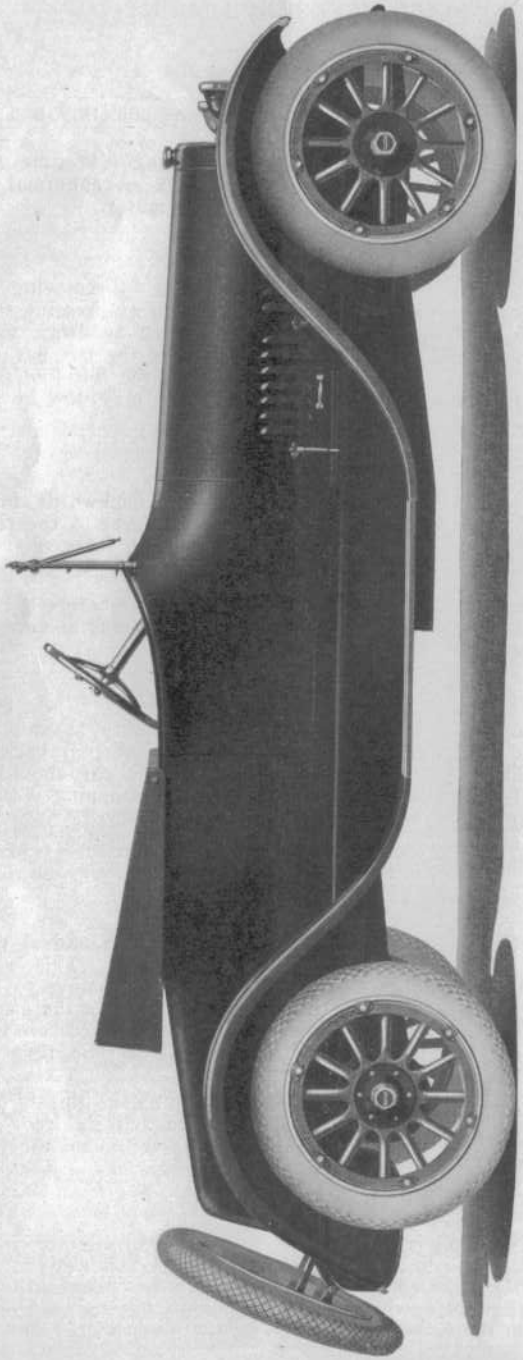
TO STOP THE MOTOR

To stop the motor, push in the ignition switch and at the same time open the hand throttle to the starting position. This will allow the motor to take in a full charge of gas before coming to rest and leave it ready for a quick start next time. Also move the spark lever back to the starting position and set the emergency brake before leaving the car. If the car is to be left for any length of time, turn the lock on the ignition switch.

Never leave the car with the motor running, as this is a useless waste of gasoline and there is always a chance that children or others may throw it into gear. With the electric starter to do the cranking, there is no excuse for letting the motor run.

COASTING

When descending a long grade it is both permissible and proper to use the motor as a brake. To do so, push ignition switch button in, and open throttle wide. This allows the motor to obtain large charges of a very lean mixture which are not ignited, but the work of compressing them in the cylinders helps check the speed of the car.



Buick Model D54 Roadster

STARTING ON A GRADE.

It sometimes becomes necessary to start the car on an up grade. To accomplish this, start motor as before, then release emergency brake and hold car with service brake while shifting gears. Now accelerate motor with the hand throttle while gradually releasing pressure on both pedals together. It takes considerable practice in operating the clutch and brake pedals to make the one take hold while releasing the other, without "killing" the motor, but it can be done very easily with a little experience.

SKIDDING

Never apply the brakes suddenly, especially when turning a corner or on slippery pavements, as it is almost sure to make the car skid. Skidding is caused by the rear wheels suddenly losing their tractive effort while the car is under the influence of centrifugal force from turning. The result is that the rear end of the car swings suddenly toward the outside of the curve. The best way to avoid skidding is to drive slowly. If skidding occurs, release the brake for an instant, and turn the steering wheel in the same direction the car is skidding This will help to straighten it up.

RACING THE MOTOR.

Never open the throttle suddenly or leave it open very far when the car is standing and the motor running idle. This is known as "racing" the motor, and there is nothing more injurious. More motors have been ruined by racing, while idle, than have ever been worn out in actual driving under load.

SPEEDING.

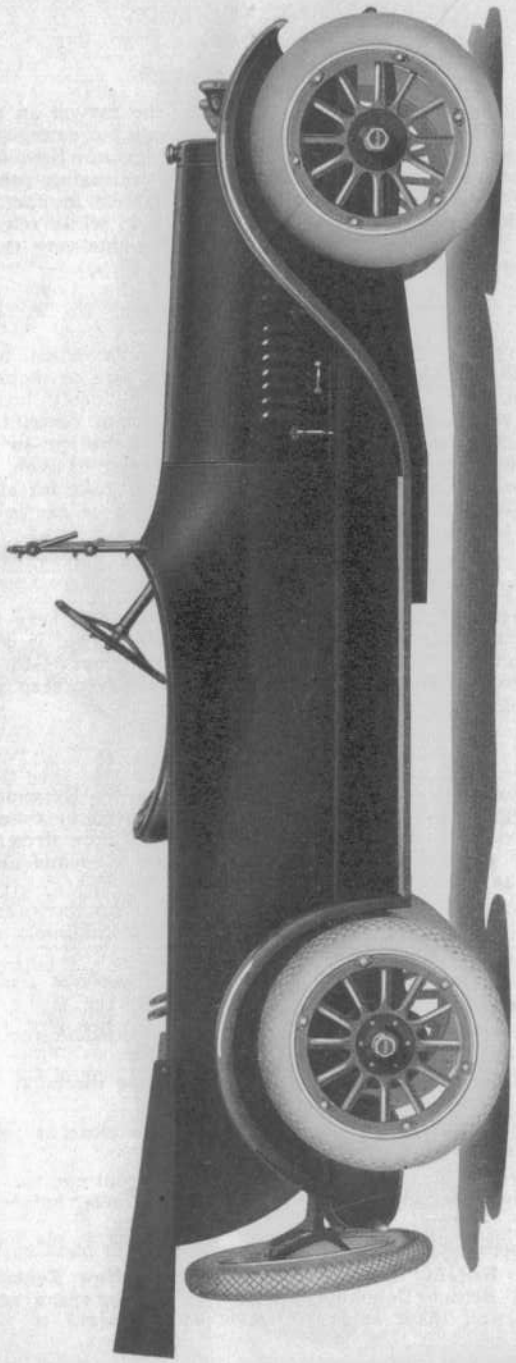
Drive slowly at first. Do not try to speed. Extremely high speeds are dangerous under all conditions and fifteen or twenty miles an hour on good roads is plenty fast enough for the new driver. Learn to handle your car properly under all conditions of roads and traffic before attempting higher speeds.

RULES OF THE ROAD.

The following "rules of the road" apply to the entire United States and the greater part of Canada. Every driver of a motor car should understand and obey them.

1. When meeting a vehicle going in the opposite direction, turn out to the right.
2. When passing a vehicle going in the same direction, turn out to the left.
3. In turning a corner to the right, keep as close as possible to the right hand ditch or curb.
4. In turning a corner to the left always continue on, past the center of the intersection of the two roads or streets, before making the turn.
5. In stopping the car, always stop at the right hand curb.

In Great Britain, South Africa, Australia, New Zealand, New Foundland, and British Columbia, as well as all European and South American countries, these rules are reversed in regard to right and left.



Buick Model D55 Touring Car

USE OF LIGHTS.

Buick cars are provided with electric lights operated from the switch board on the cowl. For night driving on country roads, both head and tail lights should be turned on by pulling out the proper switch buttons. For city driving and when leaving the car standing at the curb, the large headlight bulbs should be turned off and the small bulbs turned on. Do not leave the car standing at the curb for any length of time with the large headlights burning, as they require considerable current, and may run the storage battery down. A small electric lamp is also provided on the cowl board to illuminate the instruments at night.

WATCH THE INSTRUMENTS

Instruments placed conveniently on the cowl board keep the driver constantly informed as to the operation of his car, and he should form a habit of glancing at these instruments occasionally, while driving.

The oil sight glass tells, by the motion of its wheel, when sufficient oil is being circulated through the motor lubricating system.

The ammeter on the switchboard shows the amount of current, in excess of that being used for lights and ignition, going to the storage battery. It also shows the amount taken from the battery when cranking or idling the motor.

The speedometer gives the speed of the car and the number of miles traveled, both total and trip. The trip register may be set back to zero or to any given figure by turning the large milled screw at the right.

TO RAISE THE TOP.

In case of rain, or as a protection from the sun, the top may be raised as follows: first remove dust cover, then loosen straps which fasten the bows to the top rests on the rear of the body. Now pull up and ahead on the front bow until the top is fully extended, then pull down until the brackets fit over the studs in the windshield. The top can be raised most easily from inside the car.

The side curtains can be attached by loosening the ends held at the center of the top bows, swinging them down to the sides, unrolling and fastening them in place.

When folding the top, be sure that the side curtains are properly rolled and folded up, first, and that the folds of the top do not get caught between the bow spacers. Do not fold top when wet or damp.

For driving in rain or snow, the upper glass of the windshield may be pushed out at the bottom, affording a clear view of the road.

DRIVING LICENSE

All states and countries now require motor cars to carry driving licenses and Buick cars are equipped with special brackets for this purpose. In front, a flat bar is provided between the head lamps, and in the rear a pad is so arranged across the tire carrier or in combination with the tail lamp, that the light will always shine on the license number.

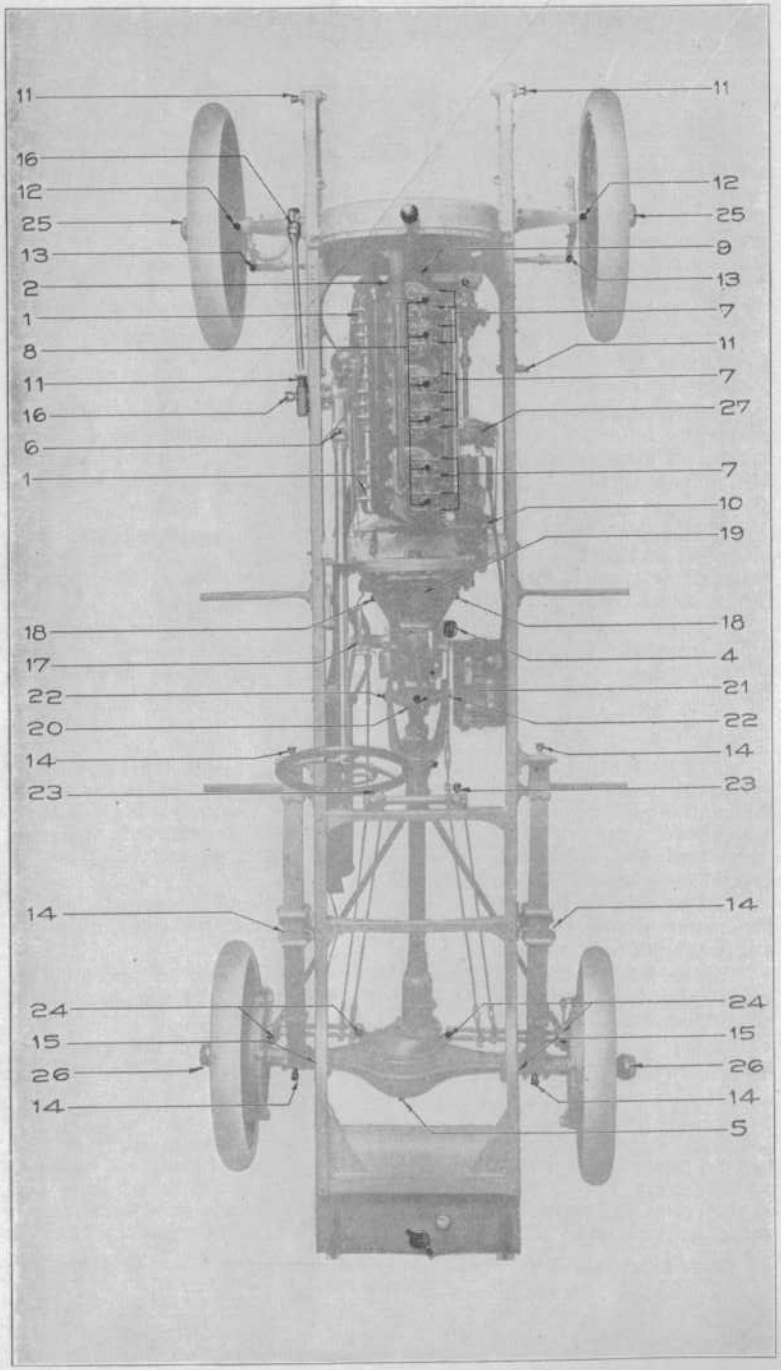


Plate 2
Plan View of Chassis Showing Lubrication

PART II.

MAINTENANCE

To keep the car operating at its maximum efficiency all the time, it must receive a certain amount of regular attention, especially in regard to lubrication. Wherever two parts move in contact with each other, constant and thorough lubrication is vital. With proper lubrication the parts will run for years and show but little sign of wear, but if allowed to run dry, even for a few hours, the results are likely to prove disastrous.

The more important parts of the car, such as the motor, transmission gearset, and rear axle, are provided with automatic lubricating systems, so that aside from adding fresh oil from time to time, they require practically no attention. Other parts are provided with oil wells and grease cups which require turning down and refilling at more or less frequent intervals. In the following instructions for lubrication, the numbers refer to the figures on Plates 2 and 3.

LUBRICATION

1. MOTOR—Motor Oil. Fill crank case reservoir through the forward breather tube on left hand side to level of the petcock. Make sure petcock is not stopped up with dirt when testing. Use long funnel which comes with the car, and do not fill above petcock as an excess will only cause smoke. Oil sight feed on cowl shows circulation of oil but does not tell when supply is getting low. Test frequently.

2. TIMING GEARS—Steam Cylinder Oil. Fill through wing plug on left side of timing gear case to one inch of the level of the opening. (See instruction plate on gear case.)

3. PUMP SHAFT BEARING—Motor Oil. Add two to four ounces at frequent intervals, but do not try to fill full, or the oil will overflow into timing gear case. (See instruction plate on gear case.)

4. TRANSMISSION—Steam Cylinder Oil. Remove filler cap on right side of transmission case, (Left side on DR44 and DR45), and fill to level of the opening.

5. REAR AXLE—Steam Cylinder Oil. Remove plug in center of differential housing cover and fill to level of the opening.

6. STEERING GEAR—Steam Cylinder Oil. Remove pipe plug in housing cap and fill to level of opening.

EVERY 100 MILES.

About every hundred miles the following points should receive attention:

7. VALVE ROCKER ARM BALL JOINTS—Motor Oil. Apply a drop or two of motor oil through the holes on top. Note 12 oil holes.

8. VALVE ROCKER ARMS—Hard Cup Grease. Give each cup half a turn. Note 6 grease cups.

9. FAN SPINDLE—Hard Cup Grease. Give grease cup one or two turns.

10. STARTER SLIDING GEARS—Soft Cup Grease. Give grease cup half a turn.

11. FRONT SPRINGS—Soft Cup Grease. Give grease cups half a turn. Note 3 cups to each spring.

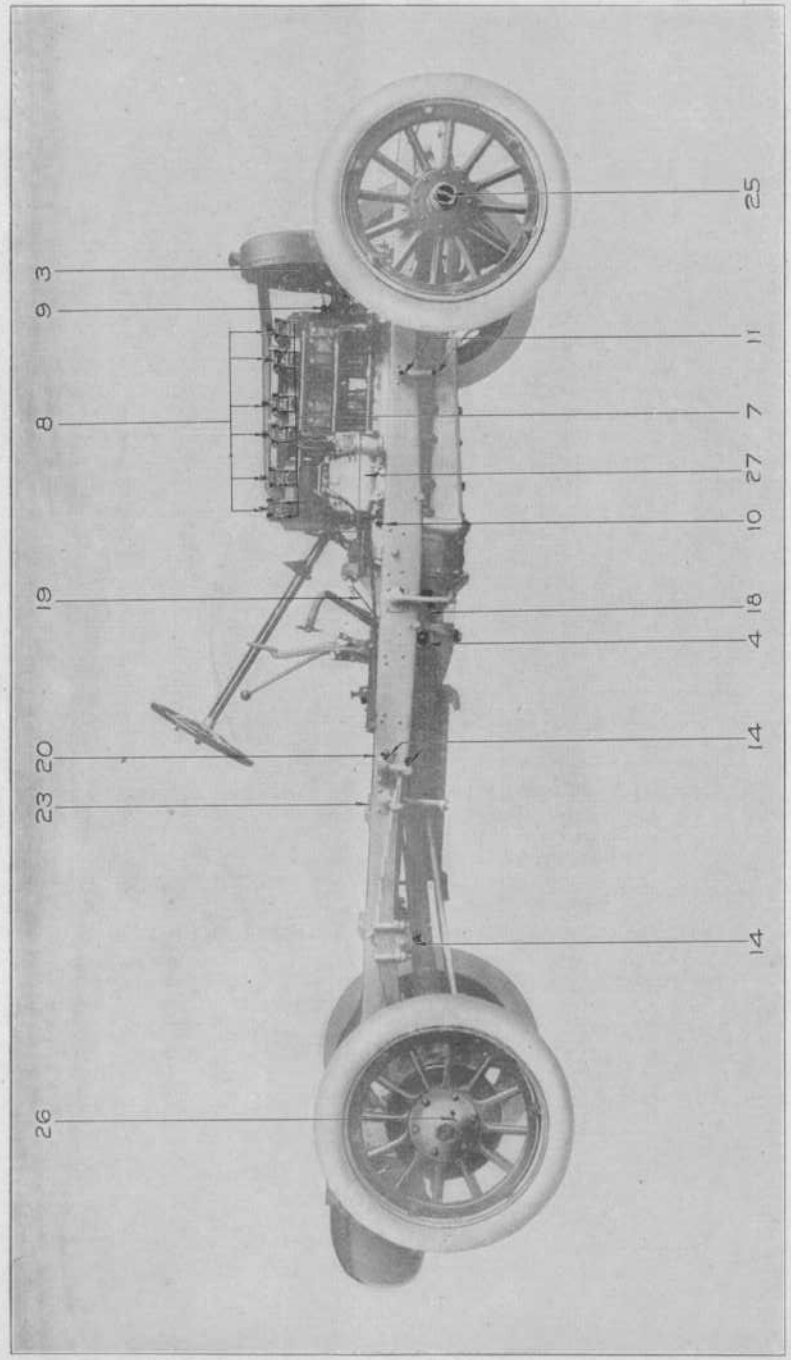


Plate 3
Side View of Chassis Showing Lubrication.

12. KING BOLTS—Soft Cup Grease. Give grease cups each a turn. Note cup on each bolt.

13. TIE ROD BEARINGS—Soft Cup Grease. Give cups half a turn each. Note cup at each end of tie rod.

14. REAR SPRING—Soft Cup Grease. Give grease cups on spring bolts, spring blocks, and ends of springs, half a turn each. There are 4 cups to each spring.

15. REAR SPRING SEATS—Soft Cup Grease. Give grease cups half a turn each.

EVERY 500 MILES.

Every five hundred miles, after thoroughly washing and cleaning the car, attend to the parts which require lubrication, as follows:

16. STEERING CONNECTING ROD—Soft Cup Grease. Give grease cups a turn or two each. Note 2 cups, one at each end of rod.

17. BRAKE AND CLUTCH PEDALS—Soft Cup Grease. Raise front floor boards and give grease cup on pedal hub a turn or two.

18. CLUTCH RELEASE SHAFT—Soft Cup Grease. Give grease cups a turn. There are 2 cups, one on each end of the shaft.

19. CLUTCH—Soft Cup Grease. Loosen wing nuts and remove cover of clutch housing. Give grease cup on clutch release ring a turn or two. Press clutch pedal and turn clutch cone around until grease cup appears, and give it a turn or two. Turn motor over by hand or with starter until grease cup on clutch spider appears, then give it a turn or two. Also apply a few drops of motor oil to the clutch release yoke trunnion bearings. Note that there are 3 grease cups on the clutch.

See that no grease or oil gets on fly wheel or clutch leather.

20. UNIVERSAL JOINT—Soft Cup Grease. Move car forward or backward until pipe plug in universal joint comes opposite offset in driving ring, then remove plug and fill with grease.

21. DRIVING RING BEARINGS—Soft Cup Grease. Give each cup a turn or two. Note 4 cups, 2 in ring and 2 on caps of driving yoke.

22. DRIVING YOKE—Soft Cup Grease. Give grease cup a turn or two.

23. BRAKE SHAFT—Soft Cup Grease. Give grease cups a turn or two. Note 2 cups, 1 at each end of shaft.

24. BRAKE CAM SHAFTS—Soft Cup Grease. Give grease cups a turn or two. Note 4 cups, 2 at outer ends and 2 at inner ends of shafts.

EVERY 1000 MILES

Every thousand miles, the wheels should receive attention, as follows:

25. FRONT WHEELS—Soft Cup Grease. Jack up front axle and remove hub caps by unscrewing them to the left. Use special wrench in tool kit. Remove cotters and unscrew spindle nuts by turning nut on right spindle to left and nut on left spindle to right. Note that these are right and left hand threads. Do not get nuts mixed. Remove safety washers and outer cones. Pack balls and hub with soft grease. Replace wheels and tighten nuts until wheels have no perceptible shake on spindles, but are loose enough to spin freely and stop with tire valves down. Replace cotters and hub caps.

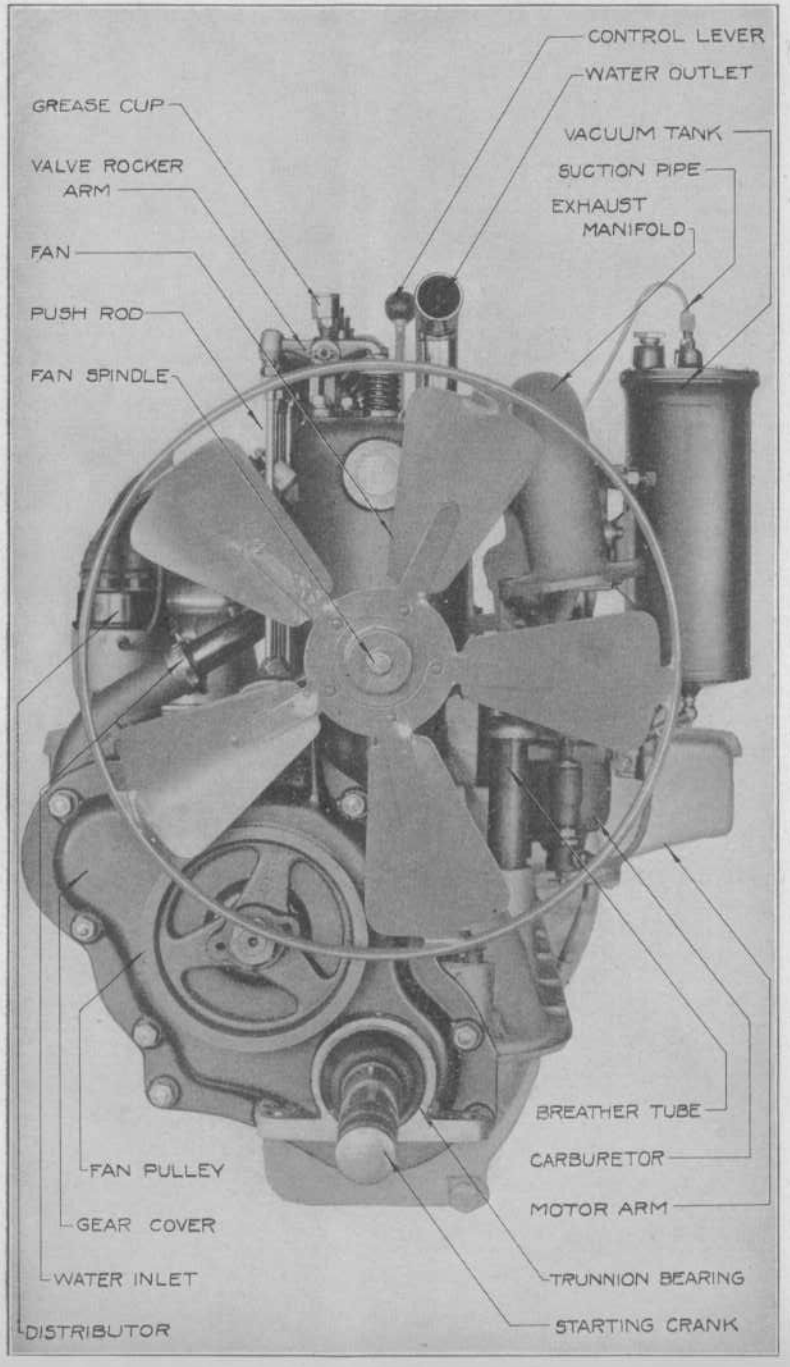


Plate 4

26. REAR WHEELS—Soft Cup Grease. Move car or jack up rear axle and turn wheels until pipe plugs in hubs appear on top. Remove plugs and fill with soft cup grease.

27. DELCO GENERATOR. See Delco Instruction Book for lubrication.

28. PINION SHAFT BEARINGS—Soft Cup Grease. Remove adjusting cover on pinion flange and fill with soft cup grease with grease gun.

LUBRICANTS

Four different kinds of lubricants are recommended for Buick cars: motor oil, steam cylinder oil, hard cup grease, and soft cup grease.

Motor Oil should be a high grade, medium heavy, mineral oil, with a flash point of not less than 400 degrees Fahrenheit and a viscosity of 80 to 90 Tagliabue, or 62 to 72 Saybolt, at 212° F. This oil should be used exclusively in the motor lubricating system, for the pump shaft bearing, and for all small parts not otherwise provided with lubrication, such as rocker arm ball joints, clutch release yoke, spark and throttle cross shaft, small joints of spark, throttle, and accelerator connections, etc.

Steam Cylinder Oil should be a heavy mineral oil, free from acid, and should be used exclusively for the motor timing gears, transmission gears, differential gears, and steering gear. It is better for this purpose than most of the so-called "gear greases."

Hard Cup Grease should be a pure mineral grease with a melting point of not less than 250 degrees Fahrenheit, to enable it to withstand heat from the motor, and should be used in the grease cups on the valve rocker arm brackets and fan spindle.

Soft Cup Grease or Vaseline should be a pure mineral product and should be used in all other grease cups, such as those on front axle, starter sliding gears, clutch, clutch release shaft, brake shafts, brake cam shafts, driving yoke and ring, and in the universal joint, steering connecting rod and wheel hubs.

APPLYING LUBRICANTS

A special funnel is provided with the car for filling the motor, transmission, etc. A small copper oil can, which may be carried in the oil can bracket on the dash, is furnished with the car and will prove useful in applying motor oil to oil holes and other parts requiring a small amount at a time. Where soft cup grease or heavy steam cylinder oil is to be applied through a hole, make use of the grease gun that is furnished with the car. To use, fill gun with grease, place nozzle in the hole, and eject grease by pushing down on handle.

Do not use too much oil. Enough is just right and any more will simply run out of the bearings and collect dust and dirt on other parts of the car.

OVERHAULING THE CAR

Three or four times a year all the oil should be drained out of the motor, transmission, and rear axle, and these parts washed out thoroughly with gasoline or kerosene before being filled again with clean oil. At lease once a year, the car should receive a thorough overhauling, at which time the motor, clutch, transmission, universal joint, steering gear, and axles should be taken apart and carefully cleaned and adjusted before being reassembled. This work should be done by an experienced mechanic.

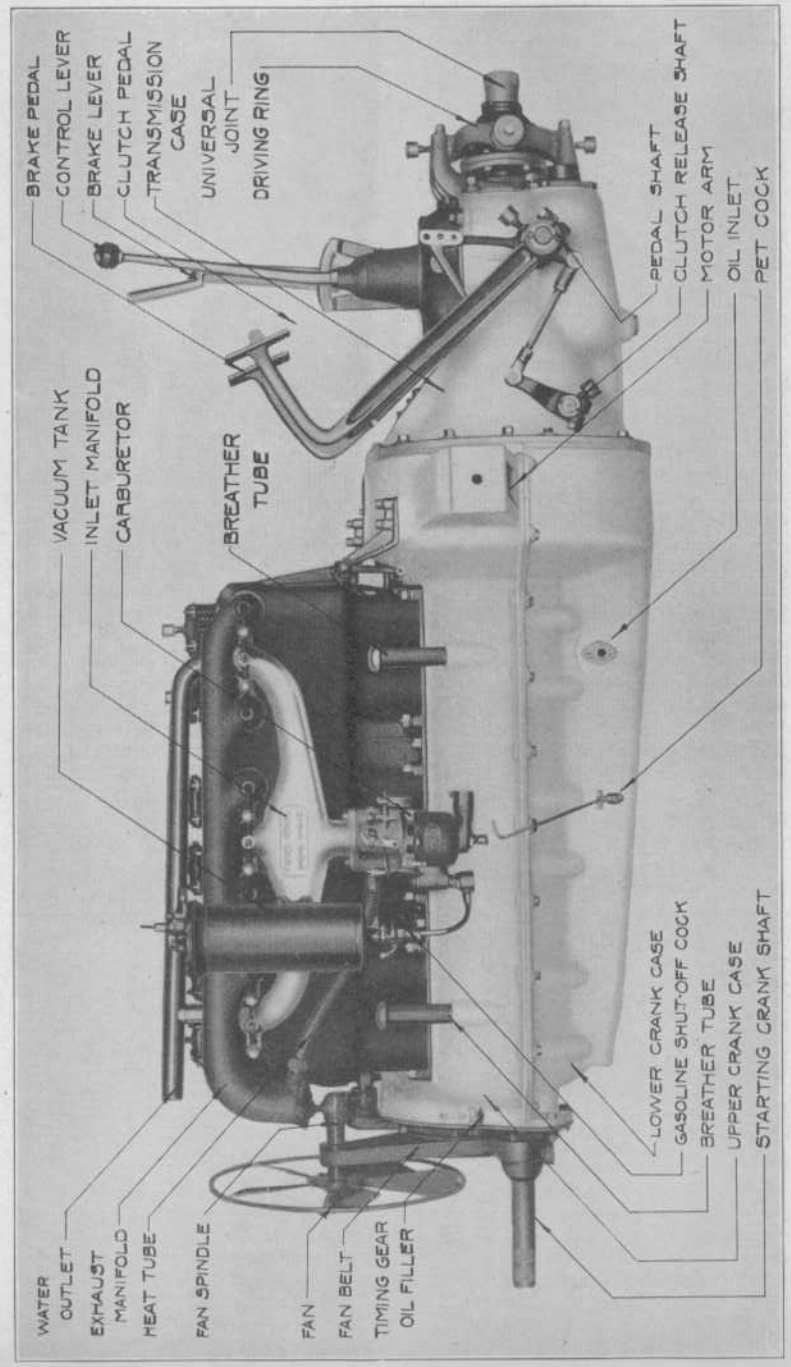


Plate 5
Carburetor Side of Power Plant.

POWER PLANT

The unit power plant is the most important part of the car. It develops the necessary power for driving the car and delivers it to the axle and road wheels where it is finally converted into motion of the vehicle.

The power plant consists of:

The Motor.
The Lubricating System.
The Fuel System.
The Ignition System.
The Cooling System.
The Exhaust System.
The Starting System.
The Clutch.
The Transmission Gearset.
The Universal Joint.

The motor is the machine which turns the pressure of the exploding gas into rotary motion of the crankshaft.

The lubricating system supplies oil for the different parts of the motor, automatically varying the amount to agree with the speed and load at which the motor may be working.

The fuel system pumps the raw gasoline from the fuel tank at the rear of the car, vaporizes it, mixes it with the proper proportion of air and sends it to the motor in sufficient quantities for the work the motor is doing.

The ignition system generates the electric current, "steps it up," or raises its voltage sufficiently to make it jump the spark gaps with a hot flame, and then distributes it to the spark plugs in the proper order, and at the proper time to explode the gas when the motor is ready for a new impulse.

The cooling system carries away the excess heat developed by the explosions in the motor cylinders, and diffuses it to the surrounding atmosphere.

The exhaust system carries the waste products of combustion away from the motor and muffles the noise of the explosions.

The starting system uses the electrical energy stored up in the storage battery to crank or spin the motor for starting.

The clutch is the connecting link between the power plant and the transmission system, and connects or disconnects the two units at the will of the operator.

The transmission gearset allows the speed of the motor to be varied in relation to the speed of the rear wheels.

The universal joint is the flexible coupling which connects the power plant to the rear axle and allows the axle to move up and down over the road surface without interrupting the driving effort.

MOTOR

The motor consists essentially of a row of six cylinders in which the gas is exploded, the force of the explosions acting on pistons which move up and down in the cylinders. The pistons are connected, by means of the connecting rods with the crankshaft, and as they move up and down turn the crankshaft around in a clockwise direction. At

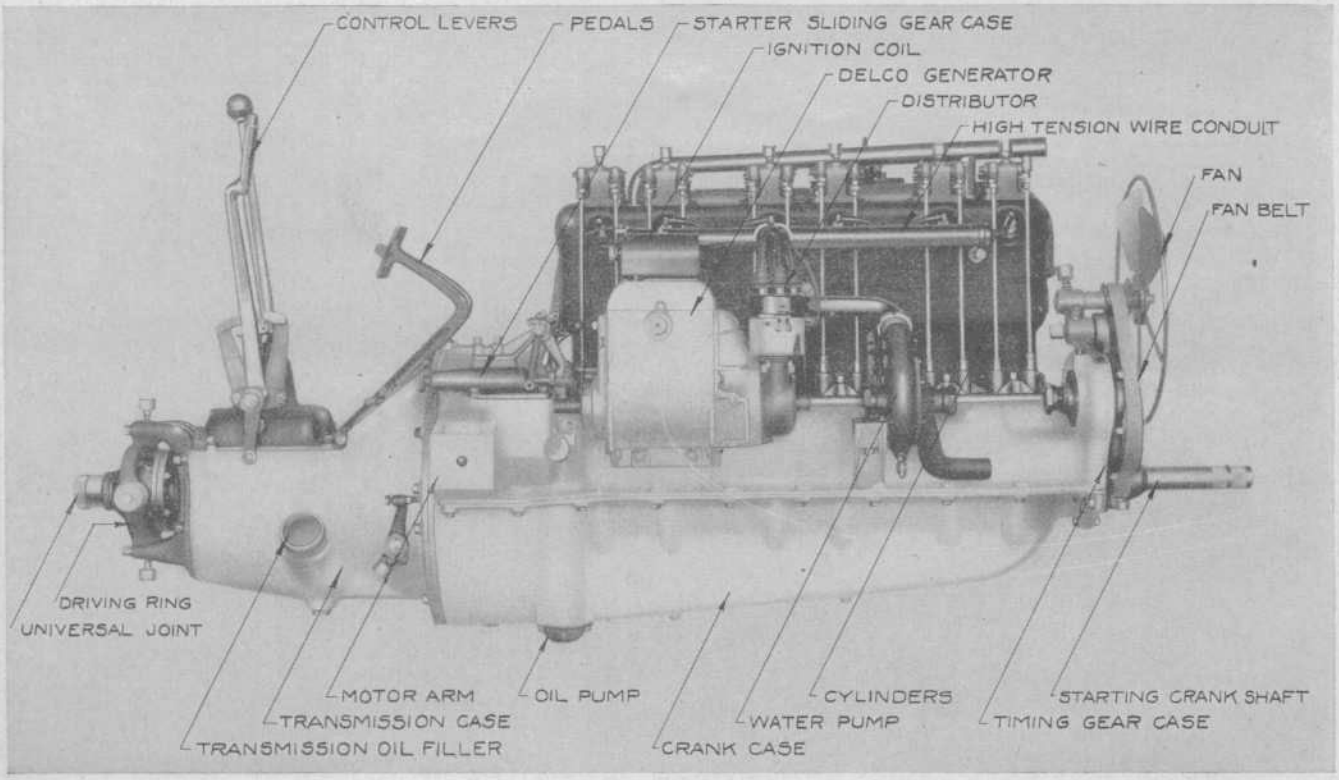


Plate 6
Generator Side of Motor.

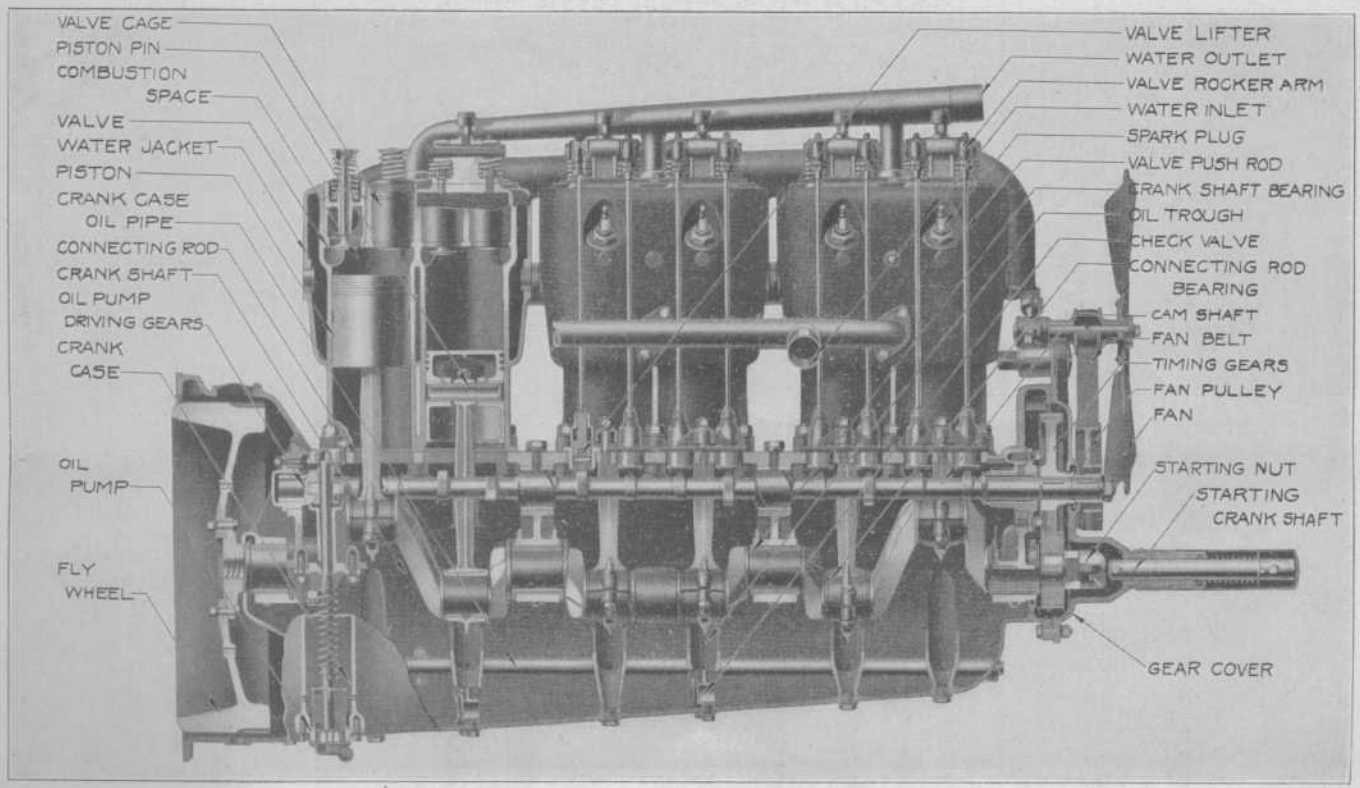


Plate 7
Section Through Motor Showing Interior Construction

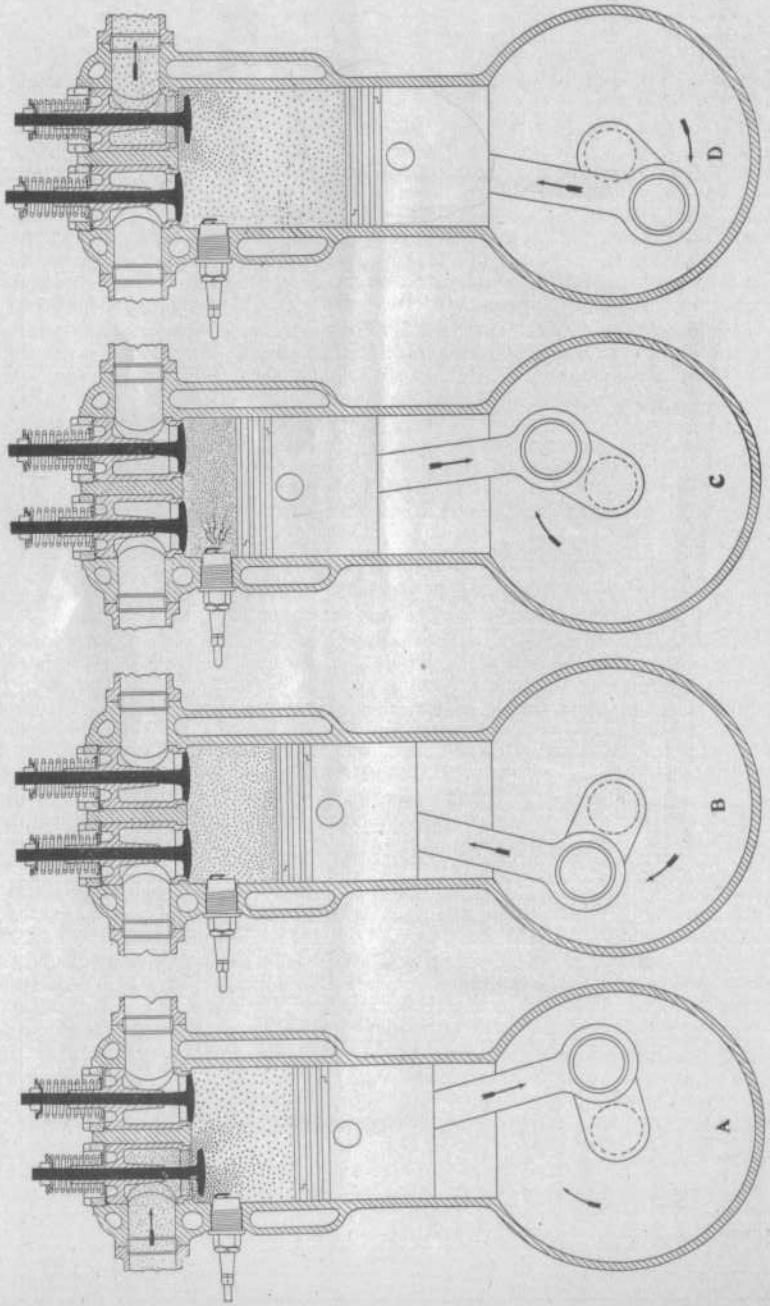


Plate 8
Diagram Showing Different Strokes of the Cycle

its rear end, the crankshaft carries a heavy fly wheel which engages with the clutch and transmits the power on to the rear wheels. Teeth are cut around the rim of the fly wheel and a small gear, driven by the electric starter, engages with these teeth when spinning the crank shaft to start the motor. The crank case, which is fastened to the frame of the car, supports the cylinders and encloses the crank shaft and its bearings.

At their upper ends, the cylinders have two openings, closed by poppet valves. One of these communicates with the exhaust system and the other with the intake manifold and carburetor. The valves are opened and closed at the proper intervals in the cycle by rocker arms and push rods, actuated by the cam shaft, which is geared to the crank shaft and runs at one-half the crank shaft speed, so that the valves are each opened and closed once for every two revolutions of the crankshaft. At its rear end the cam shaft carries another gear which drives the oil pump located in the lower half of the crank case.

Spark plugs project into the combustion space at the upper ends of the cylinders and serve to ignite the gas when a cylinder is ready for the explosion.

A double wall or water jacket entirely surrounds the upper part of the cylinders and water is kept constantly circulating through the space between the two walls by means of the water pump, which is attached to the right side of the crank case and is driven by another shaft geared to the cam shaft. The pump shaft runs 1½ times as fast as the crank shaft and also drives the Delco generator through a coupling at its rear end.

HOW THE MOTOR WORKS

The power of the motor is produced by burning or exploding charges of gas in the cylinders, above the pistons, the resulting pressure forcing the pistons down and turning the crank shaft. In the four cycle motor, of which the Buick engine is an example, it takes four strokes of the piston or two complete revolutions of the crank shaft, for each explosion or working stroke in any one cylinder. This will be more readily understood by reference to the diagram, Plate 8.

As the piston starts down on the first stroke of the cycle, as in "A," the inlet valve is opened. The motion of the piston tends to create a vacuum in the cylinder, and this sucks in a charge of fresh gas from the carburetor, through the valve opening.

When the piston has reached the bottom of its stroke, and starts back, as in "B," the intake valve closes and the piston compresses the gas it has sucked in, into the space at the top of the cylinder.

As the piston reaches the end of its upward stroke, as in "C," the compressed gas is ignited by an electric spark which occurs at the points of the spark plug, and the resultant explosion creates a large amount of heat and pressure, which pushes the piston down during the next, or working stroke, and turns the crank shaft.

On the return upward stroke of the piston, "D," the exhaust valve is opened, and the piston pushes the remaining burnt gas out through the exhaust pipe, leaving the cylinder empty and ready for the beginning of a new cycle.

It will be noticed from the above that only one stroke out of the four is a working stroke in any one cylinder, but as the motor has six cylinders, the crank shaft actually receives three impulses every revolution.

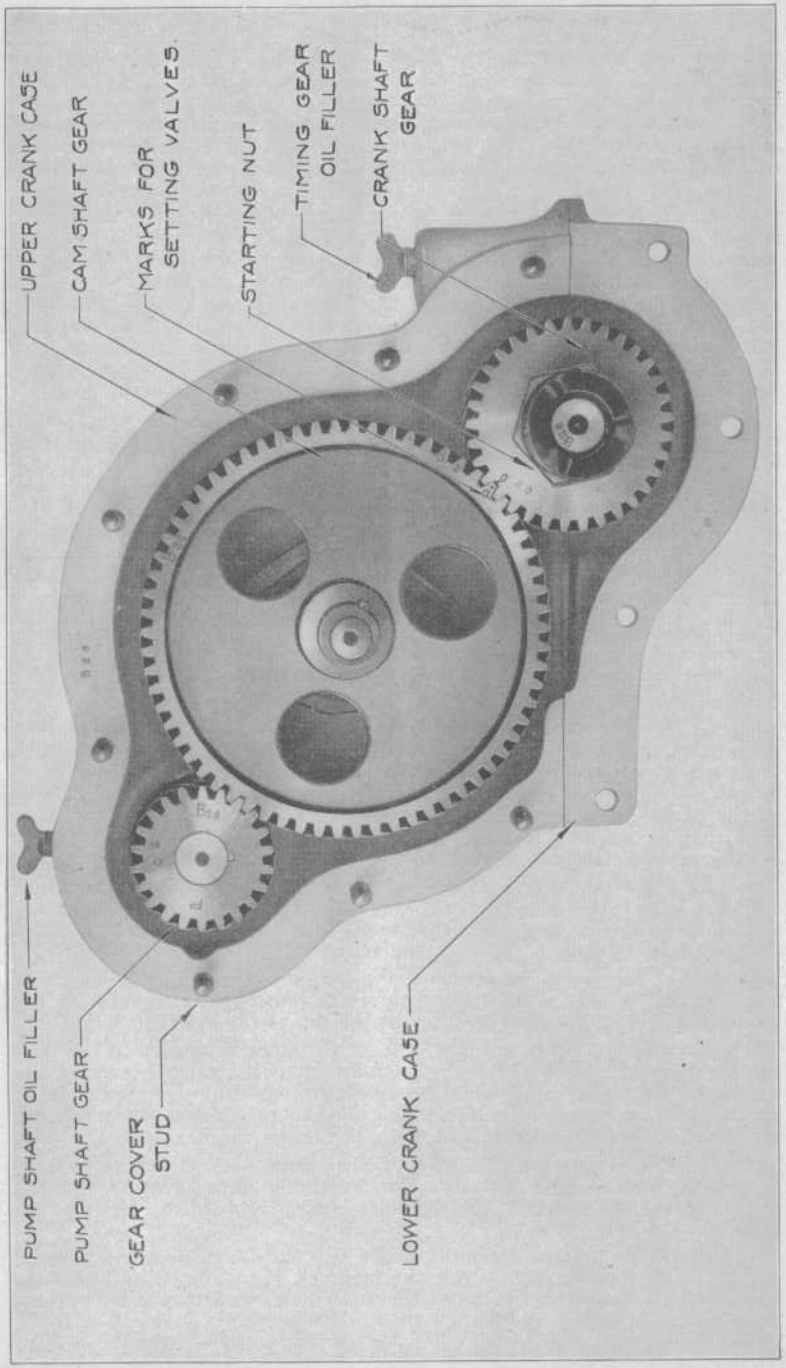


Plate 9
Timing Gears Showing Marks for Setting Valves.

TIMING THE VALVES

The points in the cycle at which the valves are opened and closed are determined by the shape of the cams and the angular relation between the cam shaft and crankshaft, and if should ever become necessary to remove one of these shafts or the gears which drive them, care must be taken to replace them in the proper relation to one another, or the valves will be "out of time." To obtain this relation see that the tooth on the cam shaft gear marked with a prick punch, matches with the correspondingly marked space on the crank shaft gear. This insures the proper angular relation of the two shafts.

ADJUSTING PUSH RODS.

With the cam shaft and crank shaft gears properly matched, the final setting of the valves may be accomplished by adjusting the length of the push rods with the threaded ball ends and lock nuts. Turn the motor by hand (in a clockwise direction, looking at it from in front), until the line marked "1 & 6," on the fly wheel, comes opposite the line on the rim of the inspection hole. This is the firing position for cylinders Nos. 1 & 6, numbering from the radiator back, and one or the other of these cylinders will be found to have both valves closed, so that both rocker arms will have a slight amount of play. The push rods should then be adjusted so as to have .005 inch clearance between the end of the valve stem and the rocker arm. This is approximately the thickness of a sheet of heavy paper or very light card, and is sufficient to allow for the expansion of the push rod when the motor gets warm. Push rods for the other cylinders may be adjusted in the same manner.

Do not turn the motor backwards in setting the lines on the fly wheel under the mark as there is a certain amount of backlash in the timing gears which is bound to affect the accuracy of the results.

TIMING THE IGNITION

When either the cam shaft or pump shaft has been removed, it will also be necessary to retime the ignition. This can be done by removing the Delco distributor head, and lifting the rotor, which carries the distributor brush off of the shaft. This will expose the breaker mechanism. Now turn the motor over clockwise, as before, until the "1 & 6" line on the fly wheel comes into view and then continue the turning slightly farther until the line marked "7°" registers with the indicator mark. This is the proper position of the crank shaft for setting the ignition point.

Retard the spark lever on the steering wheel to its topmost position, then loosen the screw in the end of the distributor shaft. The breaker cam may now be turned on the shaft. Set it first with the broadest flat side facing the clip which holds the distributor head in place, then move it very slightly, one way or the other, until the lobe of the cam nearest the breaker is just commencing to separate the contact points. Tighten screw and fix cam in this position. Return rotor and distributor head and note that distributor brush is now in contact with distributor terminal No. 1.

This is the firing position for cylinder No. 1 and the other cylinders should fire in proper sequence. The firing order is 1-4-2-6-3-5.

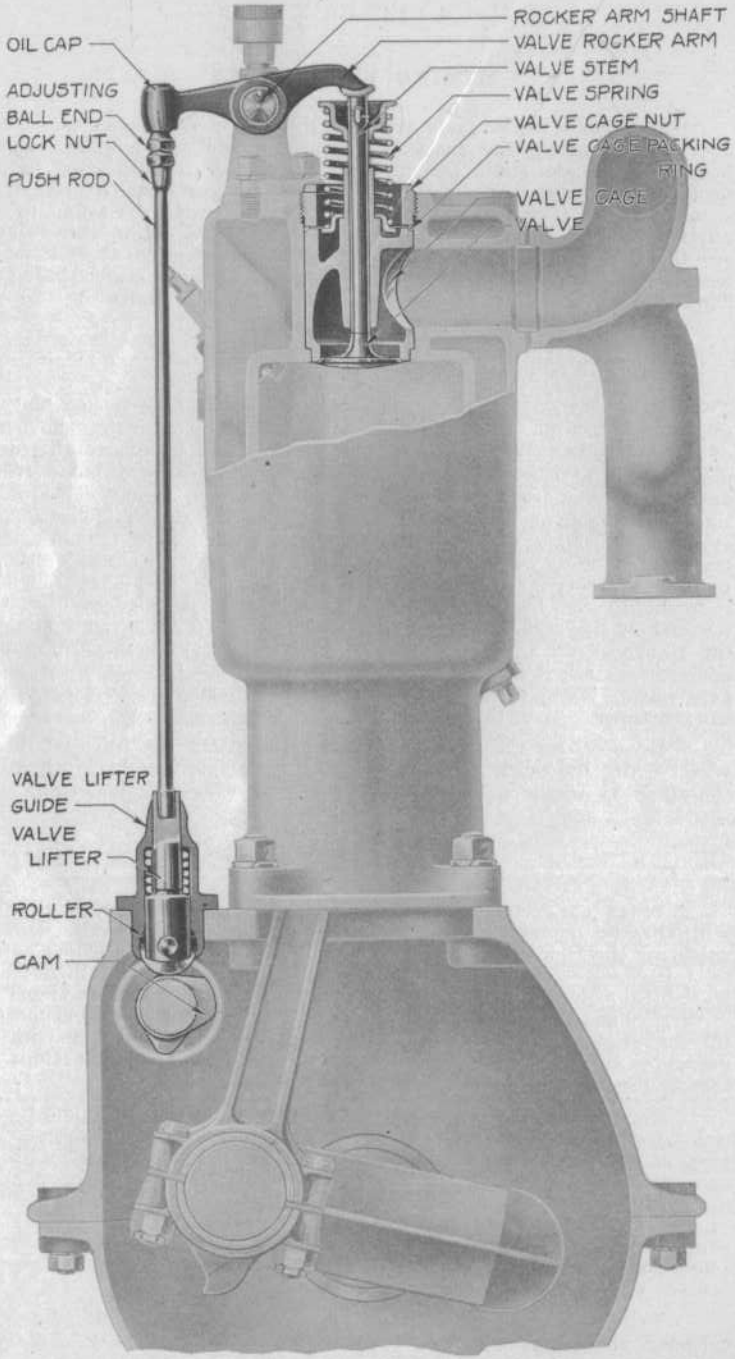


Plate 10
Buick Valve Mechanism

GRINDING VALVES

To keep the motor up to its maximum efficiency, the valves should be ground about once every thousand miles. With the Buick motor, this is a very simple operation.

Remove cotters and washers from ends of rocker arm shafts and by compressing the valve spring, lift rocker arm off of push rod. With the special spanner, which will be found in the tool kit, unscrew the notched ring, or valve cage nut, which holds valve cage in the cylinder head. A light tap with a hammer on the end of the valve stem will then loosen cage so it may be withdrawn. Be careful not to injure the small bronze packing ring on top. Remove valve spring and after cleaning with gasoline or kerosene, smear the valve and its seat with fine emery flour and oil, or with one of the valve grinding pastes now on the market. Grind, by turning valve back and forth on its seat, until both valve and seat show a bright ring $\frac{1}{32}$ inch wide all the way around. Be careful to clean out all traces of abrasive material before replacing valve.

After grinding valves, it will usually be found necessary to readjust the push rods to compensate for the wear.

REMOVING CARBON

Too much lubricating oil or too rich a mixture will form carbon in the cylinder. An excessive deposit of carbon sometimes becomes incandescent and ignites the charge before the piston has finished its compression stroke, resulting in a knock in the motor. The carbon may be burnt out with an oxy-acetylene torch, or it can be scraped off with a bent scraper through the valve cage holes. Care should be taken to see that none of the carbon dust gets into the valves or cages.

The formation of carbon in the cylinder can be prevented to a considerable extent by introducing two or three spoonfuls of kerosene through the spark plug holes, and allowing it to stand in the motor overnight. Too much kerosene is likely to thin out the lubricating oil and may cause a piston to sieze.

ADJUSTING BEARINGS

A sharp metallic knock in the motor, audible every revolution of the crankshaft, may mean that one of the bearings is loose. If removing carbon does not stop the noise, drain oil out of crank case and drop lower half. Turn crankshaft over until crank to be inspected is in a horizontal position, then while some one oscillates the fly wheel back and forth, hold the hand on each bearing in turn, until the loose one is located. To tighten, remove cap and take a single thin leaf of the laminated metal from one shim. Note that journal is bright and free from scratches and shows no other indications of a lack of lubrication. Replace cap as tightly as possible with an ordinary wrench. If the knock is still apparent remove a leaf of metal from the other shim. Never take off more than one leaf at a time.

INSERTING PISTON RINGS

If it should become necessary to replace a piston ring, it can be most easily done by removing piston, and inserting three or four strips of thin metal under the rings and across the grooves. The rings may then be slipped off or on without dropping into each groove as they pass.

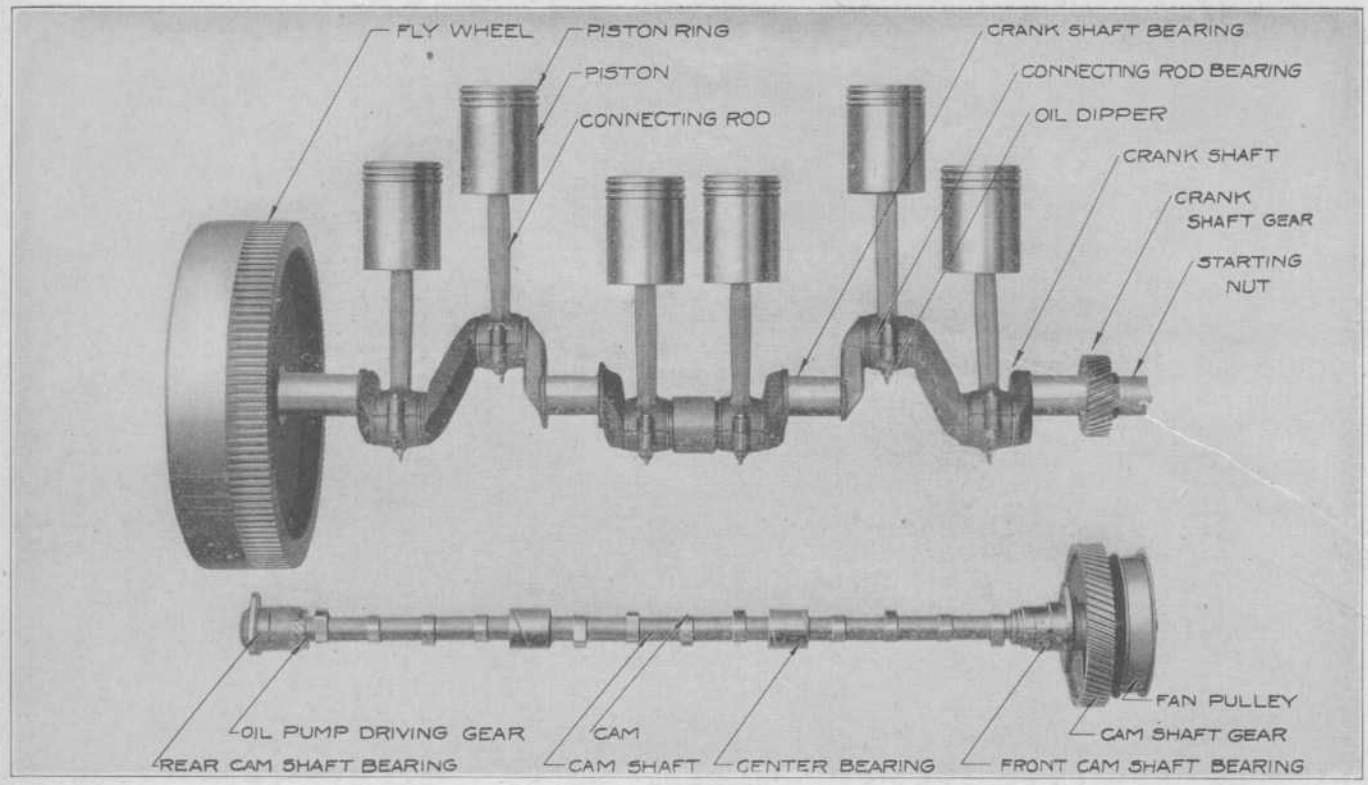


Plate 11
Crank Shaft and Cam Shaft.

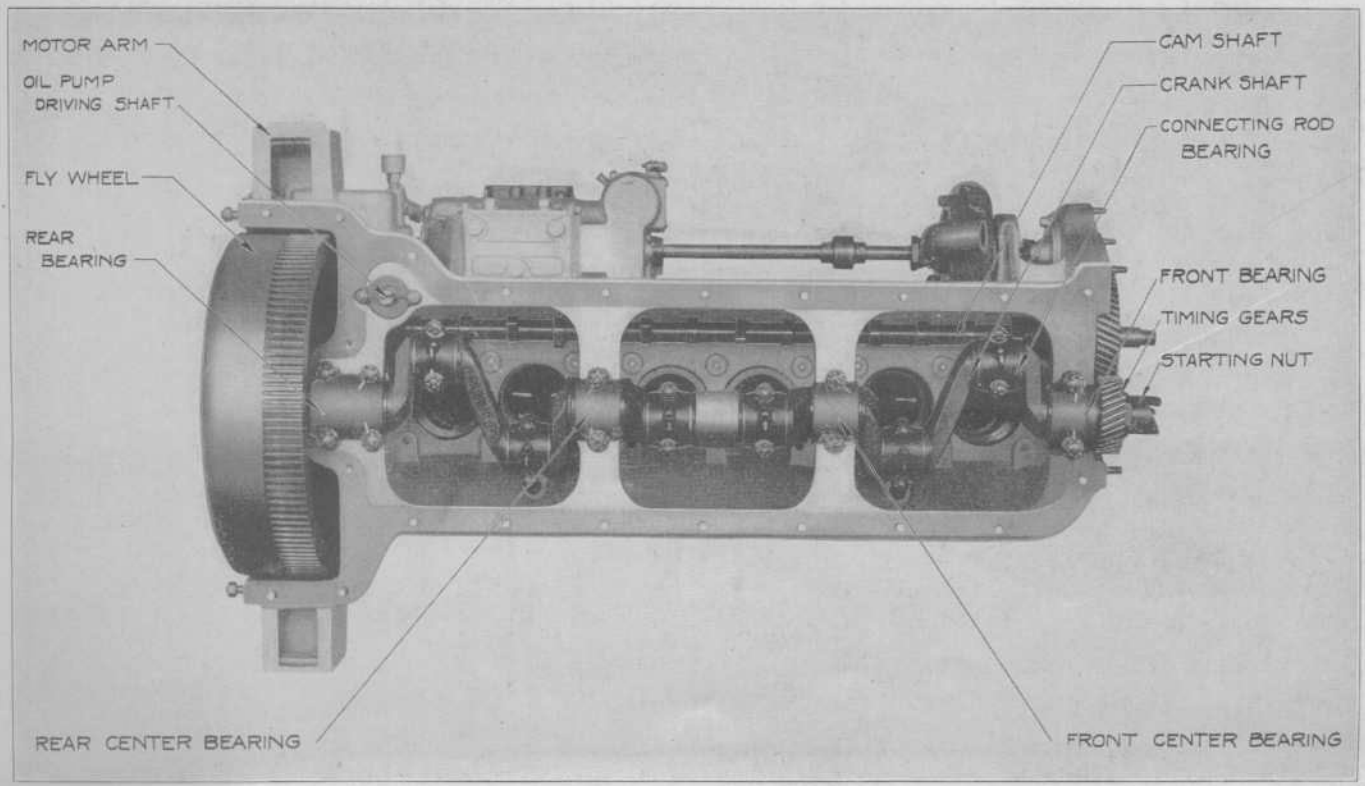


Plate 12
Bottom View of Crank Case Showing Bearings

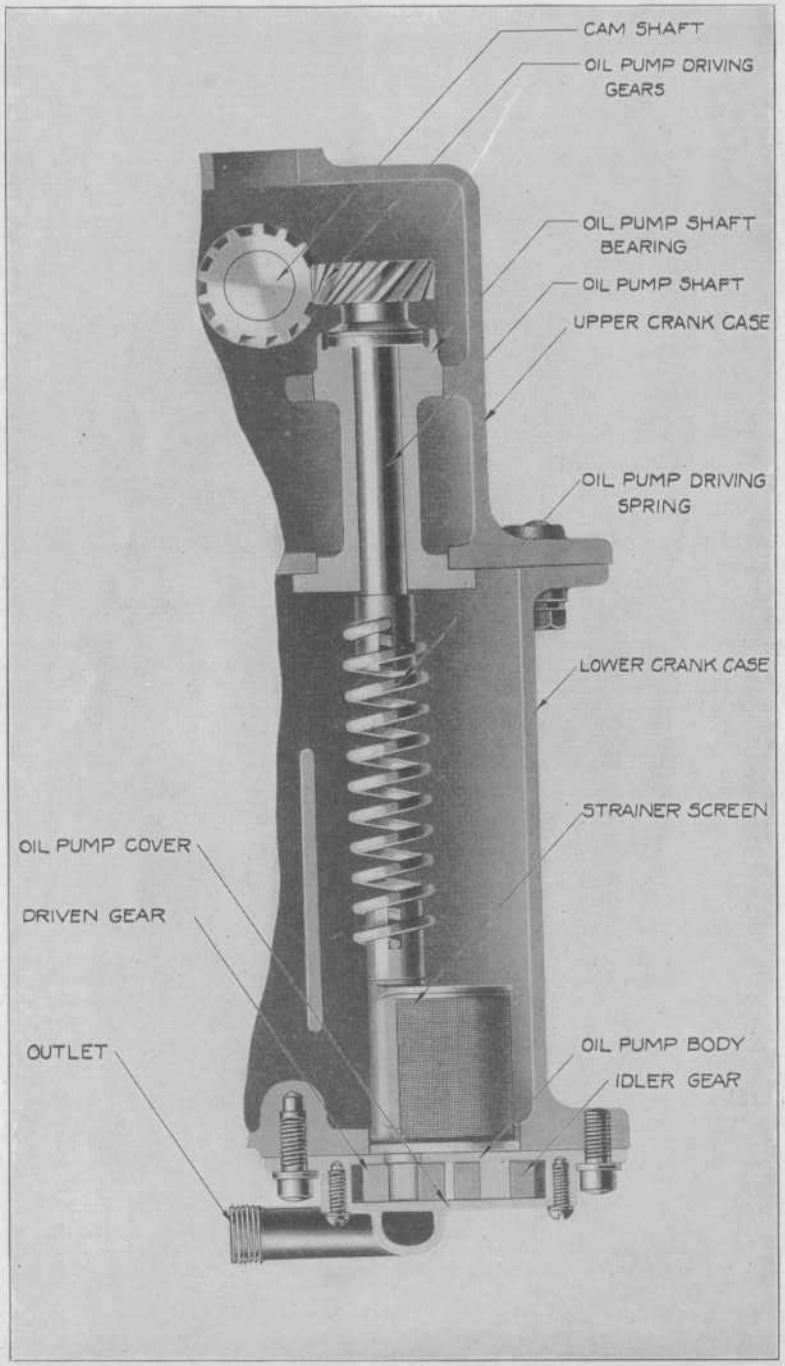


Plate 13
Oil pump and shaft

ASSEMBLING PISTONS

In assembling pistons and connecting rods, it should be noticed that the piston pin bearings are offset from the center line of the piston, and that a small arrow, cast inside the piston skirt points toward the offset. Pistons should be assembled on the connecting rods with the arrows pointing toward the flat side of the oil dipper. This brings the piston pin bearing closer to the cam shaft side of the motor and during the compression stroke the gas pressure overbalances the piston so that it does not slap back under the force of the explosion.

KEEP THE MOTOR CLEAN.

Nothing will add more to the appearance of the car when the hood is raised, than a clean motor. Clean with a soft cloth or piece of cotton waste moistened with gasoline. A stiff brush will be found useful in the sharp corners. Never squirt or spray gasoline over the motor to clean it, as this method removes all the lubricating oil as well as the dirt.

MOTOR LUBRICATING SYSTEM

The motor is provided with an automatic lubricating system which operates, as follows:

Oil from the reservoir in the lower half of the crank case is sucked through a strainer into the pump housed at the rear end of the reservoir. The oil pump forces it through a pipe to the sight feed on the cowl board, where the circulation can be observed by the driver. From the sight feed the oil returns through the distributor pipe to the splash trays or troughs, cast in the lower half of the crank case, into which the connecting rod oil scoops dip.

As the connecting rod dippers pass through the oil in the splash trays, they force some of it up into the connecting rod bearings and splash the remainder over the interior of the crank case and up into the pistons and cylinders. As it drains back, it is caught in ducts and led to all the bearings of the motor, the excess falling back into the reservoir to be used over again.

OIL CIRCULATING PUMP

The oil circulating pump consists of two small gears enclosed in a close fitting housing and driven by a vertical shaft and spiral gears from the cam shaft. As the gears turn, they take the oil into the spaces between their teeth and carry it around to the outlet, where the action of the teeth meshing together squeezes the oil out of the spaces and forces it to flow to the sight feed on the dash.

Operation of the oil pump is entirely automatic, and it requires no attention or adjustment, except the addition of fresh oil to the crank case reservoir as often as necessary to keep the level up to the petcock.

SIGHT FEED.

Note that the sight feed merely indicates circulation of the oil. It does not show when the supply in the crank case reservoir is running low. Test the oil level in the crank case by opening the petcock at frequent intervals and keep the oil up to the level of the petcock.

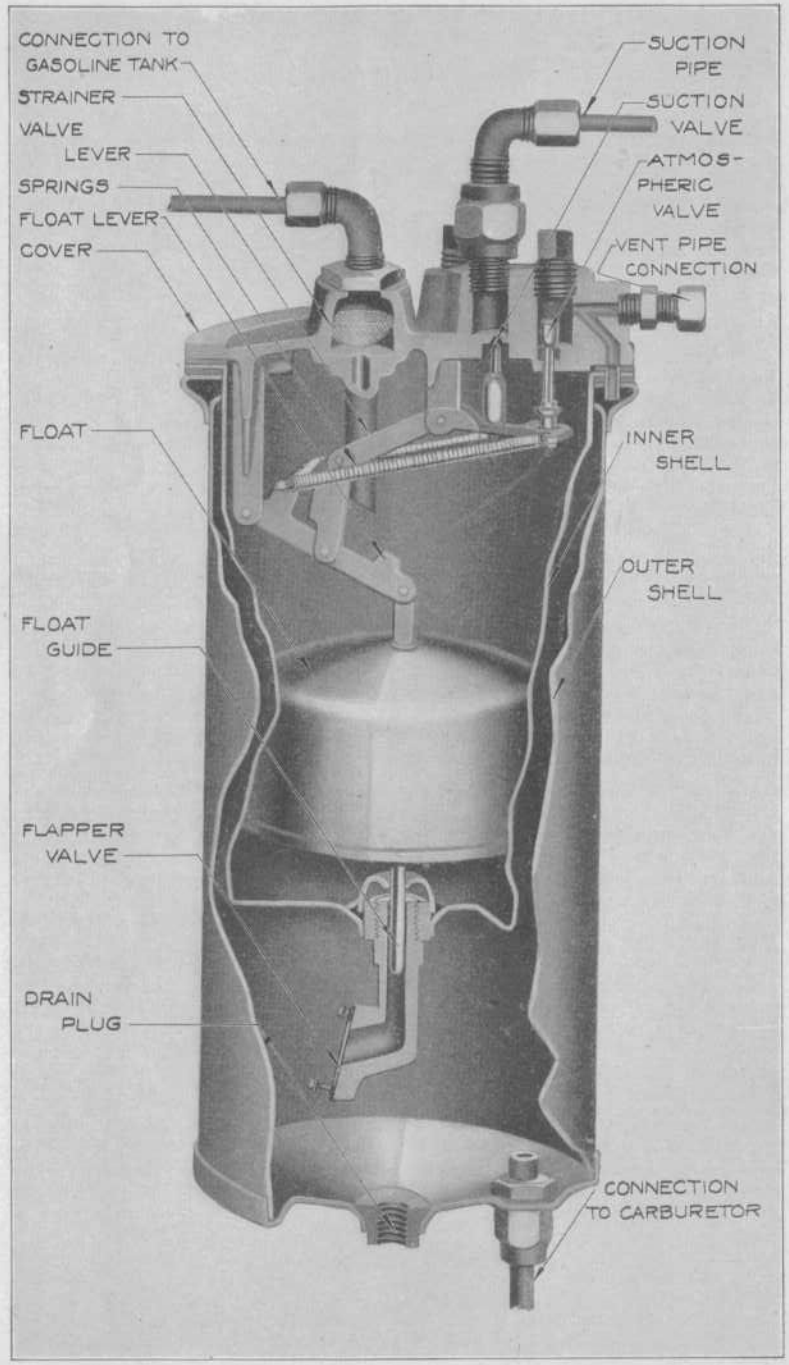


Plate 14
Section Through Vacuum Tank Showing Internal Construction.

FUEL SYSTEM

The fuel system consists of the gasoline tank, piping, vacuum tank, carburetor, and the intake manifold. There is nothing connected with the tank or piping to get out of order, the chief consideration being to carefully strain all gasoline put into the tank, and to avoid leaks which are sometimes caused by the road vibration. A leak may be temporarily repaired with chewing gum and adhesive tape. Smear the plastic gum over the leak and bind in place with tape.

VACUUM TANK

The vacuum tank draws the fuel from the gasoline tank at the rear, and delivers it to the carburetor at a constant head, as it is needed. The vacuum tank consists of two steel shells, the inner one of which contains the float and valve mechanism, attached to the cover. The inner shell is connected to the gasoline tank, the intake manifold, and to the atmosphere by a vent tube on the dash. The outer and larger shell, connects only to the carburetor and the atmosphere. The two tanks are connected with each other by a flapper check valve in the bottom of the inner shell. (See Plate).

In operation, when the float is down, the suction valve is open and the atmospheric valve closed. Suction of the motor is now communicated to the inner shell, creating a partial vacuum and drawing gasoline into the tank from the main fuel tank at the rear of the car. As the tank fills the float rises, until, at a certain point, the springs act and close the suction valve, at the same time opening the atmospheric valve. The gasoline drawn into the inner shell now flows down into the outer shell through the flapper valve, and from there to the carburetor as fast as it is needed. When the inner tank is empty and the float down, the position of the valves is reversed, and the inner tank commences to fill again.

The action of the tank is entirely automatic. There are no adjustments and there is no reason why it should ever be opened, but if the tank should show a tendency to continue to fill to a point that causes the suction line to draw gasoline into the intake manifold, it is likely due to a leaky float, for if the float leaks it will fill with gasoline, making it too heavy to act and leaving the suction valve open constantly. The weight of the float should be just sufficient to draw the operating lever, to which the springs are attached, past the center point. If not, stretching the springs slightly when they are too tight, or cutting a small piece of the end off when they are too loose, will remedy the difficulty.

Sometimes dirt or sediment lodging under the flapper valve will prevent the tank filling, and before making any change in the springs, it is well to see that all joints and valves are working freely.

To fill the tank, should it ever become entirely empty, **close the throttle,** and allow the engine to turn over a few times with the electric starter. If it still refuses to fill, it may be primed with a pint or so of gasoline through the filler plug on top.

CARBURETOR.

Buick cars are equipt with the Marvel carburetor, Model E, which consists essentially of a float chamber, in which the liquid gasoline is measured out as it is used, and a mixing chamber, in which it is

vaporized and mixed with the air to form the explosive gas which is ignited in the cylinders.

The float chamber is connected, through a strainer, with the gasoline supply from the vacuum tank, and by another passage with the spray nozzles located in the mixing chamber. It contains a cork float attached to a float valve in such a manner that when the liquid fuel has risen to a certain height in the spray nozzles and float chamber, the valve closes, preventing the entrance of any more fuel until the level falls again. By means of a tickler or flusher in the cover of the float chamber, the float may be artificially depressed to flood the carburetor when necessary for testing the connections.

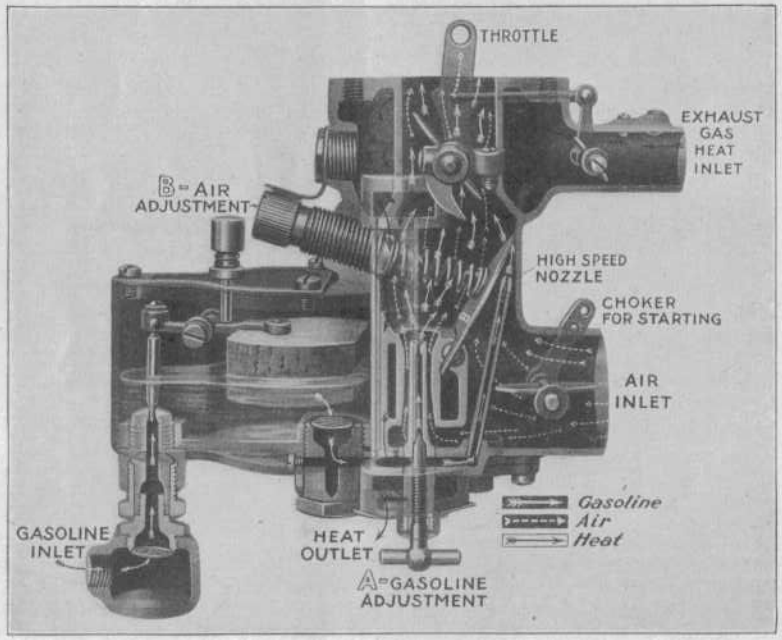


Plate 15
Section Through Carburetor

The mixing chamber contains the spray nozzles in which the liquid gasoline stands at a constant level, the venturi tube or atomizer, which surrounds the low speed spray nozzle, and an automatic air valve which controls the amount of air admitted with the measured quantity of gasoline. The throttle valve is located in the upper portion of the mixing chamber, which is also surrounded by a jacket through which hot exhaust gas from the motor is circulated to warm the mixture on its way to the cylinders. The air inlet is located near the bottom of the mixing chamber and is connected by means of a large flexible tube to the hot air muff around the exhaust pipe. A needle valve or gasoline adjustment "A," is inserted in the bottom of the low speed spray nozzle

to regulate the flow of gasoline and an air adjusting screw "B" regulates the tension on the spring which holds the air valve to its seat.

OPERATION.

In operation, gasoline enters through the strainer and float chamber, passes the needle valve "A," and stands at a predetermined level in the spray nozzles. Warm air, taken through the muff from around the exhaust pipe enters through the air intake and divides into two streams. Part of it passes through the venturi tube and picks up some of the liquid gasoline standing in the low speed spray nozzle, while the remainder opens the air valve and takes up a smaller quantity of fuel from the high speed nozzle. As the suction of the motor increases at the higher speeds, the air valve opens wider and a greater proportion of the air is admitted past the high speed nozzle, the air valve thus automatically controlling the quality of the mixture.

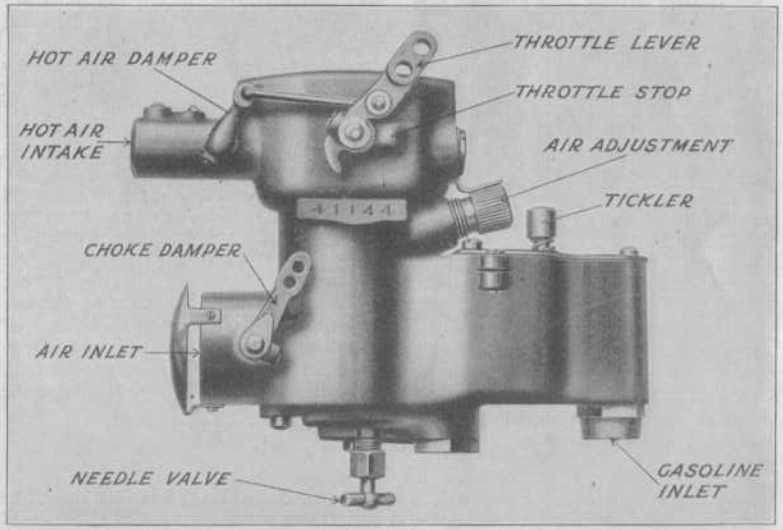


Plate 16
Throttle Side of Carburetor

ADJUSTMENTS.

In adjusting the carburetor the object is always to obtain the most economical mixture possible, consistent with the required performance. The carburetor is carefully adjusted and set before the car leaves the factory, and in most cases the best thing the driver can do is to let it alone. However, it sometimes becomes necssary to disturb the setting and when this happens the instrument may be readjusted, as follows:

1. Turn gasoline adjustment "A" to the right until it is completely closed.
2. Turn air adjustment "B" until end of the adjusting screw is exactly even with the point of the ratchet set spring above it.
3. Open gasoline adjustment "A" by giving needle valve one full turn to the left.
4. Start the motor as usual; if necessary allowing it to run for a few minutes with the air regulator button on the cowl board pulled

part way out, until it is thoroughly warmed up, and air regulator can be pushed clear in.

5. With the spark retarded, turn gasoline adjustment "A," to the right, cutting down the amount of fuel until motor idles smoothly.

6. Advance the spark, and turn air adjustment "B" to the left a little at a time, until motor begins to slow down, indicating that air valve spring is too loose. Then turn it back to the right just enough to make the motor run well.

To test the adjustments, advance spark and open throttle quickly. The motor should accelerate instantly. If it misses or pops back, open gasoline adjustment "A" slightly by turning needle valve to the left. Do not touch air adjustment "B" again, unless it appears absolutely necessary. The best possible adjustment has been secured when gasoline adjustment "A" is turned as far as possible to the right, and air adjustment "B" is turned as far as possible to the left, provided the motor idles smoothly and accelerates quickly when throttle is opened.

If motor runs too fast or stops when throttle is closed, the position of the butterfly valve can be easily adjusted by turning the throttle stop screw in the boss on the side of the carburetor.

The damper in the exhaust jacket inlet is connected by a link with the throttle lever and should be so adjusted that the greatest amount of hot exhaust gas is allowed to pass through when throttle is nearly closed. The position of the damper is indicated by the slot in the end of its shaft and may be changed by loosening the set screw in the damper lever.

The temperature of the air entering the carburetor may be regulated by means of the shutter on the flexible tube which connects the air intake to the muff. For cool weather, this shutter should be closed by loosening the clamp screw and turning the shutter around until both openings are closed. In warm weather it may be opened by reversing this operation.

The air regulator on the cowl board is attached to the choker damper in the air inlet and when button is pulled out this damper partially closes the air passage, increasing the suction on the spray nozzle and giving a very rich mixture for starting the motor. In cold weather the motor can be operated with the air regulator button pulled part way out until thoroughly warmed up.

CARBURETOR TESTS.

Never tamper with the carburetor until it is certain that motor has good compression in each cylinder; that a good hot spark occurs at each spark plug at the proper time; and that gasoline is reaching the carburetor regularly from the vacuum tank. The carburetor should be the last thing to touch.

If trouble is finally traced to the carburetor, determine its nature by the following tests:

1. Depress the tickler on float bowl cover and note whether or not gasoline appears from air inlet. If not, look for dirty strainer, clogged connection, defective vacuum tank, leak in piping, or empty gasoline tank.

2. If carburetor floods or leaks gasoline when car is standing, look for a leak in the connections, or an obstruction under the float valve.

3. If a popping noise occurs in carburetor when throttle is suddenly opened with spark advanced, it indicates a weak mixture. Open gasoline adjustment slightly.

4. If motor runs sluggishly, with black smoke at the exhaust, it indicates an over rich mixture. Close gasoline adjustment slightly.

5. If motor misses when idling or lacks "ginger" at higher speeds, turn air adjustment slightly to the right.

MANIFOLDS

Both intake and exhaust manifolds are held on the left side of the motor by yokes. To remove intake manifold, loosen set screws. To remove exhaust manifolds, loosen yokes.

IGNITION SYSTEM

The charge of gas introduced into the cylinder by the fuel system is ignited by an electric spark which jumps across the gap between the points of the spark plug.

The spark plug consists of a steel shell, threaded to screw into the cylinder, containing a porcelain core with a wire moulded in its center. The wire ends in a terminal at its outer end and forms one of the points within the cylinder. The other point is set in the steel shell and is in contact with the cylinder. To secure the best results, the points of the spark plug should be about .025 inch apart.

The electric current, which is taken from the battery, is conducted first to the ignition coil which "steps it up." or increases its voltage, until it has enough energy to jump the gap at the plug, and is then sent through the distributor which times the point of ignition to the proper moment in the cycle.

The exact point in the cycle at which the spark occurs is governed by the automatic spark advance and the spark lever on the steering wheel. The spark lever need only be used for further retarding the spark on steep hills or extremely heavy roads.

For wiring diagrams, and a complete explanation of the ignition system, see Delco Instruction Book.

COOLING SYSTEM

Buick cars are water cooled by what is known as the pump circulating system. Its operation is as follows:

Cool water is drawn from the lower portion of the radiator by a centrifugal pump, located on the right side of the motor and driven by a gear meshing with the cam shaft gear. The pump forces this cool water through the water inlet pipe to the bottoms of the cylinder jackets, where it absorbs the excess heat of the explosions. As the water becomes heated, it rises to the top of the jackets and finally flows off through the water outlet pipe back to the top of the radiator. Here it commences its descent through the narrow passages in the radiator core and rapidly loses its heat to the atmosphere, until it reaches the bottom, where it is drawn off and begins its circuit afresh.

WATER CIRCULATING PUMP

The water pump is of the centrifugal type and consists of an impellor with curved blades, keyed to the shaft, and a loose fitting, air tight casing, with inlet and outlet connections, fastened to the motor crank case. As the impellor revolves, it sucks water from the radiator to the center of the impellor and by centrifugal force, throws it off at the outer ends of the blades and out of the casing to the cylinder jackets.

In order to keep the casing air tight the pump shaft is carried in glands, filled with prepared wick packing which also acts as a lubricant. These glands should be tightened from time to time as they show indications of leakage, but care must be taken to keep them from

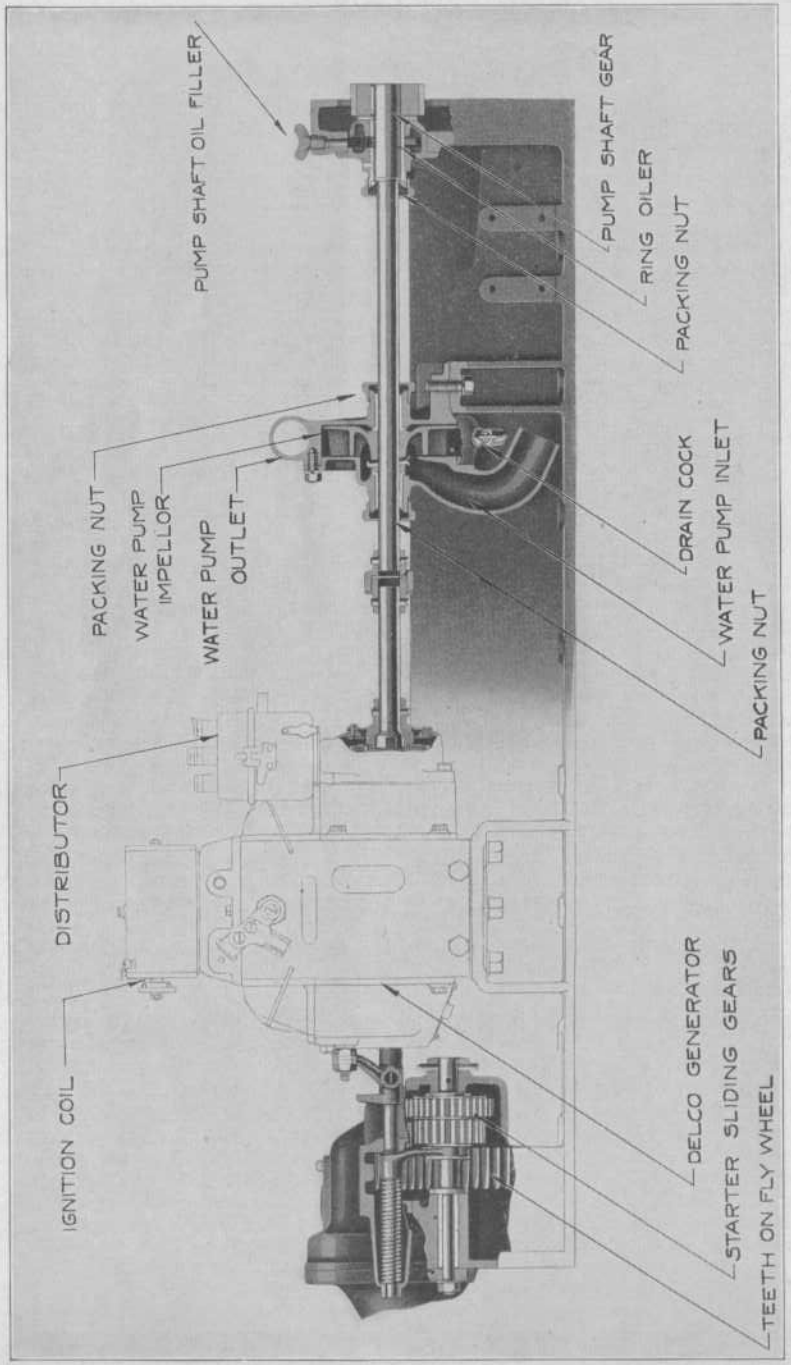


Plate 17
Section Through Water Pump and Starter Sliding Gears.

binding the shaft. When the packing wears out, it is an easy matter to remove the nuts and renew it.

RADIATOR FAN.

In order to keep a strong draft of air blowing through the radiator even when the car is standing still, a fan is mounted on a bracket attached to the timing gear case of the motor and driven by a flat leather belt from a pulley on the cam shaft. The fan itself consists of a six bladed sheet metal propeller running on a spindle. The grease cup which lubricates this spindle should receive frequent attention and should be filled with hard cup grease. The fan belt may be tightened, when it becomes loose by loosening the clamp bolt and swinging the bracket up.

RADIATOR

The radiator consists of a core of thin sheet metal cells, attached at top and bottom to tanks and enclosed in an enameled steel case. The upper tank is provided with a filler and an overflow pipe. The case is bolted to the frame.

As long as the radiator is kept filled with clean water, it will require no attention, except an occasional cleaning. A saturated solution of common soda in clean warm water may be used to clean it. Fill radiator with soda solution and allow motor to run long enough to get it thoroughly warmed up and circulated through the entire system, then drain and rinse out with clean water before filling again.

In cold weather the radiator should be filled with an anti-freezing solution to prevent damage by freezing. A solution composed of 4 parts alcohol and 6 parts water, will prevent freezing at a temperature of 20 degrees below zero. Four ounces of glycerine should be added to the solution to retard evaporation. The alcohol will evaporate much faster than the water, however, and more will have to be added from time to time, to keep the solution up to strength. In warmer climates a weaker solution should be used to prevent boiling.

EXHAUST SYSTEM

The exhaust system begins with the exhaust manifold on the left side of the motor and includes the exhaust pipe, cut-out valve, and muffler.

The muffler is composed of three concentric sheet metal drums clamped between the heads and fastened to the frame of the car by brackets. The two inner drums have holes punched in them at opposite ends in such a manner the hot gases are forced to travel the full length of each drum in turn, before reaching the atmosphere, thus losing their velocity and reducing the noise.

The cut-out valve is simply a large poppet valve in the front muffler head which may be opened by the foot pedal in the driving compartment. When it is open it allows the exhaust gas to escape directly into the atmosphere without passing through the muffler. This valve is provided principally to test the firing of the motor and it should not be used as a warning signal or for amusement. Its use will not increase the power of the motor.

No part of the exhaust system requires any particular attention on the part of the driver. If after long use, the muffler should become filled with soot, it can easily be cleaned by removing the rear head, which is held by a single bolt in the center.

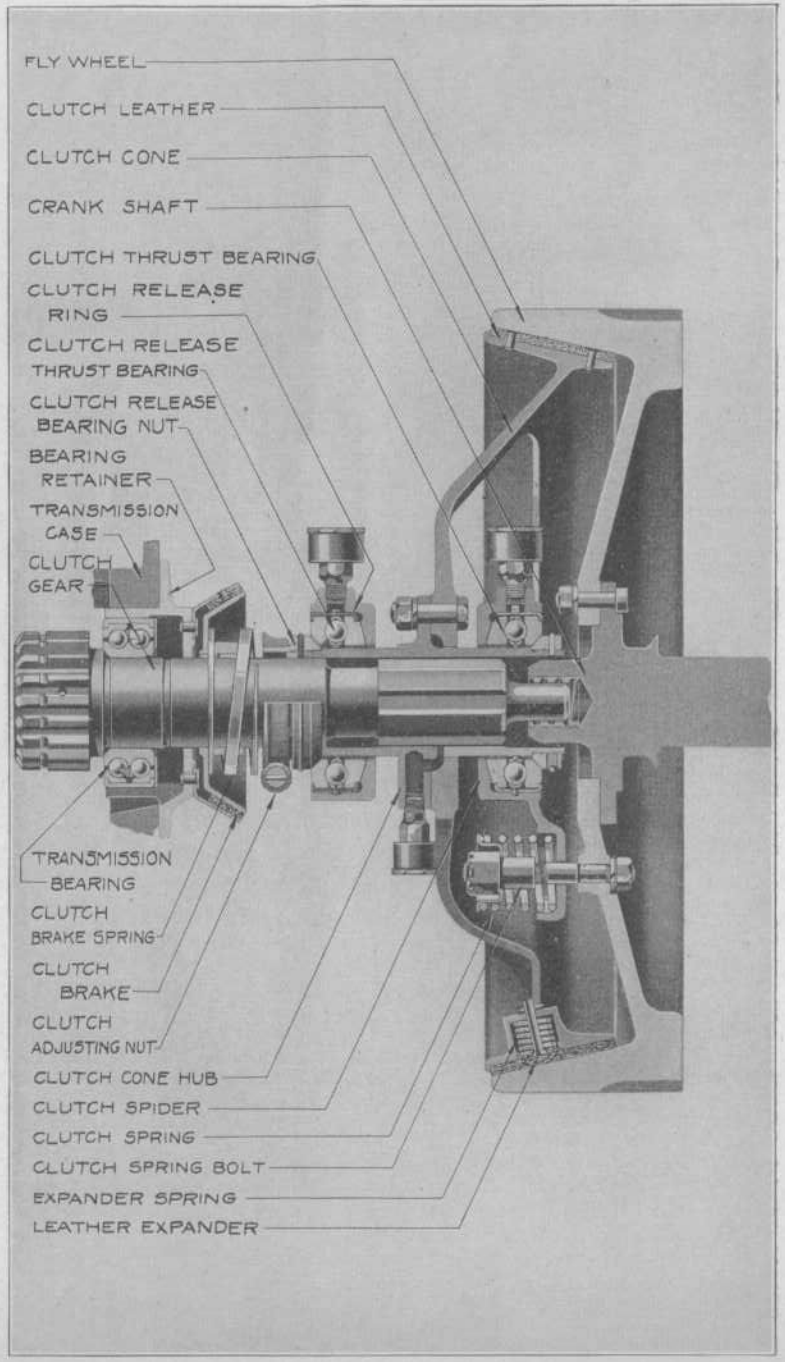


Plate 18
Section Through Clutch Showing Internal Construction

STARTING SYSTEM

The electric starting system is very closely related to the ignition system and many of the parts are common to both. It consists essentially of the storage battery, motor-generator, starting pedal, switches, etc. In operation, pulling out the ignition switch button closes the circuit and "motors" the generator, or in other words sends enough current through the generator windings to cause the armature to turn over slowly so the gears may be easily meshed together. Pressing the starting pedal then brings the starter sliding gears into mesh with the teeth on the fly wheel and at the same time closes the motor circuit. The generator is then operated as an electric motor to spin the gasoline engine.

For wiring diagrams and full explanation of the starting system, see Delco Instruction Book.

STORAGE BATTERY.

The storage battery receives the excess current from the generator when the motor is running and stores it up for use in cranking. The battery is carried in a bracket on the right side of the frame, and consists of three cells, or rubber jars, of plates in a solution of sulphuric acid and water. As the battery receives the charge of current the lead sulphate paste with which the plates are coated is converted into metallic lead and the sulphuric acid released is taken into the solution, increasing its specific gravity, and as the current is discharged, this action is reversed. The state of charge may therefore be determined by a hydrometer reading of the density of solution or "electrolyte." When fully charged, the battery solution should read 1.275 to 1.300 on the hydrometer. If battery solution gets below 1.150, the battery should be recharged immediately.

The level of the solution in each cell must be kept up to the filling tubes at all times, and evaporation must be replaced by the addition of distilled water at frequent intervals. Do not add acid.

For complete instructions in regard to care of storage battery, see Delco instruction book.

CLUTCH

Because the gasoline motor cannot start under load it becomes necessary to provide some means of applying the load after the motor has started and reached its normal speed. In the automobile this is accomplished by the clutch.

The clutch, therefore, is simply a device for connecting the motor with the driving mechanism of the car at the will of the operator. In Buick cars it consists of a leather faced aluminum cone which is held tightly against the inside of the tapered rim of the motor fly wheel by four springs carried on a spider (See Plate). The aluminum cone is mounted on a steel sleeve which can slide back and forth on the clutch gear shaft to engage the cone with the fly wheel. A trunnion ring and fork on the rear end of the sleeve, connects the clutch to the clutch pedal, and a small brake, attached to the transmission case, serves to keep the clutch from spinning after it is released. Four small spring plungers located under the leather, force it out at these points and prevent "grabbing," when the clutch is engaged.

In operation, pressure on the clutch pedal is transmitted by the connecting link and clutch release shaft to the yoke operating on the ball bearing release ring, which pulls the clutch back out of engage-

ment with the fly wheel. The small brake now holds the clutch stationary, while the clutch spider and springs continue to turn with the fly wheel until the clutch is again engaged. When in full engagement, the clutch and fly wheel turn as a unit, transmitting the power to the gearset and so on to the road wheels.

When the motor is picking up its load the clutch will always slip a little before taking hold, but under other circumstances slipping should be avoided. Frequent slipping tends to burn or harden the leather facing. To keep the facing soft and pliable, paint with Neat's Foot Oil occasionally.

Do not allow oil or grease from the grease cups to get on the clutch leather or inside of the fly wheel, or the clutch will slip.

If clutch shows signs of slipping, wash leather and fly wheel thoroughly with gasoline and apply a little Fullers' earth, ground very fine. Constant slipping after a long period of service may indicate a worn leather, in which case the wear can be taken up by increasing the tension on the four large springs. In doing this, be careful to turn each nut the same amount. When the lining of the clutch brake becomes worn, or the clutch spins too long after being disengaged and makes gear shifting difficult, adjust by loosening clamp bolt and turning adjusting nut to the left. This will cause it to compress the brake spring a little soooner and consequently stop the clutch more quickly.

TRANSMISSION SYSTEM.

Properly speaking, the transmission system of a motor car includes all those parts which transmit the power from the motor to the rear wheels, such as the clutch, the gearset, the universal joint, and the rear axle. Usually, however, the gearset alone is spoken of as the "transmission."

The gearset, or change speed gear, is made necessary by the fact that the power developed by the gasoline motor is almost directly proportional to the speed. In other words, if a given motor develops 10 horse power at 500 revolutions per minute, it will develop very nearly 20 horse power at 1000 revolutions. Hence, the higher the speed, the greater the power developed.

On the other hand, the car frequently requires the most power when it is moving slowest, as when pulling up a steep hill or through sand or mud. At such times the transmission gearset is utilized to change the ratio between the speed of the motor and the speed of the rear wheels.

Buick cars are provided with a selective, sliding gearset, mounted as a unit with the motor. It consists essentially of two shafts, mounted one above the other in an oil tight casing. The upper shaft is divided into two parts, the forward portion mounting the clutch gear A (See Plate) and extending through to connect with the clutch, while the rear portion is squared and carries the sliding gears F and G. At its rear end, the squared shaft connects with the universal joint. The lower shaft carrics the four counter gears, B, C, D and E, all of which revolve together. At one side of the lower shaft is mounted the reverse idler gear H, which is constantly in mesh with gear E, on the lower shaft. The two sliding gears are provided with grooved collars into which the shifter forks fit, the forks being supported on shifter rods which slide in the transmission case cover, and which are operated by the control lever. The upper, or divided shaft, is mounted on ball bearings and the gears run in a bath of oil.

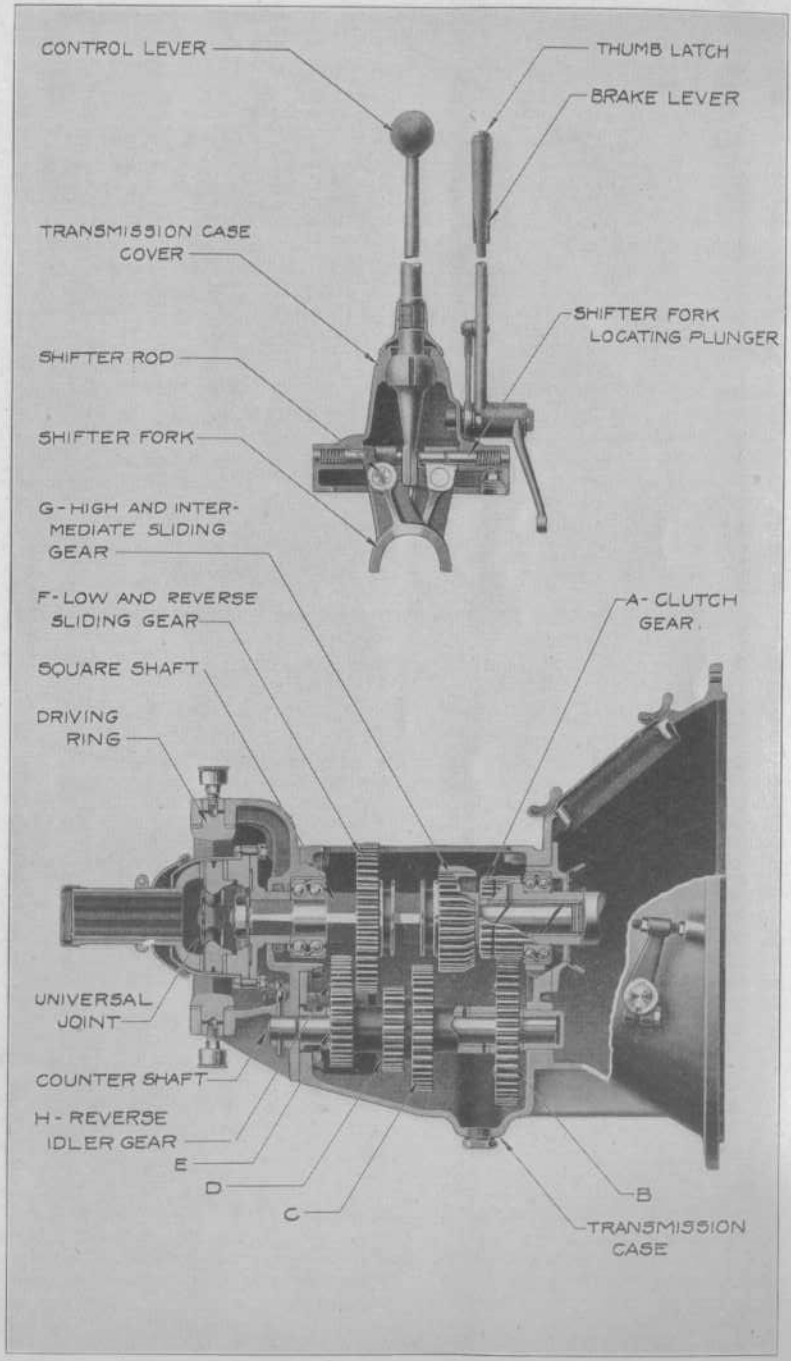


Plate 19
Section Through Transmission Gearset and Control Lever Showing Internal Construction.

NEUTRAL POSITION

In the neutral position, the gears stand as shown in the illustration and neither of the sliding gears F or G is in mesh with another gear. If the clutch is engaged with the fly wheel, gear A turns to the right with the motor, and at the same speed; and gear B, which is always in mesh with gear A turns to the left, counter gears C, B, and E turning with it. The sliding gears F and G remain stationary, as does the car.

FIRST SPEED POSITION.

To start the car it is necessary to shift the gears into the first speed position, the operation being as follows:

When the top of the control lever is moved to the right and back, its bottom end engages with the left shifter rod and moves it forward, the shifter fork carrying gear F with it to engage with gear D. The power of the motor is now transmitted through gears A, B, D, and F to the propellor shaft and rear axle, and gears A and F both turn to the right with the motor, though at different speeds, depending on the number of teeth in each gear. In this position the total gear ratios are such that the motor makes about 12½ revolutions for every revolution of the rear wheels.

INTERMEDIATE SPEED POSITION

When the control lever is shifted to the left and forward into the second or intermediate speed position, it engages the right shifter rod and moves gear G back into mesh with gear C. The power of the motor is now transmitted through gears A, B, C, and G, and the motor makes approximately 6 revolutions for every turn of the rear wheels.

HIGH SPEED POSITION.

Shifting the control lever to the left and back into the third or high speed position, moves gear G forward over gear A. Gear G has teeth cut on the inside of its rim which engage with the teeth on gear A and lock the two parts of the divided upper shaft solidly together. The power is now transmitted straight through the transmission without reduction, and the motor only revolves about 3¼ times for each turn of the rear wheels, which is the fixed gear reduction of the rear axle. The gears on the countershaft continue to revolve in the opposite direction but without doing any work.

REVERSE POSITION

To reverse the motion of the car, the control lever is moved to the right and forward, engaging with the left shifter rod and moving gear F back into mesh with the reverse idler gear H, which in turn meshes with gear E on the countershaft. The power is now transmitted through gears A, B, E, H, and F, respectively, and gear A revolves to the right with the motor, counter gears B and E to the left, reverse idler H to the right again, and sliding gear F to the left, which reverses the rotation of the propeller shaft and hence of the rear wheels.

The transmission gears are made of special alloy steel and have very short, strong teeth which are sharpened on the ends to make them slide into mesh with each other more readily, but the clutch must always be withdrawn before shifting, to prevent the rapidly moving edges of the teeth from grinding against each other as they go into mesh.

CONTROL LEVER.

Movement of the sliding gears is affected through the control lever, which is pivoted to the cover of the gear case by a ball joint. The shifter forks which are carried on two rods set side by side in the cover, are provided with slots into which the lower end of the control lever fits when shifting gears. In the neutral position the lever stands in a vertical position with its lower end out of engagement with either shifter fork. Small spring plungers set in the side of the cover register with notches in the shifter rods and latch the gears in the proper positions for the different speeds, preventing them from jumping out of mesh until the lever is moved.

EMERGENCY BRAKE LEVER.

An extension on the right side of the gear case cover carries the emergency brake lever and its ratchet sector. It is locked in position by a spring operated pawl which engages with the teeth of the sector and is released by pressing the button in the top of the handle.

UNIVERSAL JOINT

The transmission gearset is held solidly in the car frame, but the rear axle is hung on springs and must be free to follow the uneven surface of the road. In order to allow a steady and continuous transmission of the power from one of these parts to the other, the universal joint is interposed between them. In consists principally of a cross, the arms of which constitute four bearings. A yoke attached to the squared shaft of the gearset is connected to two of these bearings, while the splined sleeve which fits over the forward end of the propeller shaft is connected to the other two. The entire joint is enclosed in a sheet metal case and should be kept filled with soft cup grease, a plug being provided for that purpose.

REAR AXLE.

The rear axle assembly includes the driving yoke, propeller shaft, differential, axle shafts, brakes, and wheels, and constitutes the final element in the transmission system.

The propeller shaft connects with the splined sleeve of the universal joint at its forward end and carries the driving pinion at the rear. It is a heat treated alloy steel shaft, running in ball bearings, and is entirely enclosed in a heavy steel tube carrying the driving yoke at its forward end, and connecting with the driving ring on the rear end of the transmission case. This tube transmits the driving thrust of the rear wheels to the transmission case and so on to the frame of the car, and also absorbs the torque reaction of the bevel driving gears.

THE DIFFERENTIAL

The differential is the mechanism which allows one of the rear wheels to turn faster than the other, when the car is turning a corner and equalizes the amount of power applied to the wheels so that both will exert the same tractive effort in propelling the car. It consists essentially of a case, made in two halves, bolted together, and a spider or ring with four arms which are clamped between the two halves of the case (See Plate). A small bevel side pinion runs on each of the arms of the spider and meshes with an intermediate gear carried in each half of the case. The case is mounted on ball bearings and

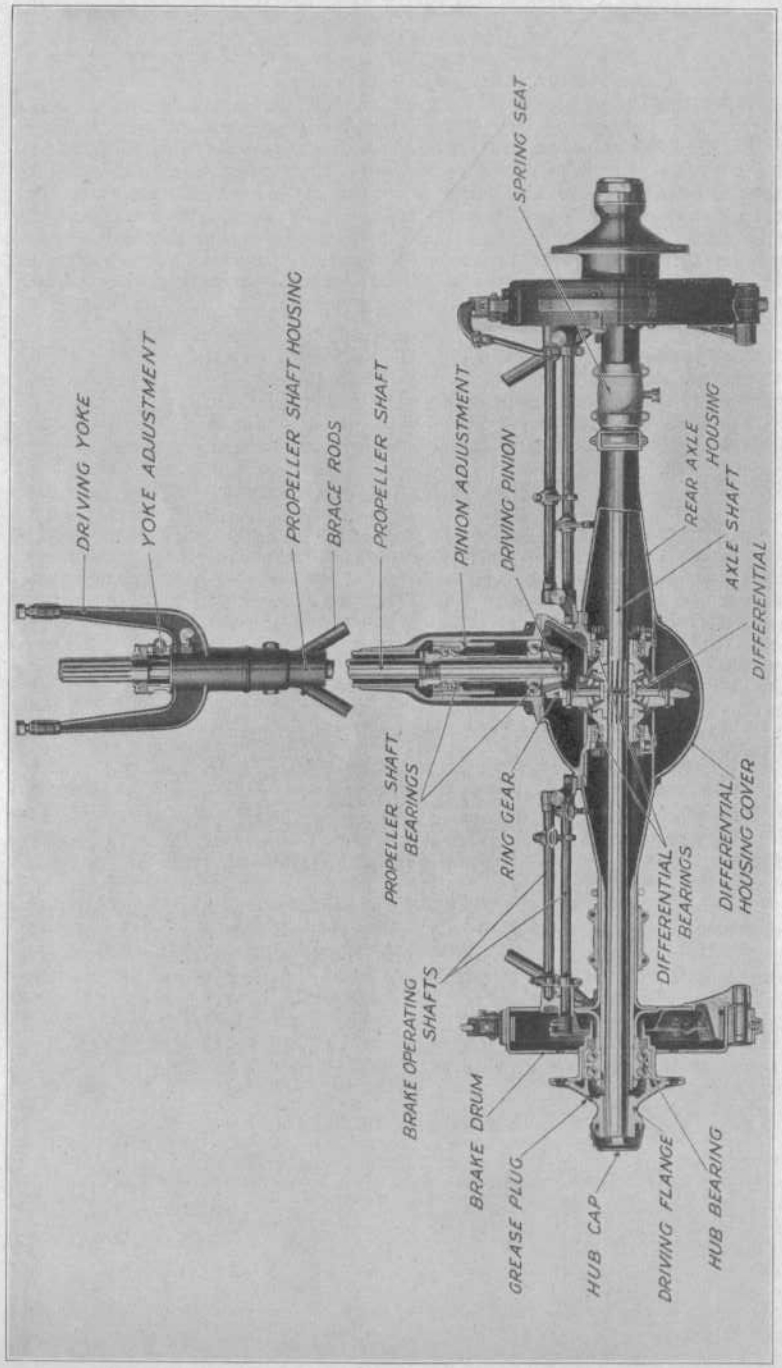


Plate 20
Section Through Rear Axle Showing Internal Construction.

carries the bevel driving ring on its outer circumference. The main shafts, or axle shafts, which drive the wheels, extend through the case and fit into the intermediate gears which are bored out and splined to receive them.

When the car is travelling straight ahead the power, applied through the propeller shaft, turns case, gears and axle shafts as a unit, all the gears within the case remaining stationary in relation to each other. But when the car turns a corner, the shaft and intermediate gear attached to the inside wheel begins to lag in relation to the case, setting the small side pinions in motion about their studs, and thus increasing the speed of the other intermediate gear and its shaft. Thus the driving gears and differential case continue to turn at the same speed while one intermediate gear within the case turns slower and one faster, the difference being equalized by the small side pinions.

This explains why, when both rear wheels are jacked up, turning one wheel by hand will cause the other to revolve in the opposite direction, and also why, when one wheel is held, with the engine driving the axle, the other wheel will double its speed in the same direction.

WHEEL HUBS

Driving flanges are keyed to the outer ends of the axle shafts and bolted to the wheel hubs, which run on double row ball bearings mounted on the outer ends of the tubes which form the axle housing, so that all the weight of the car is carried by the housing and the axle shafts transmit only the driving effort. For this reason the axle is known as the "full-floating" type. The hub bearings are lubricated with cup grease introduced through a plugged hole in each hub.

BRAKES.

Brake drums are fastened to the rear wheels and the brakes are mounted on flanges attached to the rear axle housing. The service, or external brake, consists of an asbestos lined band arranged to contract around the outer surface of the drum when the right pedal in the driving compartment is pressed. The emergency or internal brake consists of another asbestos faced band, arranged to expand against the internal circumference of the drum when the hand lever is set.

BRAKE ADJUSTMENT.

The internal or emergency brakes are seldom used and are subject to but little wear, therefore no adjustment is provided. The service or external brakes, however, are subject to constant use, and should be adjusted, as the lining wears, to give smooth and even action on both wheels.

In adjusting service brakes, the most important point to observe is that of clearance. Note that lining of brake is round and true and that there is a uniform clearance of not less than 3/64 of an inch at all points between lining and drum. If clearance exceeds this amount very much, the brakes will not hold, and if it is less, they will drag on the drum and run hot. The clearance may be adjusted by first loosening turnbuckles on brake pull rods, to allow brakes to assume their natural positions. Then, by turning the set screw in the outer brake lever, which is attached by the link to the operating lever on the brake band, adjust lever connected to pull rod, so that it stands at an angle of about 30 degrees from the vertical, leaning back toward the axle. By means of the lock nut, fix set screw in this position.

Next, adjust clearance of band by means of the wing nut, for upper half, and the adjusting nut for lower half, until a uniform space of 3/64

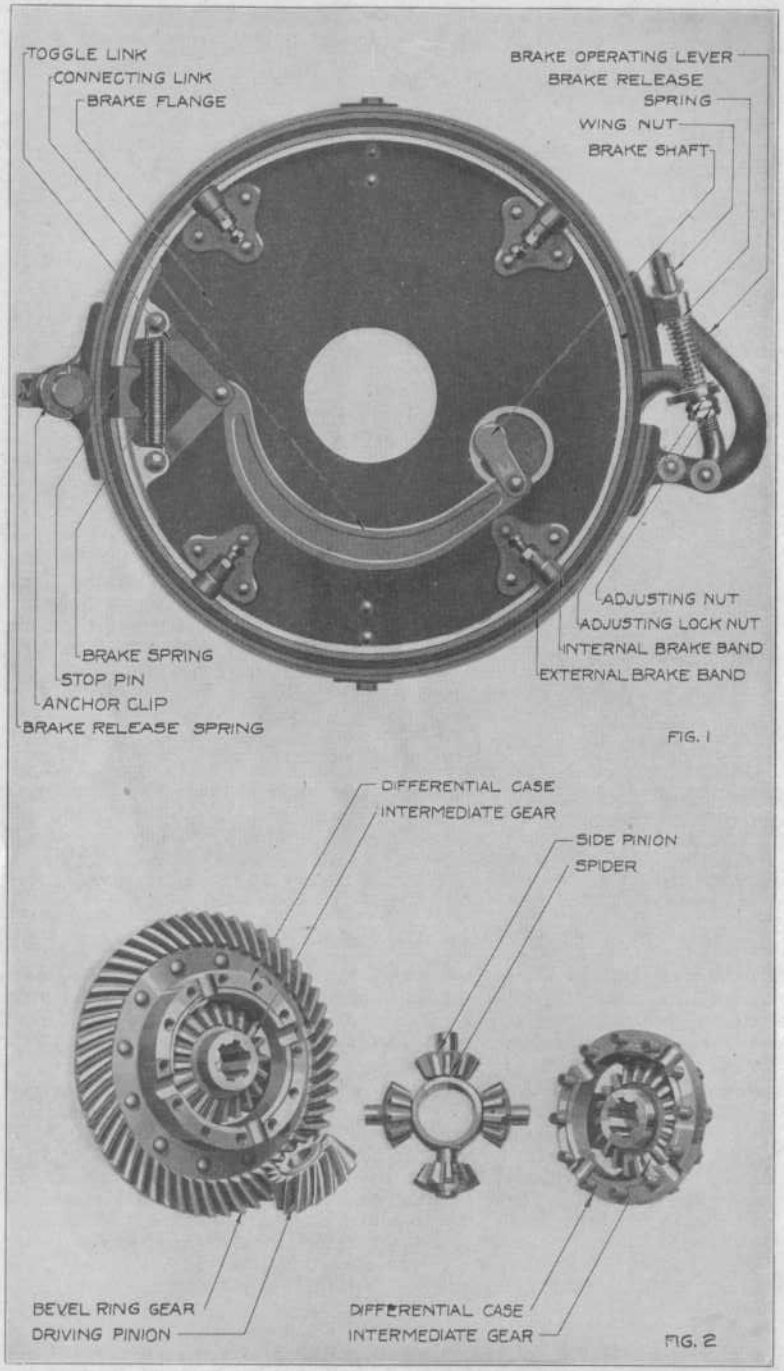


Plate 21.
Brakes and Differential

of an inch has been secured between band and drum all the way around. Note that wing nut is turned so that it rests in the groove in the upper clip before determining clearance.

Lastly, adjust pull rod with the turnbuckle and lock nuts so that it will contract the brake at first pressure of pedal.

Care should be taken to see that brakes on both wheels are adjusted exactly alike, or there is danger of the car skidding when brake is applied. When linings become so badly worn as to be ineffective, they should be renewed by the nearest Buick repairman.

The rear hubs are provided with oil guards to prevent oil or grease getting on the brake linings, but should this occur, it can be washed off with gasoline and a little Fuller's earth applied between the drum and lining.

GEAR ADJUSTMENT

If the driving gears become noisy it is a sign that they are out of adjustment, and should be corrected at once. This is a rather delicate operation and should be performed by an experienced mechanic whenever possible. Adjustment is made, as follows:

Remove rear cover and determine mesh of gears by painting teeth with thin white lead or Prussian blue. This will show the amount of contact between the teeth. The driving pinion may now be adjusted by turning the slotted sleeve through the inspection hole on right side of pinion flange, and the ring gear by adjusting differential bearing sleeves. The teeth should show a broad even line of contact clear across their faces. See that adjusting sleeve locks are in place before replacing covers.

YOKE ADJUSTMENT

To take up end play in the driving yoke bearing, adjust by loosening clamp screw and turning nut on forward end of tube.

Always keep axle filled to the level of the filler plug opening with heavy steam cylinder oil, but do not fill any higher or it may leak out on the brakes.

FRONT AXLE

The front wheels are carried on steering knuckles pivoted to the front axle so that they can turn in response to the steering gear. Steering arms are inserted in the knuckles and connected together with an adjustable tie rod so that both knuckles will turn simultaneously. A third arm attached to the left hand knuckle connects with the steering gear by means of the steering connecting rod. In order to make the car steer easily it is essential that the points of contact between the wheels and the road should fall almost under the center line of the king bolts which pivot the knuckles to the I-beam. This is what is known as the "camber" of the front wheels, and to overcome the effect of this camber on the tires, the wheels are also given a certain amount of "gather" or toe-in toward the front.

CAMBER AND GATHER.

If the tie rod or steering knuckles should ever be bent, it will be found necessary to readjust the camber and gather of the wheels. This may be done by straightening the rod or arms and turning the adjusting

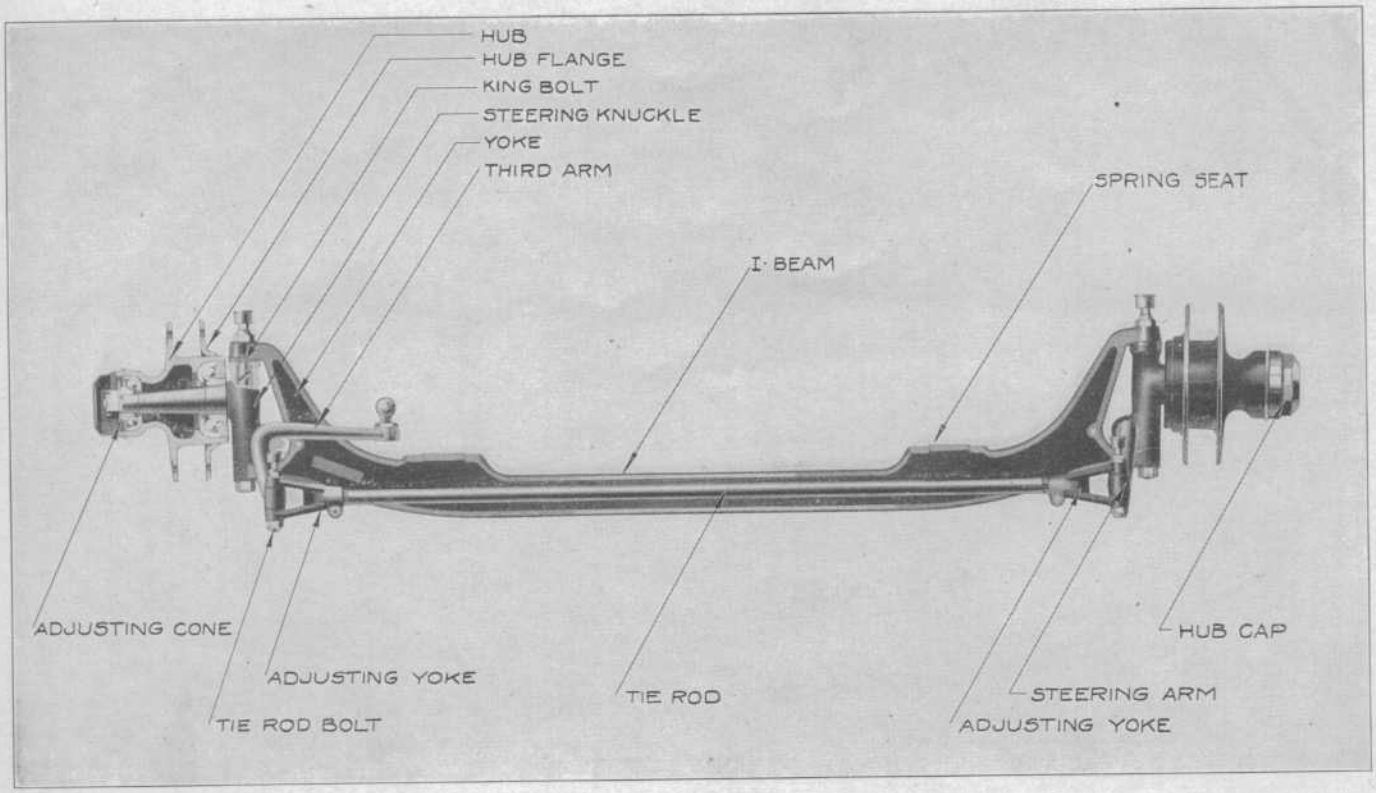


Plate 22
Front Axle and Section Through Hub Showing Internal Construction.

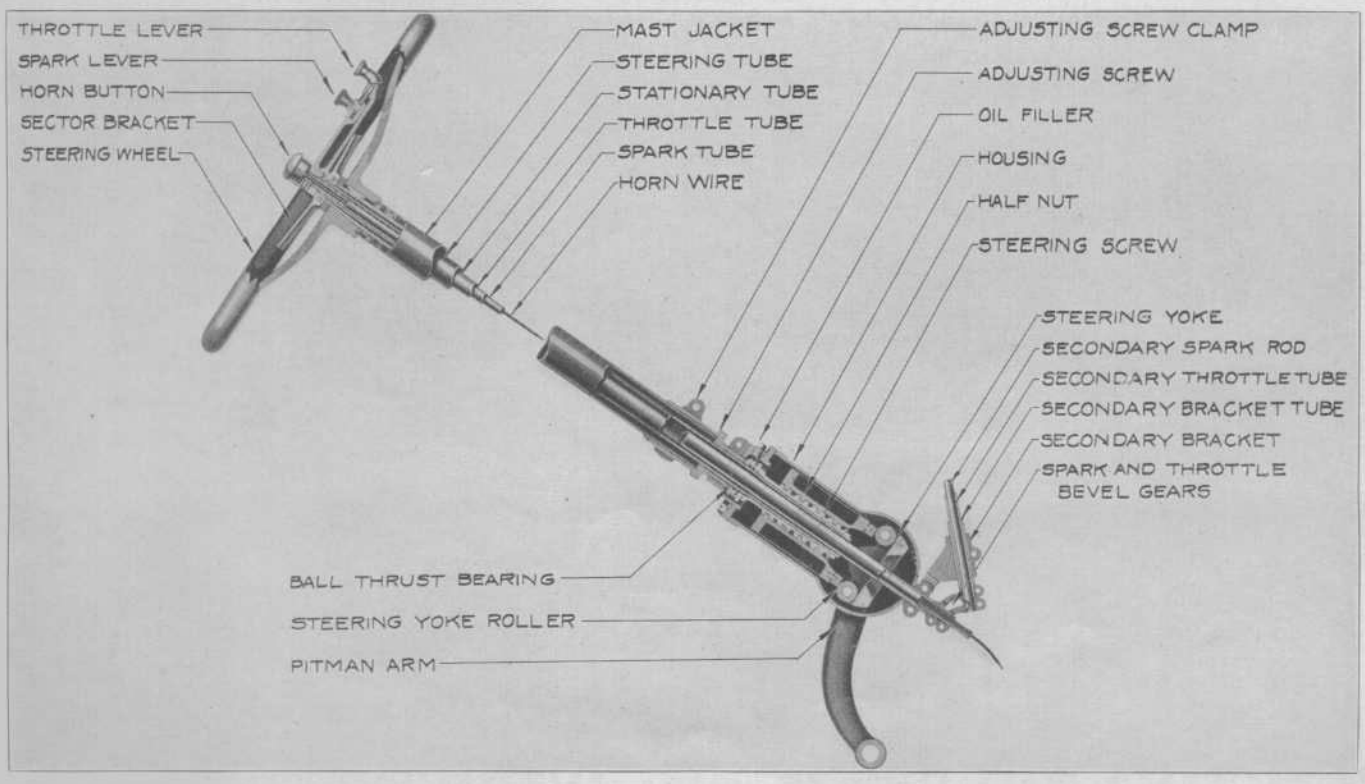


Plate 23
Section Through Steering Gear Showing Internal Construction.

yokes until the proper angle is reached. When in perfect adjustment the front wheels should measure as follows:

For 32 inch wheels, 1 9/16 inches closer together at the bottom than at the top, and 7/16 inch closer in front than at the rear.

For 34 inch wheels, 1 21/32 inches closer together at the bottom than at the top, and ½ inch closer in front than at the rear.

For 36 inch wheels, 1¾ inches closer together at the bottom than at the top, and ½ inch closer in front than at the rear.

These measurements should be taken between the inner edges of the rims and at points diametrically opposite on the circumference.

FRONT HUBS.

The front wheels run on cup and cone ball bearings in the hubs and contain a hollow space which is packed with grease so that they require very little attention, but when removed for cleaning and lubrication, care must be taken to see that the bearings are properly adjusted. To obtain correct adjustment, slip wheel on spindle, assemble adjusting cone and safety washer, and tighten nut until wheel has no perceptible "shake" or side play, but is loose enough to turn freely and will stop spinning with the tire valve at the bottom. Note that adjusting nuts have right and left hand threads.

STEERING GEAR

The steering gear operates on the front axle, through the steering connecting rod, to turn the steering knuckles and road wheels in response to the motion of the hand wheel.

Buick cars are equipt with a worm and nut type of steering gear, which consists principally of a double threaded worm or steering screw attached to the hand wheel by means of a hollow shaft, and two half-nuts, one of which has a right hand thread and the other a left. At their lower ends the nuts bear on rollers located on opposite sides of a yoke, to which the steering pitman arm is attached. As the hand wheel and worm are rotated, one of the half nuts moves up and the other down, thus turning the yoke and swinging the steering pitman arm back and forth. The steering connecting rod then transmits this motion to the steering knuckles and front wheels. At its upper end the steering screw runs against a large ball thrust bearing provided with an adjustment for taking up the wear. The steering screw and half-nuts are enclosed in an oil tight housing and operate in a constant bath of oil, while a nickeled casing or mast jacket, surrounds the upper portion of the hollow shaft to which the hand wheel is attached. Enclosed within the steering tube are other tubes which carry the sector bracket and the spark and throttle levers on their upper ends, and which are connected at their lower ends, by means of gears and pinions to the carburetor and distributor.

STEERING GEAR ADJUSTMENT

There is but one adjustment of the steering gear and that is for the purpose of taking up the wear in the worm and half nuts and thus reducing the lost motion of the hand wheel. To adjust, loosen clamp and turn adjusting screw in top of housing cap. Tighten clamp to fix adjustment. The steering wheel should be adjusted to allow not more than one inch of lost motion at the rim.

SPRINGS

The springs are interposed between the axles and the frame to absorb the road shocks before they can be transmitted to the more delicate parts of the mechanism. Buick cars are equipt with semi-elliptic springs in front and with special floating cantilever springs at the rear. The front springs are attached to the frame at both ends and to the front axle at their centers, while the rear springs are attached to the frame at their centers and front ends and carry the axle on their rear ends.

Careless driving and loose clips are responsible for 99% of the broken springs reported. All springs are carefully tested before the car leaves the factory, but jumping the car over high culverts and across ditches while driving at a high rate of speed, or allowing nuts of spring clips to work loose will eventually break any spring that can be made. To avoid broken springs, drive slowly over rough roads, and keep the nuts tight. A broken spring leaf cannot be repaired and when a break occurs it is necessary to replace the entire spring.

To prevent the springs squeaking, see that the shackle bolts are kept well supplied with grease, as indicated on the lubrication charts.

WHEELS

Automobile wheels are of the artillery type in which the spokes meet at the center and are bolted between the flanges of metal hubs. Both front and rear wheels have twelve spokes and the rear wheels also carry the brake drums bolted to them. A steel felloe band is shrunk on the outer rim of the wooden wheels to receive the demountable rims.

RIMS

The demountabe rims supplied with Buick cars are known as the Baker Bolted-On Type and may be removed from the wheel with the tire. The operation is as follows:

With the brace wrench, loosen all bolts about ¾ inch, except the ones on each side of the valve stem, (Fig. 1). Insert screw driver at right hand side of wedge, between rim and wheel, (Fig. 2), and strike handle of screw driver to free the wedge. When free, turn wedge around, (Fig. 3), and tighten bolt to hold wedge in this position so it will not interfere with rim while dismounting.

To take rim out of tire, lay rim and tire flat (Fig. 4), so that the end of the cut in rim farthest from the valve stem is up. Remove anchor plate, and beginning at end of rim which does not have the valve stem, insert sharp end of tire tool under bead of tire. Force down end of tire tool in hand (Fig. 5), until end of rim is out of tire. This will bring the two short sides of the rim together, thus reducing its circumference. Repeat operation, as necessary, to free rim. Next, turn rim and tire completely over (Fig. 6), and force tire tool between both beads of tire and rim, then, holding tire with the foot (Fig. 7), grasp free end of rim and pull it out of the tire.

To replace tire on rim, lay rim flat on the ground with tire on top (Fig. 8.) Raise end of rim which is drilled for the valve stem, and after valve stem has been inserted, put both beads of tire entirely into the end of rim that has been raised, making sure that other end of rim is under both beads of the tire. After the beads of the tire have been properly started, insert them all the way around, leaving other end of rim to be put in last. If tire is too stiff to force on by

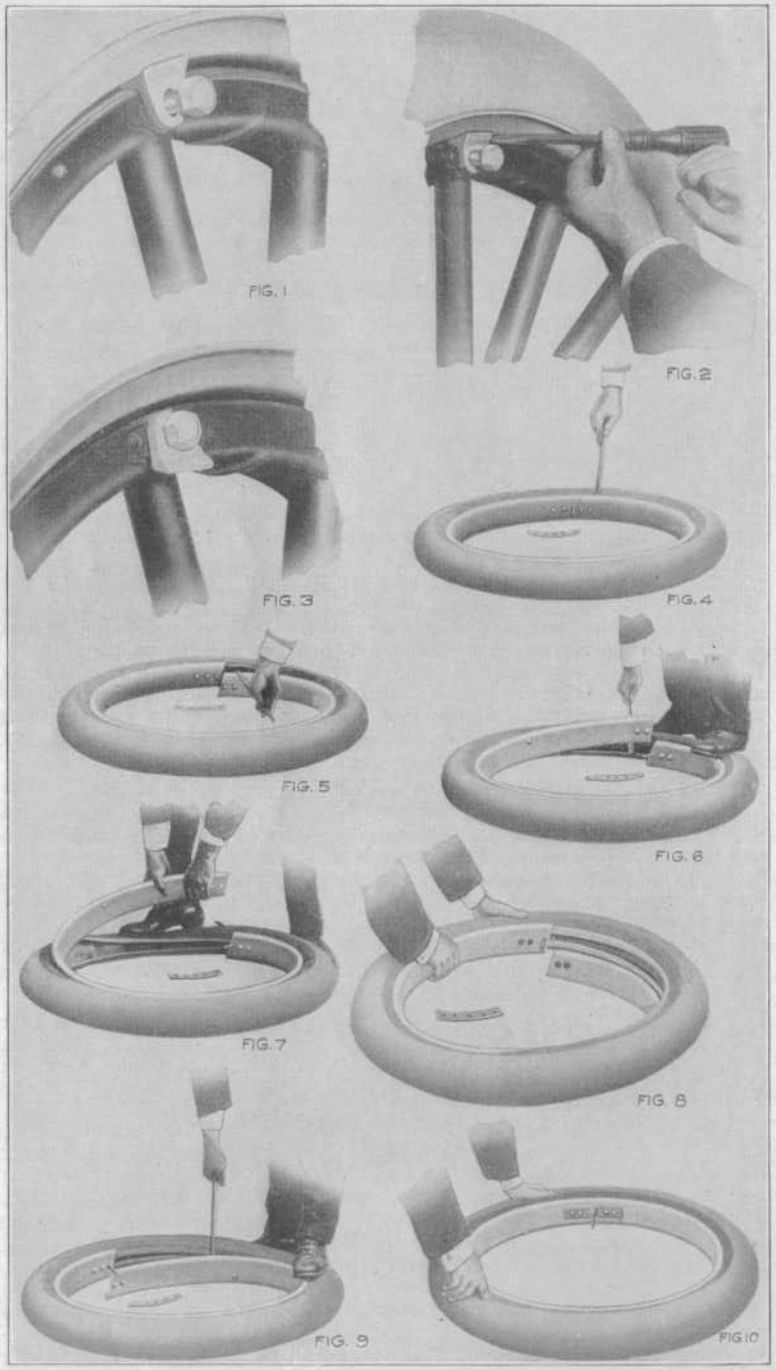


Plate 24
Operation of demountable rims

hand, use tire tool (Fig. 9) Add archor plate and valve cap after inflating (Fig. 10).

To prevent beads of tire sticking to rim, smear with graphite.

TIRES.

The pneumatic tires now in universal use on motor cars are made in two parts, the tube and casing. The tube is simply a circular rubber bag provided with an automatic check valve for inflating. The casing consists of alternate plies of rubber and cotton canvas, into which two rings of braided steel wire are moulded to from the beads which hold the tire on the rim.

Expert tire repairmen contend that 75% of all tire trouble may be traced to a lack of sufficient pressure. A gauge should be used to determine the pressure and tires should generally be inflated to about 20 pounds pressure per inch of width. In other words, 4 inch tires should carry 80 pounds, and 4½ inch tires should carry 90 pounds per square inch.

Punctures cannot be avoided, but a well inflated tire is less likely to pick up nails than a soft one. Bruises, cuts, and sand boils can generally be avoided by careful driving, but should be repaired as soon as they appear. Gasoline and oil should be kept away from the tires, as these articles tend to soften the rubber. If car is to be out of service for any length of time, the tires should be removed, deflated to but a few pounds pressure and stored in a cool, dark place.

Better tire mileage can generally be obtained by occasionally shifting the tires from front to rear and right to left. Fast driving is directly opposed to tire economy, as is driving in street car tracks and deep ruts. For safety, an extra tire and one or two extra tubes should be carried at all times.

BODY

The body is the passenger carrying part of the car and consists principally of an oak frame, covered with a steel shell, and into which the seats and cushions are fitted. It is bolted to the frame and aside from cleaning and washing will require no attention on the part of the driver.

In washing the body, care must be taken not to injure the highly polished surface. Soak the dirt off with a gentle stream of cold water. Do not use a nozzle on the hose and **don't rub.** Sticky mud should be removed before it gets dry and hard. After the mud and dust have been soaked off, the grease may be removed with a strong suds made by dissolving Ivory or Castile soap in luke-warm water. Use a soft sponge and do not rub any more than absolutely necessary. Rinse thoroughly with cold water and dry and polish with a clean, soft chamois skin. Never use a cleansing agent which contains free alkali or an acid.

UPHOLSTERY.

The leather upholstery of the seats and cushions should be wiped clean with a damp cloth and after drying thoroughly should be rubbed down with a few drops of sweet oil sprinkled on a soft cloth. This will preserve the leather and prevent it from cracking.

TOP.

The top should never be folded until it is thoroughly dry. When folding be careful to see that the cloth is not pinched between any of the bow spacers. Always fit dust cover when top is folded, to keep out dirt. When not in use dust cover can be carried under the seat.

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