ESSEX SERVICE

Instruction Manual

For Essex Owners and Mechanics

ISSUED BY THE SERVICE DEPARTMENT OF THE

ESSEX MOTORS

DETROIT, MICHIGAN

U. S. A.

INTRODUCTION

This Instruction Manual has been compiled by the Service Department of our organization with the object of giving assistance to Essex owners and mechanics in foreign lands.

ESSEX MOTORS
DETROIT, MICHIGAN
U. S. A.

GENERAL INDEX

INDEX OF ILLUSTRATIONS

Unboxing and Assembling

HOW TO OPEN THE CRATE

A shipping number is marked on the front and side of the box. This number appears on your invoice and bill of lading. If box is lost, this number should be mentioned to aid in the tracing of it.

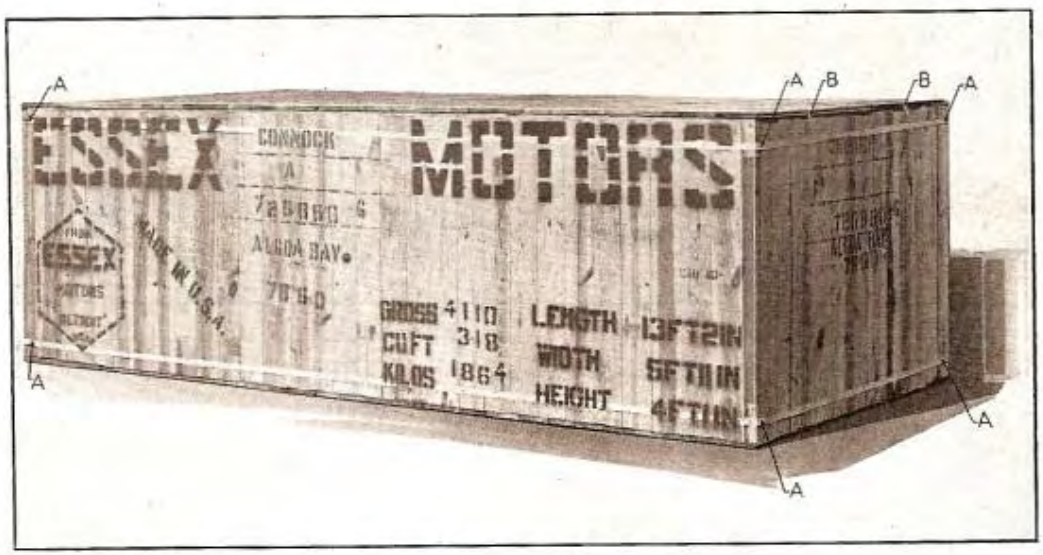


Illustration No. 1

See that box is right side up, Illustration No. 1. Cut the iron straps marked A and B.

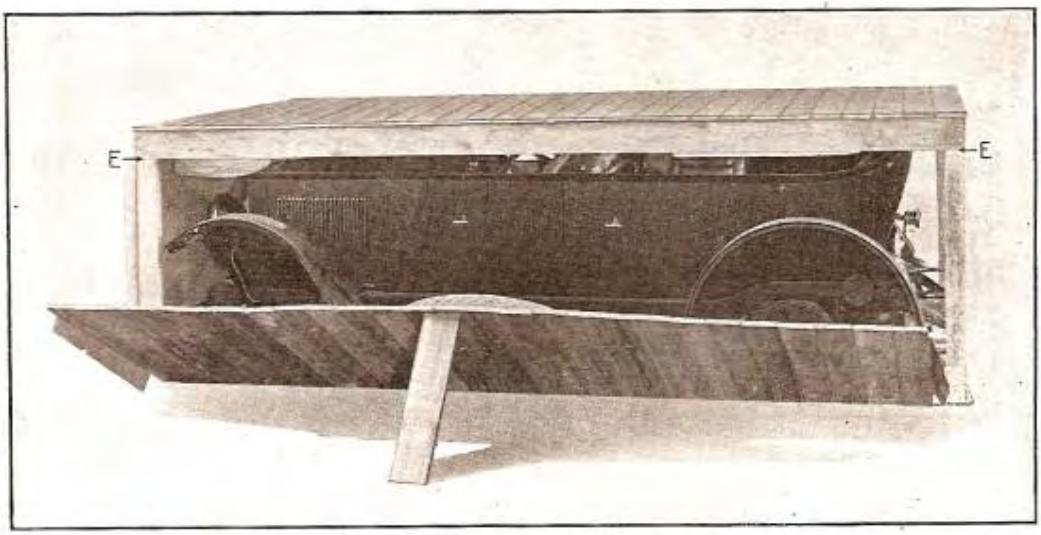


Illustration No. 2

Loosen tops of sides and ends; lower side as in Illustration No. 2.

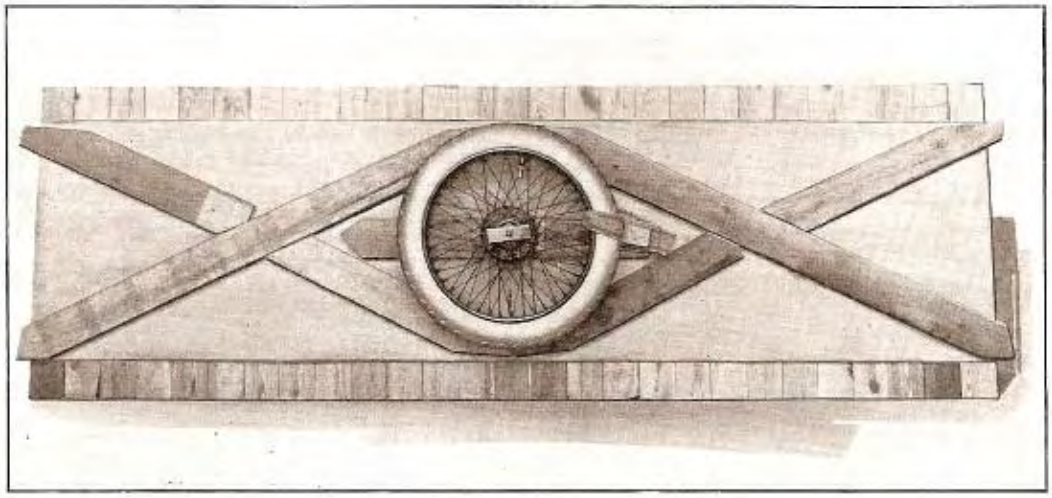


Illustration No. 3

Showing wheel fastened to side unit.

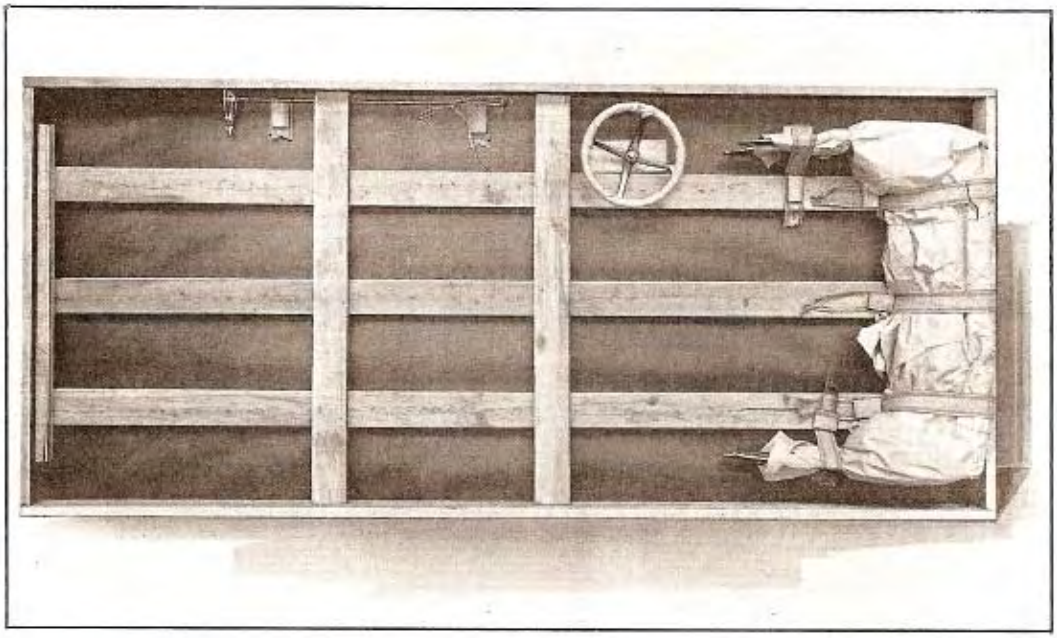


Illustration No. 4

Note that sides, ends, top and bottom are made in units and should always be dismantled as units. See Illustration Nos. 3 and 4.

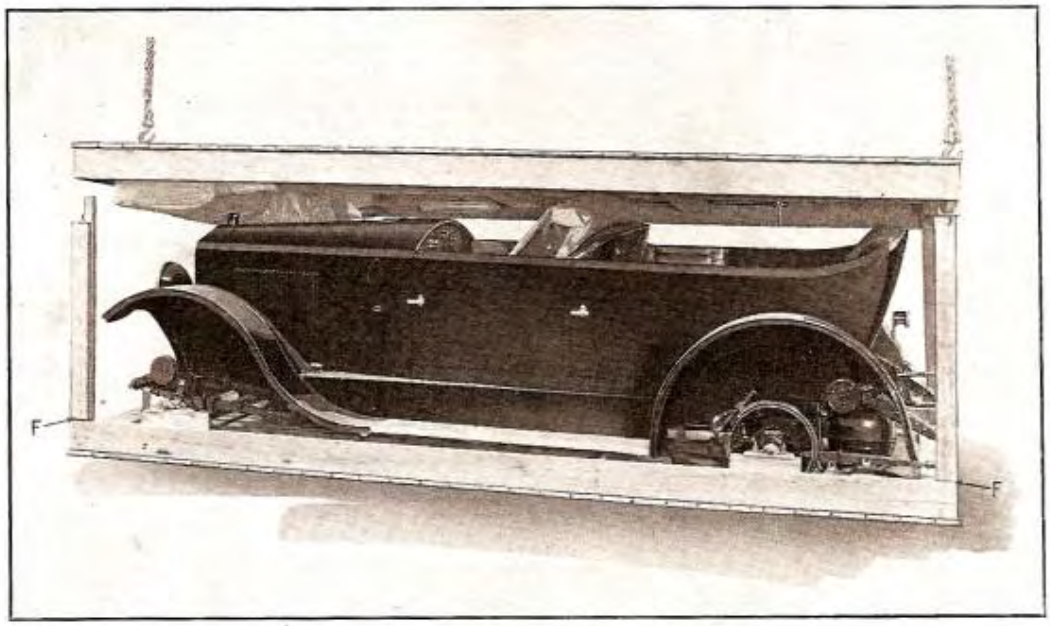


Illustration No. 5

Raise the top as shown in Illustration No. 5. **Caution**—Do not remove one board at a time, as parts are fastened to underside of top. Dismantle ends by cutting off corner posts at F.

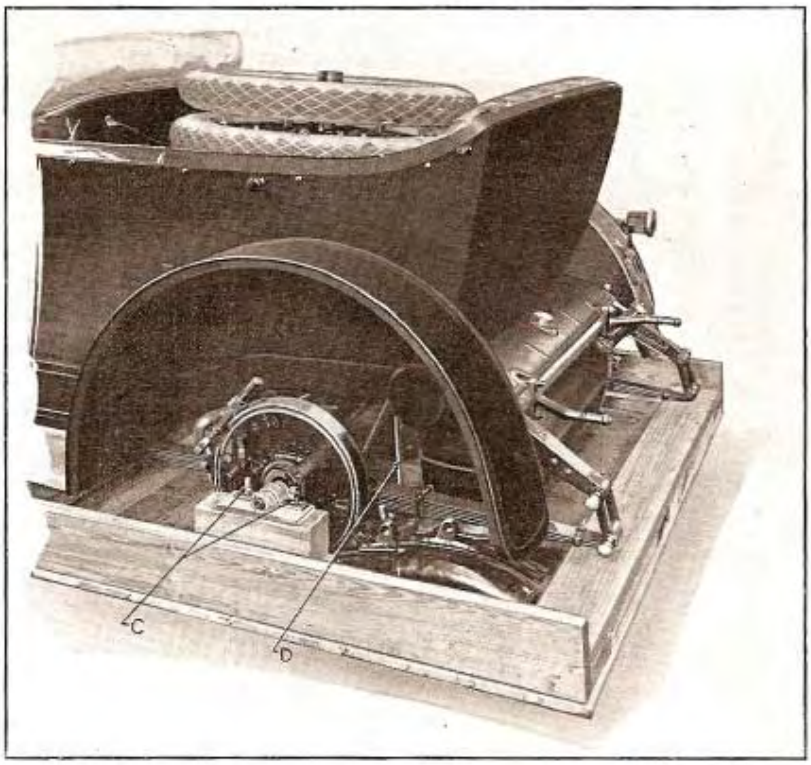


Illustration No. 6

Remove clamps C from axle shafts; also clamps D from springs, Illustration No. 6.

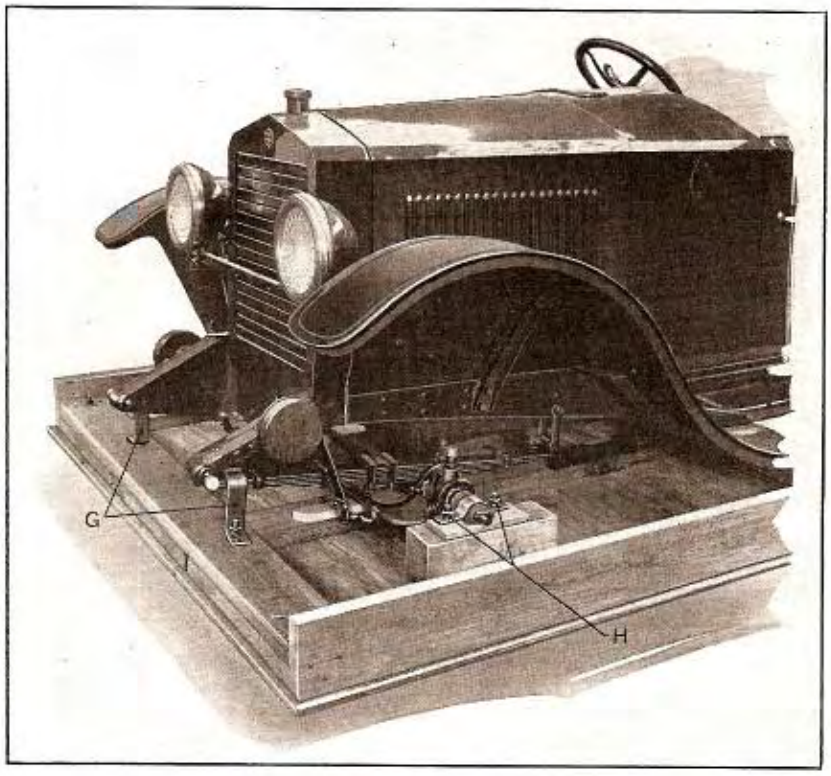
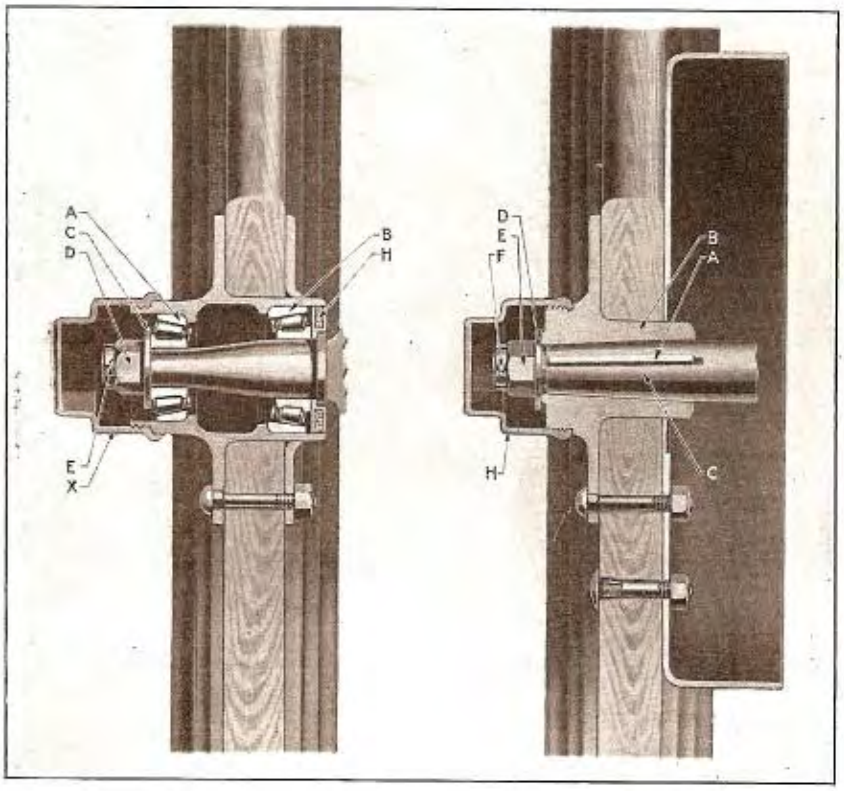


Illustration No. 7

Remove clamps G and H, Illustration No. 7.

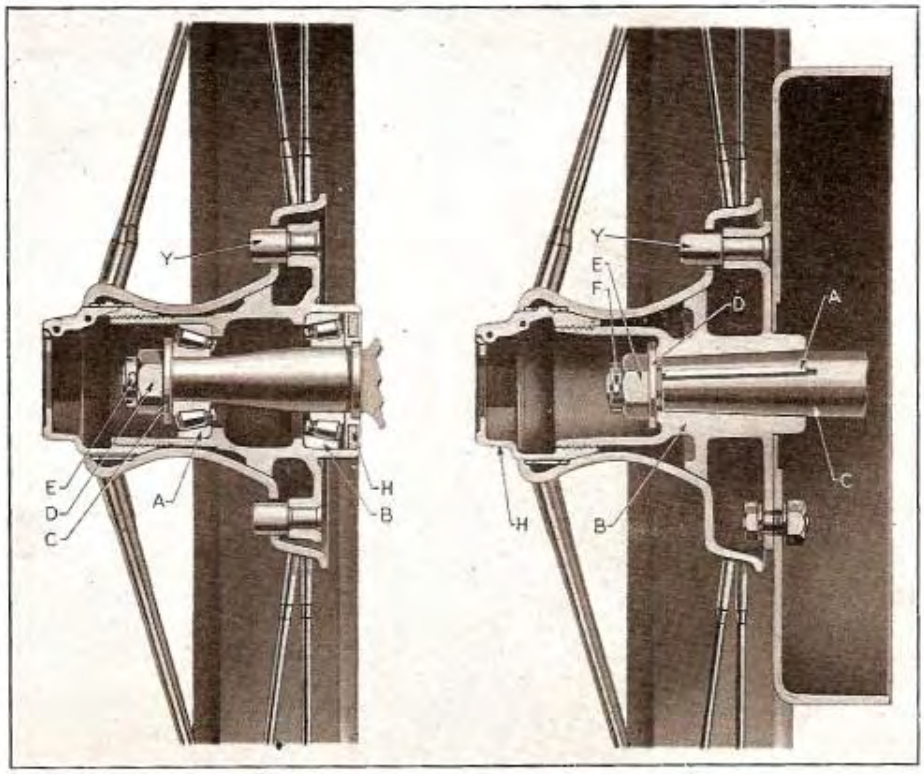


Front WOOD WHEELS Rear

TO MOUNT WHEELS ON AXLES

In mounting rear wheels on axle shafts, clean the shafts and hub with emery cloth. See that shaft keys A are fitted into both wheel hub B and axle shaft C. Wheels are secured by nut E and cotter pin F; hub cap H is then put on.

In mounting front wheels see that roller bearings are thoroughly lubricated. Mount first felt washer container H, then roller bearing B. Mount wheel on spindle, then outer bearing A, washer C and nut, and adjust D until wheel revolves freely without end movement. Lock with cotter pin E; then mount hub cap X.



Front Rear

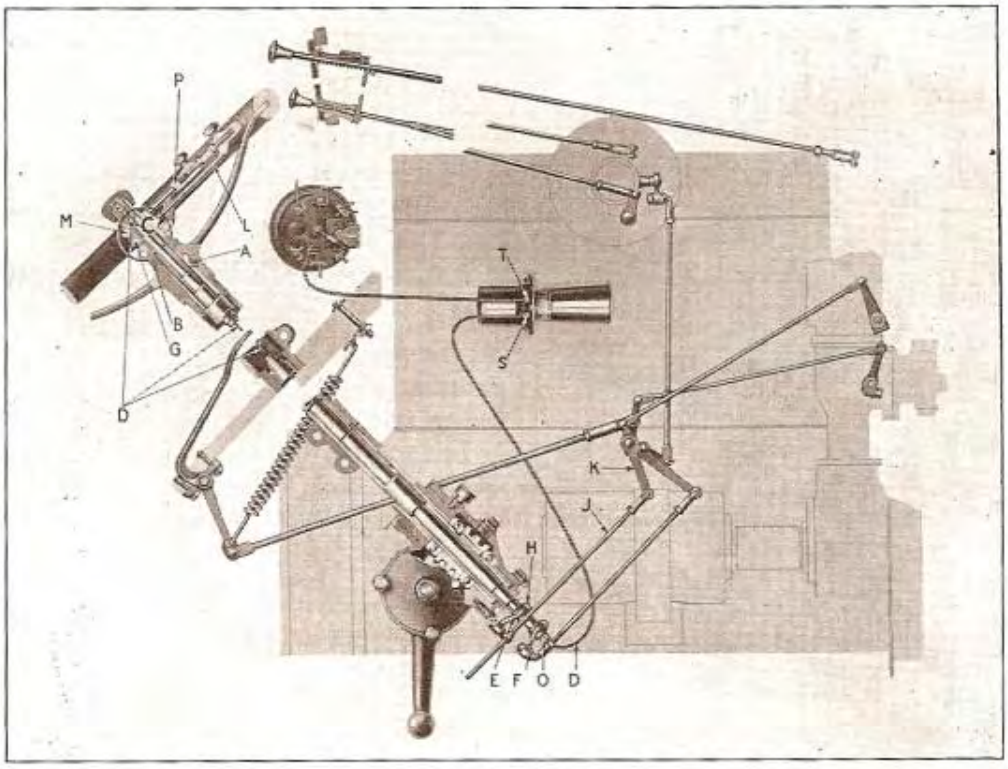
WIRE WHEELS

When mounting wire wheels, proceed as instructed under wood wheels, making sure that there is no movement on driving pins Y when wheel is assembled. See also page 33 (wire wheels).

ASSEMBLING STEERING GEAR

When mounting steering wheel see that key A is in place in steering post and that keyway in steering wheel lines up with key. Then drive wheel over post and tighten in place large nut B. If key, nut or any other part is not in place, look inside pockets of doors. The control lever tubes C, horn wire D, etc., should be inserted in steering column after throttle levers E and F have been removed. When tube assembly is mounted in steering column, connect up lever E and F as follows:

Loosen tension on screw in upper gas control lever at G so that tube can be turned, then tighten the throttle lever by clamping to the tube with screw H, connect lever E to rod J running to lever K,

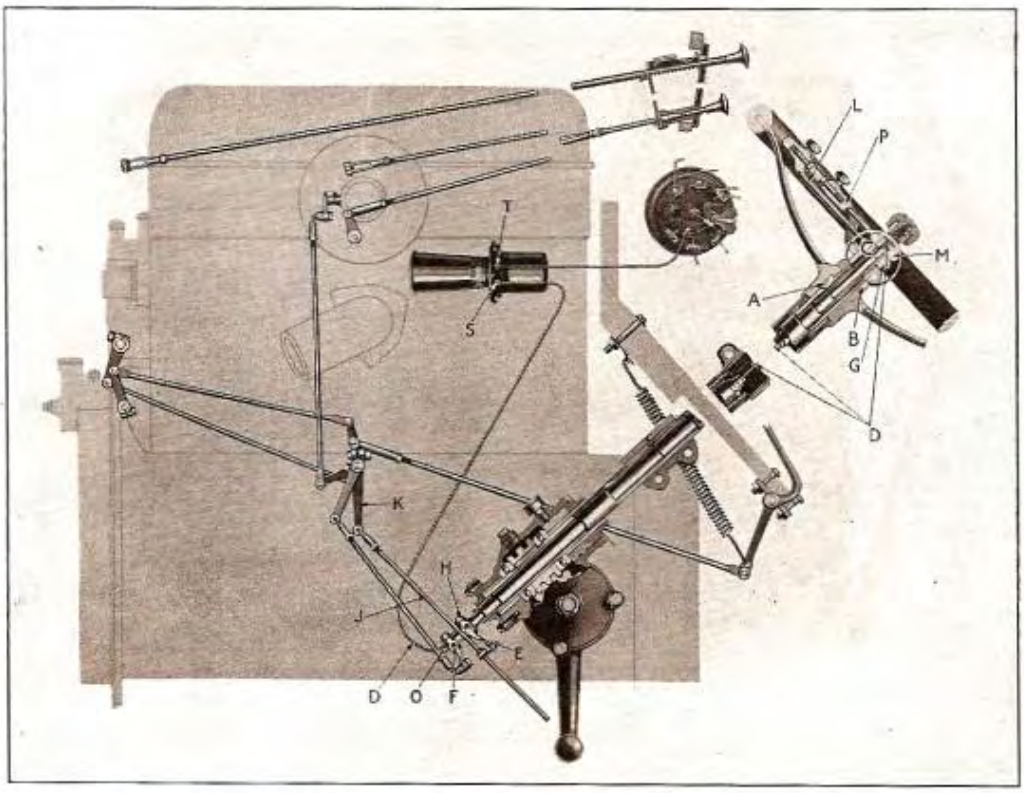


R. H. DRIVE

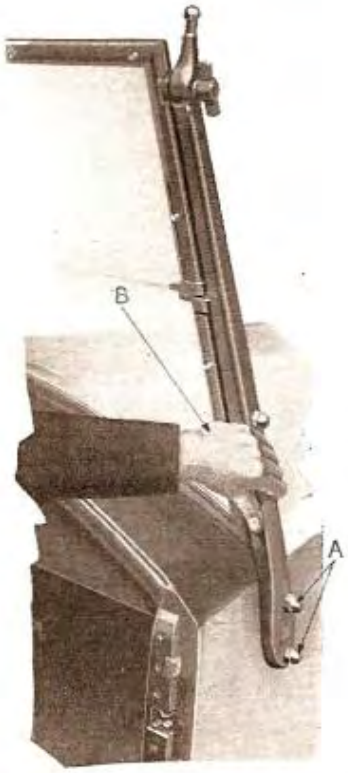
with the butterfly valve in carburetor fully closed. When lower connections are adjusted, move throttle lever L to bottom of quadrant and clamp to tube with screw G.

To connect spark control loosen clamp screw M on upper spark lever so that the tube can be turned, then tighten lower spark lever F to tube with clamp screw O. Advance spark lever to full advanced position, couple up the spark lever F at lower end of steering column and clamp lever to tube with screw O. Set upper lever P at top of steering post to top position of quadrant and secure to tube with clamp screw.

Connect horn wire to terminal S and connect to switch as shown.



L. H. DRIVE



WINDSHIELD

In mounting windshield the nut A should be drawn up tightly and evenly, washers being inserted, if necessary, to prevent straining. Do not jam lower half of glass down on body. Before tightening nut see that windshield is drawn back, "B," towards rear of car so as to remove movement from bolt in bolt holes. See illustration.

TO MOUNT TOP OR HOOD

Place hood in position, inserting bolt through hinge eyes and top irons on body. When top is raised see that the two tension straps on rear of body to rear bow of hood are fastened. Then drop rear curtain and fasten in place with tacks found in left hand pocket of door. Adjust rear tension strap to suit curtain, drawing up until all creases are removed. Side curtains will be found under the rear seat.

To lower top proceed as follows: Illustration No. 1 shows how cover should be pulled out. This cover should be rolled as shown in Illustration No. 2. When rolled into place the weight is carried by the lower bow, Illustration No. 3. The hood cover is then installed, as shown in Illustration No. 4.

Illustration No. 1—Shows how this cover should be pulled out while you are lowering the top.

Illustration No. 2—The sides are folded in and a neat roll of the cover is started.

Illustration No. 3—Shows this roll up in place. Note how the weight of the roll is carried by the lower bow, not by the back curtain.

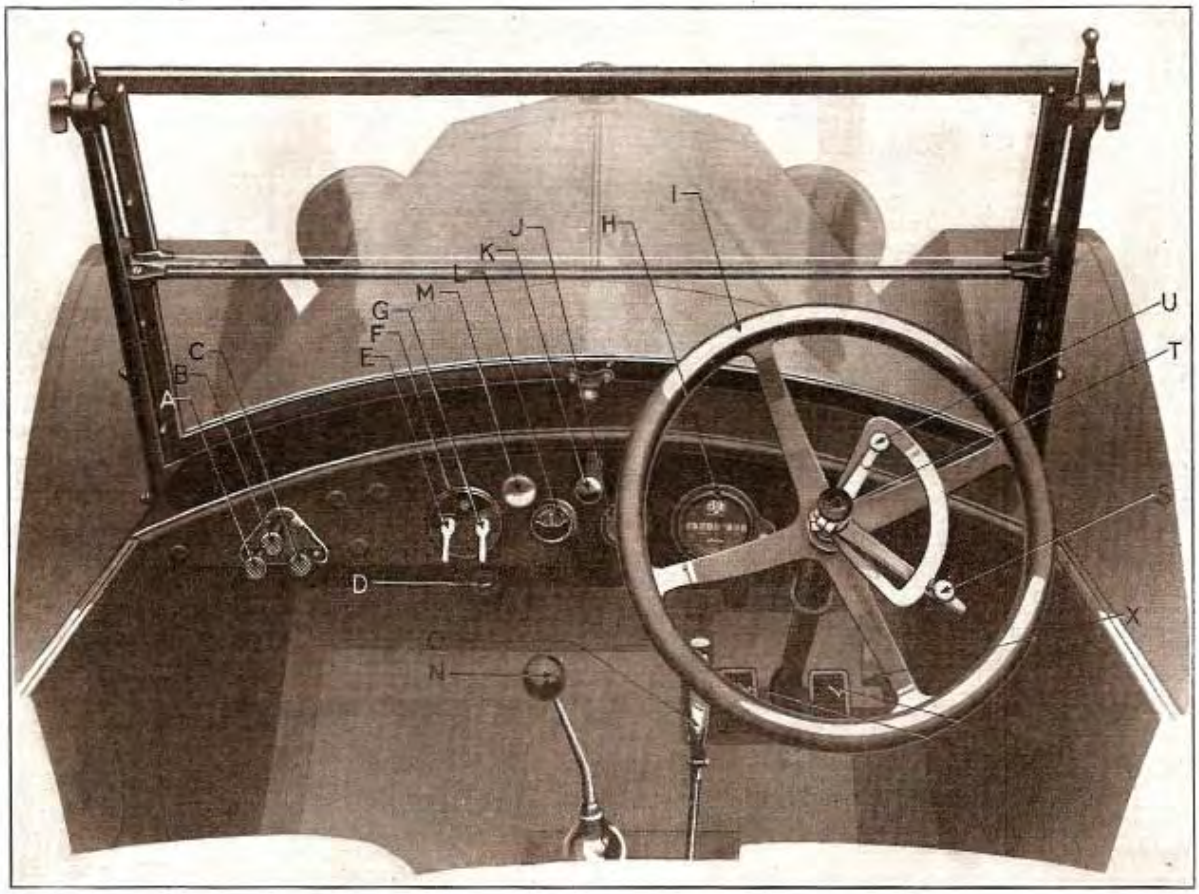
Illustration No. 4—The slip cover is being applied. This also shows that there is no sagging whatever on the under side of the slip cover to present an unsightly appearance and interfere with the spare tire.

STORAGE BATTERY

The battery is situated under left hand front seat. The battery is shipped dry and should be charged immediately after car is unboxed. Full instructions for placing battery in service and keeping it in condition will be found on page 45.

Before Starting Engine Prepare Car as Follows

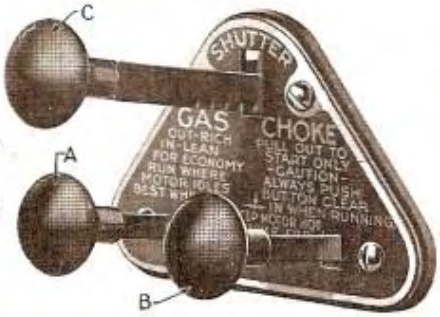
1. Fill cooling system with soft water.
2. Fill fuel or petrol tank.
3. Lubricate where necessary. (Page 14.)
4. Drain oil from engine base and refill with good oil of light body. (Page 32.)
5. Remove spark plugs and pour a little oil in each cylinder. Crank engine by hand for few revolutions.
6. Jack up rear wheels. Adjust brakes. (See page 23.)
7. Start the engine and allow it to run for two or three hours with gear shift lever in high speed.
8. Oil gauge should always register when motor is running.



FUNCTIONS OF FITTINGS IN DRIVER'S COMPARTMENT

A. Gas Button.
B. Shutter.
C. Choke.
D. Starter Pedal.
E. Ignition.
F. Switch.
G. Lights.
H. Speedometer.
I. Steering Wheel.
J. Oil Pressure Gauge.
K. Dash Light.
L. Battery Indicator.
M. Cowl Ventilator Regulator.
N. Gear Shift Lever.
O. Hand Brake Lever.
P. Clutch Pedal.
R. Brake Pedal.
S. Throttle Lever.
T. Horn Button.
U. Spark Lever.
X. Accelerator Pedal.

TO START THE ENGINE



1. Put gear shift lever in neutral. (See page 9.)
2. Place hand throttle lever near bottom of quadrant and spark lever near top. (See illustration above.)
3. Pull gas button A outward about 5 notches, or to No. 4 or 5 on scale.
4. Pull air button B out.

5. Turn ignition lever (left hand lever on switch) to left.

6. Press starter pedal and move air button in and out till engine starts.

7. Then quickly remove foot from starting pedal and see that air button is in or you will flood engine. If necessary move it rapidly in and out several times when warming engine. Do not drive with this button pulled out.

8. When engine is warm, adjust gas as lean as possible while allowing engine to run idle.

9. Always close radiator shutter until the motometer indicates that the proper driving temperature has been reached. The red fluid should show as in illustration. Then open the shutter enough to keep the temperature at that point.

10. Do not speed up the motor when it is doing no work.

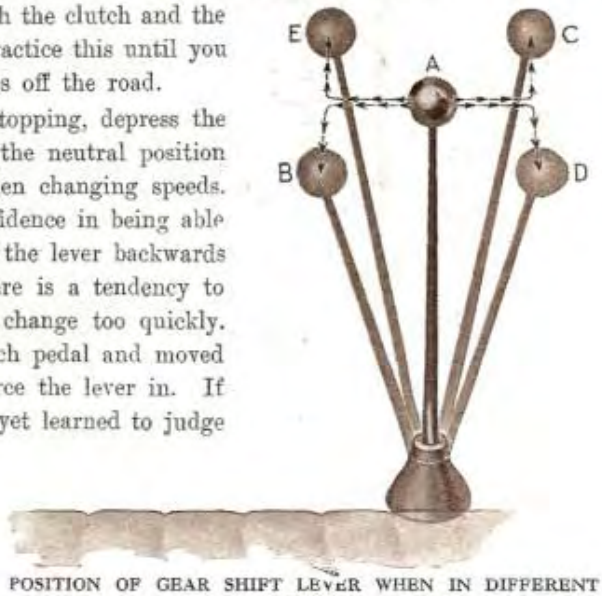
HOW TO DRIVE THE CAR

Start the motor as instructed on page 8. The throttle lever should be open just enough to permit the engine running without danger of stalling through the improper manipulation of the clutch.

Depress the clutch pedal with the left foot and keep it depressed while putting the gear shift lever into the first gear position. (Study illustration for gear shifting position.) You are now ready to start the car by letting the clutch pedal back gently. If you do this gently the car will start into motion very smoothly. Run the car with the gear in first speed until you have become accustomed to the feel of driving and steering. Get used to the operation of the brakes by depressing both the clutch and the foot brake until you are able to stop the car at will. Practice this until you are able to find the hand brake without taking your eyes off the road.

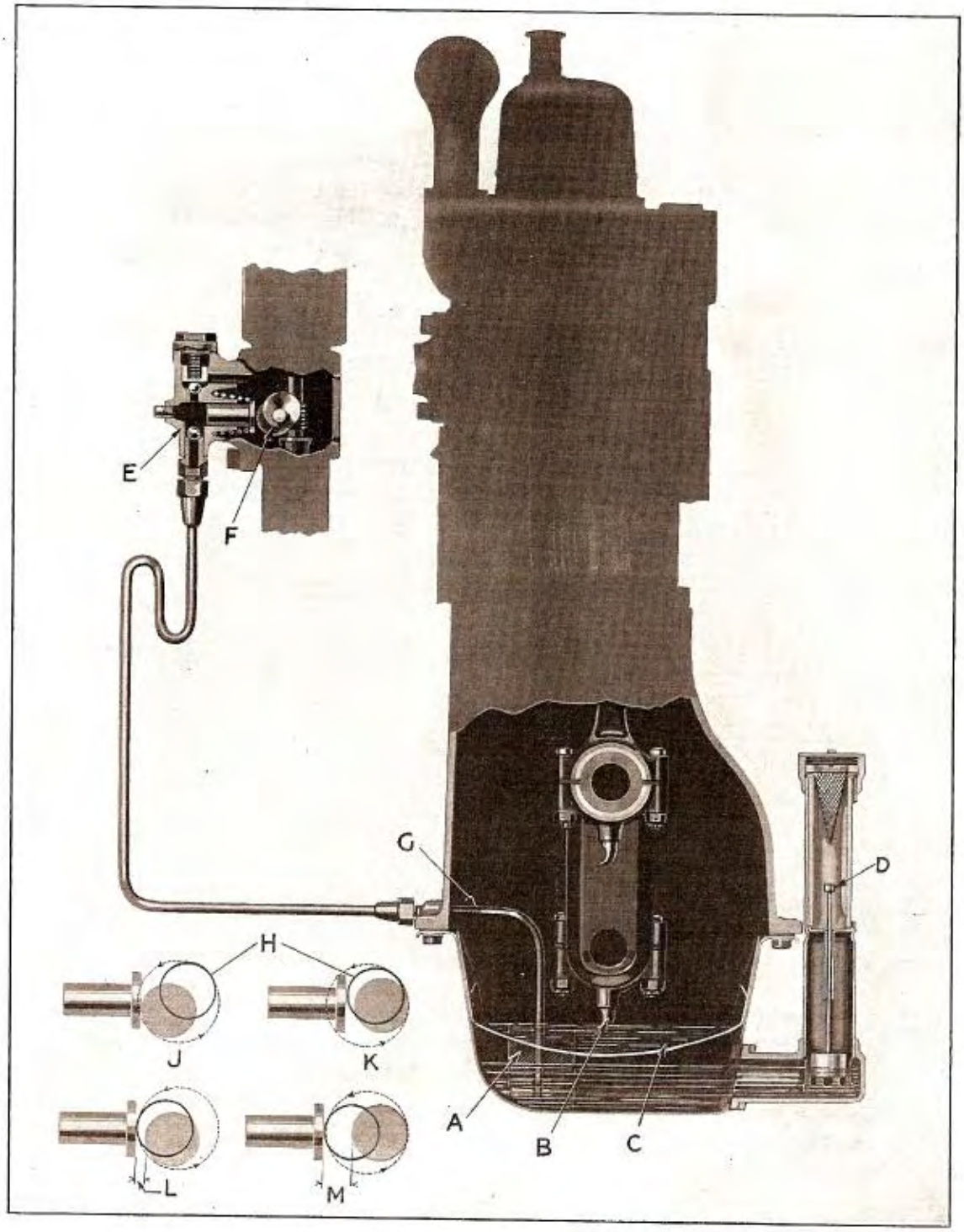
When you have mastered the art of steering and stopping, depress the clutch and shift the gear lever from low gear through the neutral position into the second gear. Don't look at the gear lever when changing speeds. This takes your eyes off the road and destroys your confidence in being able to control the car. Depress the clutch again and bring the lever backwards to high gear. If in changing from first to second, there is a tendency to clash gears, it is because you are trying to make the change too quickly. Wait a second or two after you have depressed the clutch pedal and moved to neutral position before shifting to second. Never force the lever in. If the gears do not mesh easily, it is because you have not yet learned to judge the correct car speed at which to make the change. The same rule applies in changing from second to high.

Never attempt to change to the reverse gear when the car is in motion. By so doing you will invariably strip the gears.



POSITION OF GEAR SHIFT LEVER WHEN IN DIFFERENT SPEEDS
A—Neutral, B—First Speed, C—Second Speed, D—High, E—Reverse

Never slip the clutch in order to reduce the speed of the car or in an effort to make it climb a hill on high gear. The transmission is the device containing the different gear ratios, and its sole purpose is to minimize the strain on the driving mechanism. Get into the habit of using the transmission gears at the right moment. Don't wait for the motor to knock and stall under an excessive load before making it work under an impossible load as a result of failing to shift gears. No matter how bad the roads are or how steep the grade, if the driver changes the gears judiciously neither the motor nor the car need ever be placed under an excessive strain.



DETAILS OF OILING SYSTEM

A. Oil Reservoir Screen.
B. Connecting Rod Dippers.
C. Oil Trough.
D. Oil Level Indicator.
E. Oil Pump.
F. Cam.
G. Oil Tube Reservoir to Oil Pump.
H. Revolving Cam.
J. Stroke Control, Slow Speed.
K. Stroke Control, High Speed.
L. Stroke Allowed by Control in Slow Speed Position.
M. Stroke Allowed by Control in High Speed Position.

EXPLANATION OF OILING SYSTEM DIAGRAM

The Essex oiling system is a circulating, constant level, splash system.

The pump takes oil from the pressed steel reservoir at the bottom of the motor, drawing all of it through a filter or metal screen "A" of fine mesh. The oil is then fed directly into the front compartment containing the timing gears and their bearings, and flows from this into the first oil trough immediately under No. 1 cylinder. The oil dipper "B" on the end of the connecting rod strikes the oil in trough "C" at every revolution, throwing the oil into suitable channels or gutters on the side of the reservoir and crank case. The upper gutters lead to the main bearings and thus a continuous stream of oil feeds to these. The lower gutter feeds the oil directly into No. 2 trough. (Follow the line of travel indicated by the arrows in the illustration for a clearer understanding of this detail.) The splash from No. 2 oil trough feeds No. 3, and so on until No. 4 trough or the rear end of the motor is reached, at which time the oil goes back into the lower reservoir through an opening. It is therefore apparent that all the oil which enters at the front end must circulate completely through the various troughs and bearings of the motor before it can find an exit at the rear end of the trough, there to re-enter the reservoir.

The float indicator "D," mounted on the left side of the motor, shows the level of the oil by means of a button working in a glass tube which also acts as a filler tube.

The reservoir contains 5 quarts U. S. or 4¾ litres of oil in the troughs and in the reservoir itself. On account of its being of pressed steel construction its exposed position, under the motor, affords excellent cooling facilities. The large quantity of oil insures a slow enough circulation to allow proper cooling before the oil is recirculated through the bearings and troughs.

The pump "E" is of a plunger piston type operated by a cam "F" which is driven by a worm gear mounted on the distributor shaft. You will note from the illustration on page 10 that while the oil pump is of conventional type and operated by a plunger bearing on a cam, its control mechanism is connected to the carburetor throttle. This is done to regulate the stroke of the oil pump in proportion to the throttle opening, because the engine needs more oil at high speed than at low speed. This may sound complicated, but it is extremely simple. At low speeds the eccentric holds the plunger away from the cam, but as the motor speeds up the eccentric is turned by the movement of the throttle, thereby cutting down the distance the plunger is held away from the cam, increasing the action of the plunger accordingly. In this way the pump has a short stroke when the motor is running slowly, but the minute the throttle is opened the stroke of the pump immediately increases in proportion.

An oil gauge is mounted on the dash, which is connected directly to the top of the oil pump. This gauge acts simply as an indicator that the oiling system is operating. It is not a true indicator of the amount of oil delivered. That is governed by the adjustment of the oil pump stroke itself.

HOW TO ADJUST OIL PUMP ON EARLY 1919 MODELS

(See Illustration No. 1, Page 12.)

1. Remove plug "A."
2. Start motor and hold fan from turning.
3. Insert wire "C," allowing it to butt against the plunger. The travel of wire can then be noted. Minimum stroke allowable is $\frac{3}{32}$ inch. On cars that are driven hard, stroke should be more than $\frac{3}{32}$ inch.
4. Loosen nut "B" and turn shaft "D" to change amount of stroke. On this model control rod "F" should be adjusted so lever "E" points downward and rests against case, when wire "C" shows minimum stroke.

The reading of the oil gauge on instrument board can be adjusted by removing plug "G" and altering spring. Lengthening spring increases gauge reading and shortening it reduces reading.

HOW TO ADJUST OIL PUMP ON PRESENT CARS

(See Illustration No. 2, Page 12.)

Proceed with adjustment same as instructed for early 1919 cars, noting, however, that on these cars the lever "E" points upward and forward and must be in this position when adjustment is made.

Adjustment of Oil Pump on Early 1919 Cars

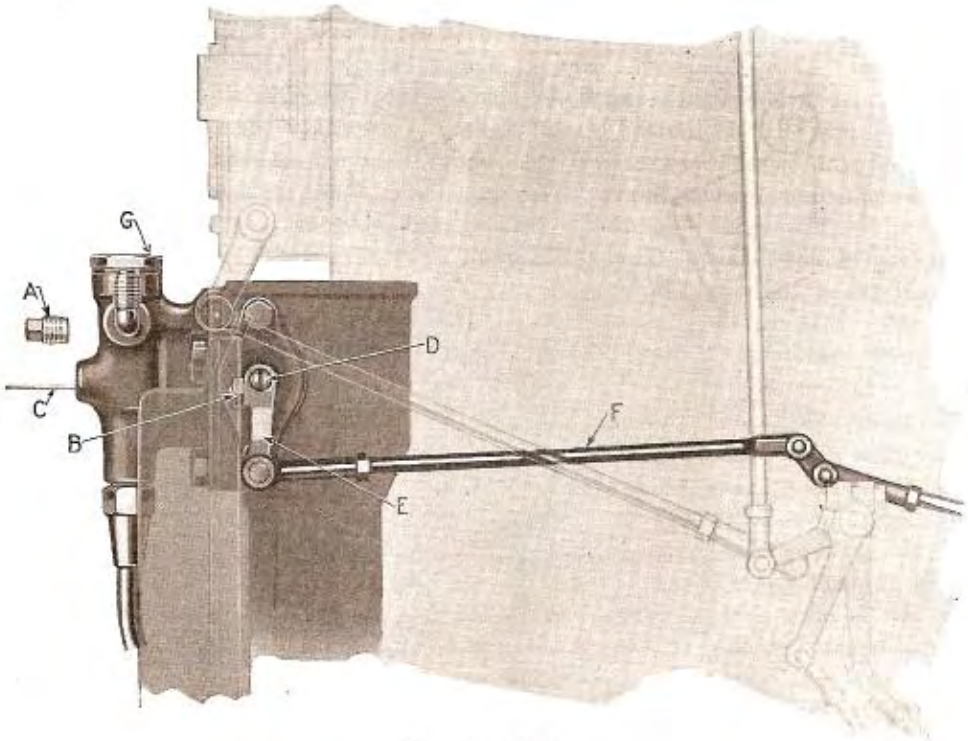


Illustration No. 1

Adjustment of Oil Pump on Present Cars

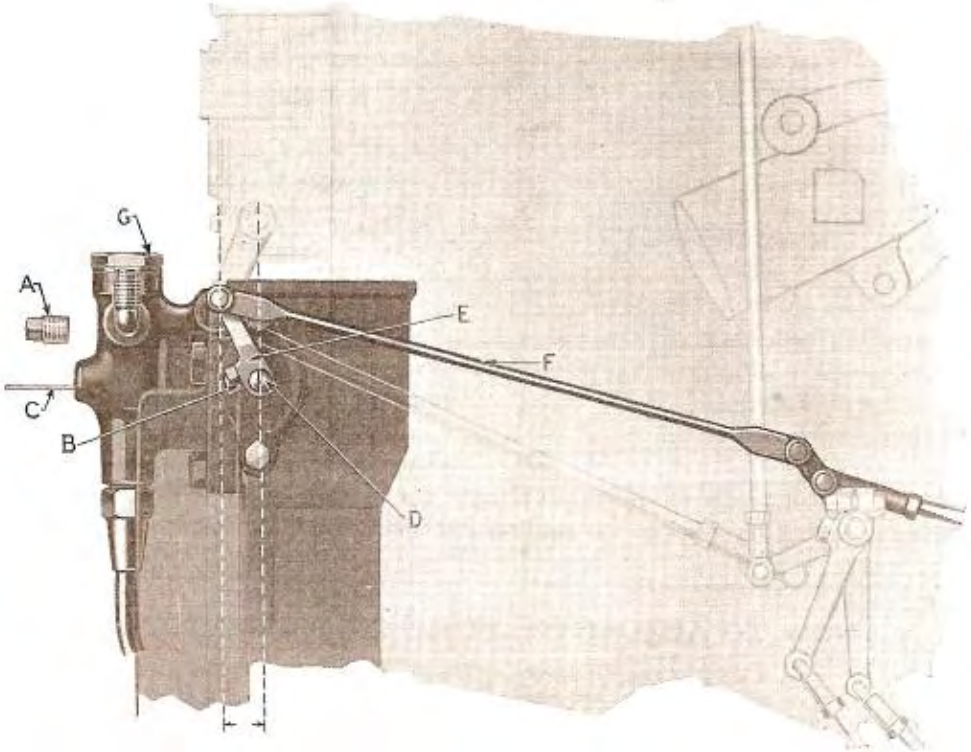
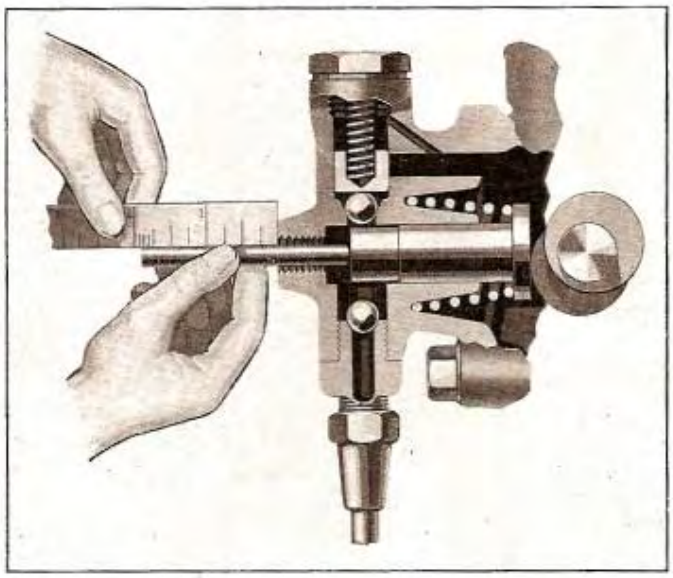


Illustration No. 2

Oil Pump



HOW STROKE OF OIL PUMP IS MEASURED

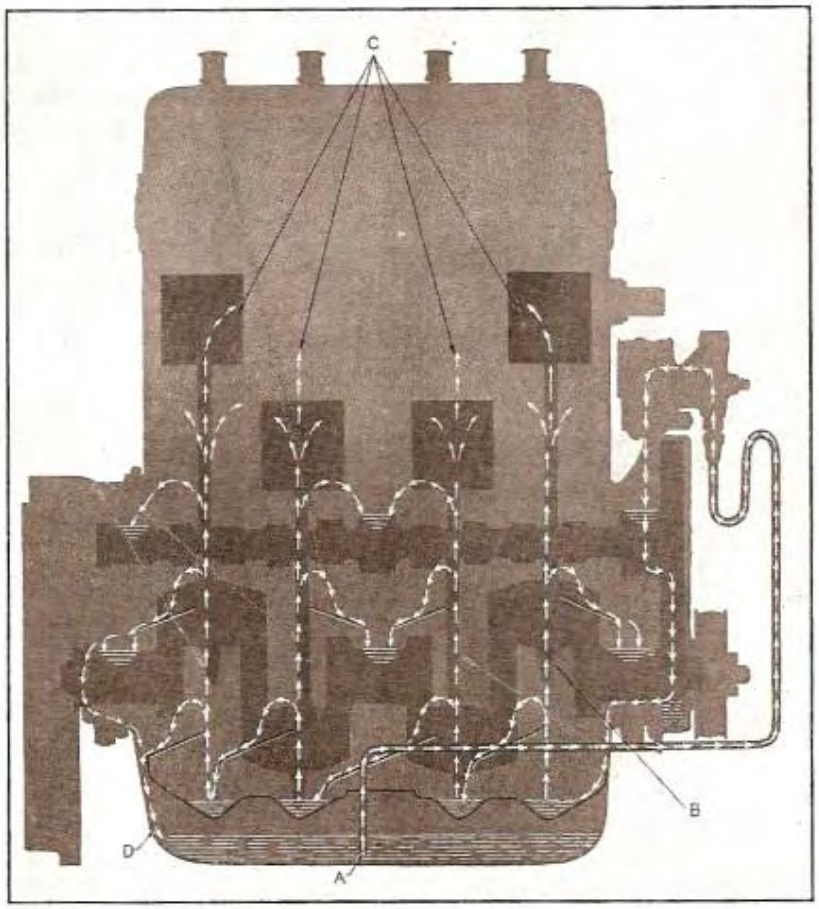


DIAGRAM SHOWING TRAVEL OF OIL

A. Start.
B. Dipper.
C. Splash to Cylinders.
D. Return.

OILS AND GREASES BEST SUITED FOR THE ESSEX CAR

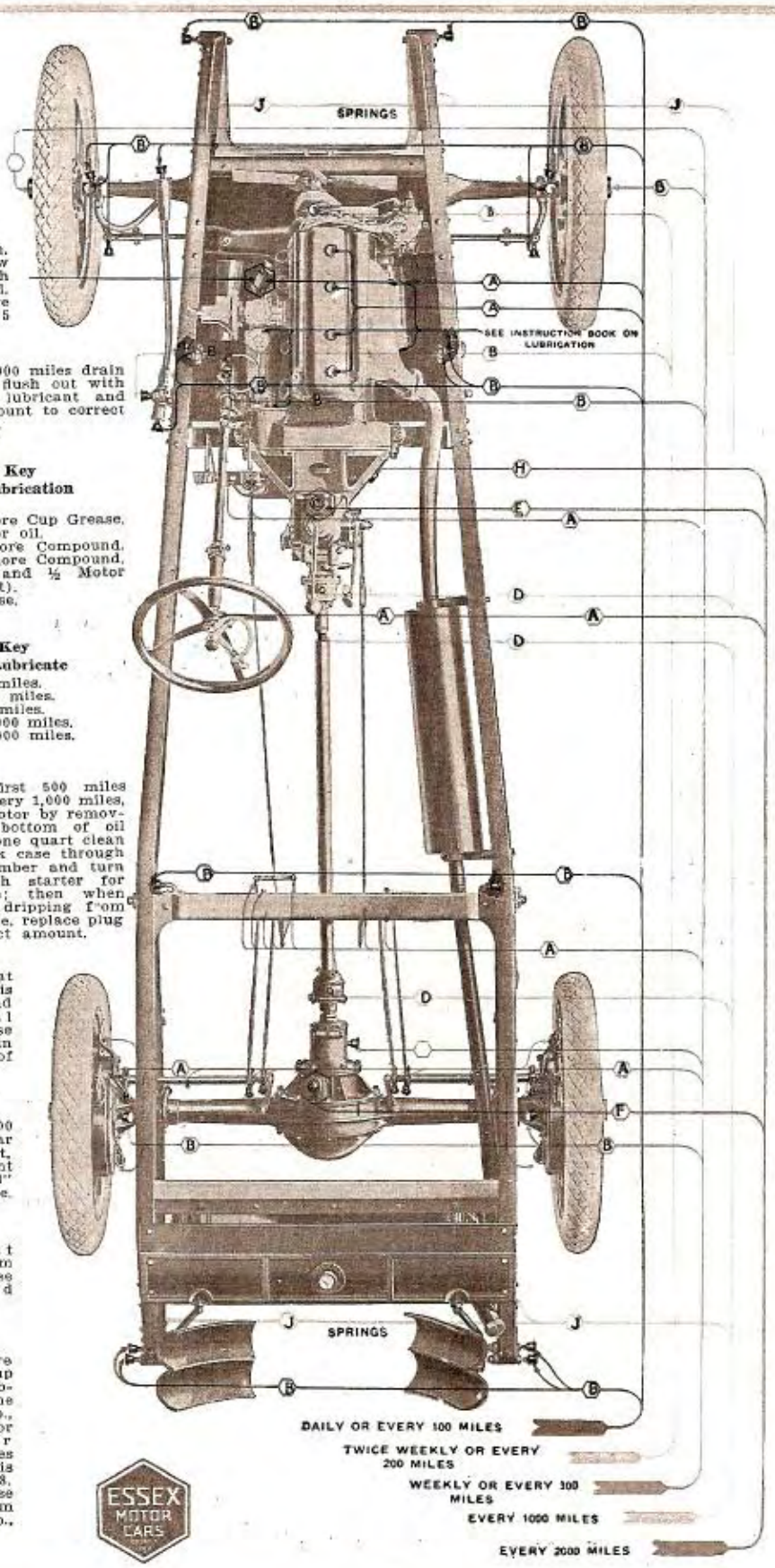
Motor Lubricating Oil: Use only high grade oils, of light or medium light body. Always use light when low temperatures are encountered.	Amount required—5 quarts U. S. or 4¾ litres. Allow supply in reservoir to become low, then drain off and refill with new oil. Clean reservoir once or twice a year.
Clutch: Regular lubricating oil mixed with kerosene or coal oil in equal proportions.	Clutch holds one-half pint of mixture.
Transmission or Gear Box: Whitmore's Compound No. 7 or Regular Transmission Oil. Do not use a hard or cup grease.	Fill until oil reaches overflow plug hole in side of case.
Universal Joints: Whitmore's Special Universal Joint Composition or any soft grease of good quality.	Fill joints every 1,000 miles, using grease gun.
Rear Axle: Whitmore's Compound No. 45 or Regular Rear Axle Oil.	Fill until oil reaches overflow plug in rear cover. Pinion housing should be kept well supplied through grease cup.
Steering Gear: Whitmore's Compound No. 45 or Heavy Oil Compound or Light Grease.	Fill case.
All Other Grease Cups: Whitmore's Compound No. 5 or Light Cup Grease.	Frequent attention.
Starter-Generator Bearings, **Electric Horn Bearings:** Use 3-in-1 oil or a good grade of Sewing Machine Oil.	A few drops every 500 miles.

Once a season the clutch, transmission or gear box and the rear axle should be drained, flushed out with kerosene or coal oil, and refill.

Whitmore's Compounds may be obtained abroad. A list of foreign agents will be found on page 58.

They may be used over again after straining through a fine screen to separate the metal chips and particles.

Essex Lubrication Chart



Note — Drain, flush out with new oil, then refill with fresh motor oil. "Full" on gauge approximately 5 quarts.

Note—Every 2,000 miles drain off transmission, flush out with kerosene, strain lubricant and add to bring amount to correct quantity, 2½ lbs.

Letter Key
Type of Lubrication

A—Motor Oil.
B—No. 5 Whitmore Cup Grease.
D—Steam cylinder oil.
E—No. 7 Whitmore Compound.
F—No. 45 Whitmore Compound.
H—½ Kerosene and ½ Motor Oil (½ pint).
J—Graphite Grease.

Color Key
When to Lubricate

Red—Every 100 miles.
Green—Every 200 miles.
Blue—Every 300 miles.
Yellow—Every 1,000 miles.
Brown—Every 2,000 miles.

Motor—After first 500 miles and thereafter every 1,000 miles, drain oil from motor by removing plug from bottom of oil reservoir. Pour one quart clean oil into the crank case through valve tappet chamber and turn engine over with starter for about a minute; then when clean oil starts dripping from reservoir plug hole, replace plug and fill to correct amount.

Note—See that due attention is paid to front and rear universal joints, as these are vital parts in the mechanism of the car.

Note—At 2,000 miles drain off rear axle, flush out, strain lubricant and add to "full" level plug on side.

Note—See that grease oozes from parts when grease cup is screwed down.

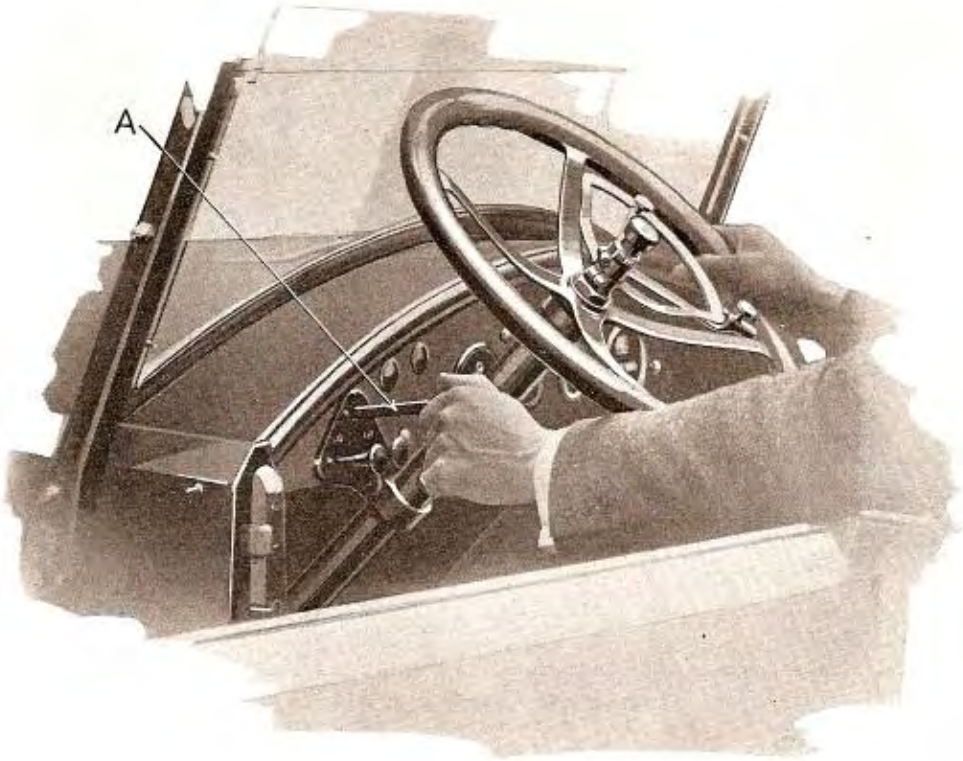
Note—Whitmore compounds and cup grease can be obtained from the Whitmore Mfg. Co., Cleveland, O., or any of their foreign branches a list of which is shown on page 58. Moore fibre grease is obtainable from the Moore Oil Co., Cincinnati, O.

THE ESSEX RADIATOR SHUTTER

In cold weather all petrol used in excess of what is the standard for the same engine during the hot weather is the unburned portion which goes through the carburetor but does not vaporize. Drawn up into the combustion chamber in a liquid state it seeps past the pistons into the crank case. This distillate cuts the lubricating oil in the crank case and renders it useless. It therefore follows that if the motor is run in a choked condition and is not allowed to warm up to a point where all of the petrol going through the carburetor is properly vaporized, seepage is going on from the combustion chamber to the oil reservoir. This makes it necessary to remove the oil from the crank case every few hundred miles because of its diluted and dangerous condition.

Perhaps a more simple way of explaining the reason why a radiator shutter, such as is installed on the Essex, is so essential in obtaining continued good results from a petrol motor is to point out the similarity of action between it and the human body. The human body functions properly only through a small range of temperature. This temperature, under normal conditions, remains constantly at 98.4 degrees Fahrenheit, regardless of surrounding conditions. Any variation from this point results in illness. Exactly the same conditions prevail in the engine. If it is driven too hot, the carburetor does not function as it should. If driven too cold, carburetion is again but partial. There is only one efficient point. Deviating from that either way decreases the performance of the engine proportionately.

With a shutter equipment you will be able to conserve and regulate most of the heat generated in the motor. In fact, it is possible with this equipment to keep the temperature of the motor under all climatic conditions to the ideal temperature.



Its Operation

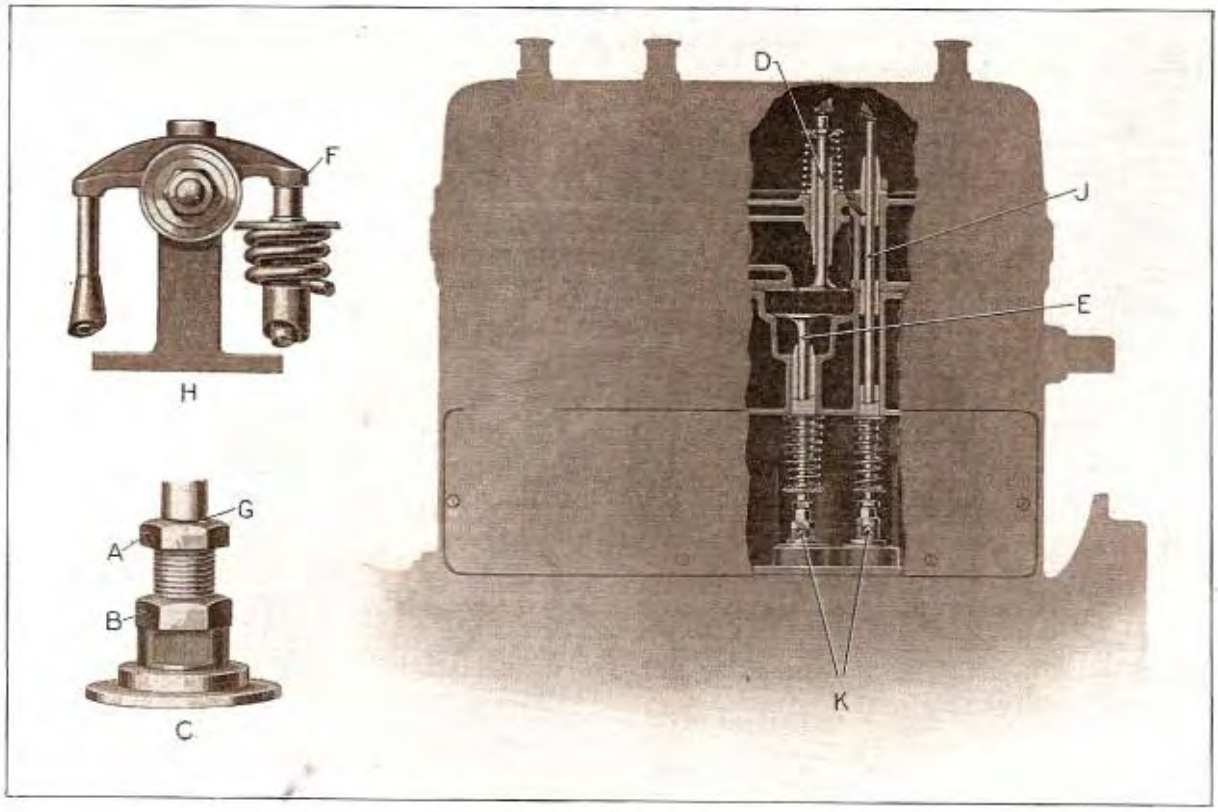
A small operating lever "A" on the dash sets the shutter in any position. This regulation depends entirely, of course, upon the weather. Close the shutter when you leave the car standing. Have it closed when you start and leave it closed until the red fluid in the motometer reaches the center of the circle, indicating a temperature of approximately 180 degrees Fahrenheit or 65 degrees Centigrade.

Petrol economy will depend very much upon your manipulation of the shutter.

General Motor Adjustment

ADJUSTING TAPPETS

The push rods are provided with adjusting screws "A" and lock nuts "B." The proper clearances are .006 inch on the intake "F" and .008 inch on exhaust "G." More clearance is better; less clearance very harmful. The exhaust tappet clearance is checked by inserting a feeler between the push rod and tappet screw "C." Inlet tappet clearance should be measured between rocker arm and stem "H." When adjusting tappets the motor should be turned over until No. 1 cylinder is on the compression stroke and the piston has assumed its highest point, or dead center, when Nos. 1 and 2 tappets should be adjusted (numbering from the front of the motor). As the motor fires in the order 1, 3, 4 and 2, it follows that one-half revolution of the motor will now bring No. 3 piston to the top on the firing stroke, when Nos. 5 and 6 tappets may be adjusted. Then one-half revolution will bring No. 4 piston up, and when Nos. 7 and 8 are checked, one more half turn puts No. 2 cylinder on dead center, when Nos. 3 and 4 tappets may be set, thus completing the series. The importance of adjusting the tappets according to piston position is that it gives absolute assurance that the push rods are assuming their lowest position on the cam.



VALVE AND TAPPET ADJUSTMENTS

A. Adjusting Screw.
B. Lock Nut.
C. Exhaust Valve Tappet Clearance.
D. Intake Valve.
E. Exhaust Valve.
F. Adjust to .006 Inch Clearance.
G. Adjust to .008 Inch Clearance.
H. Intake Valve Tappet Clearance.
J. Intake Valve Rocker Push Rod.
K. Valve Tappet Push Rod.

VALVE GRINDING

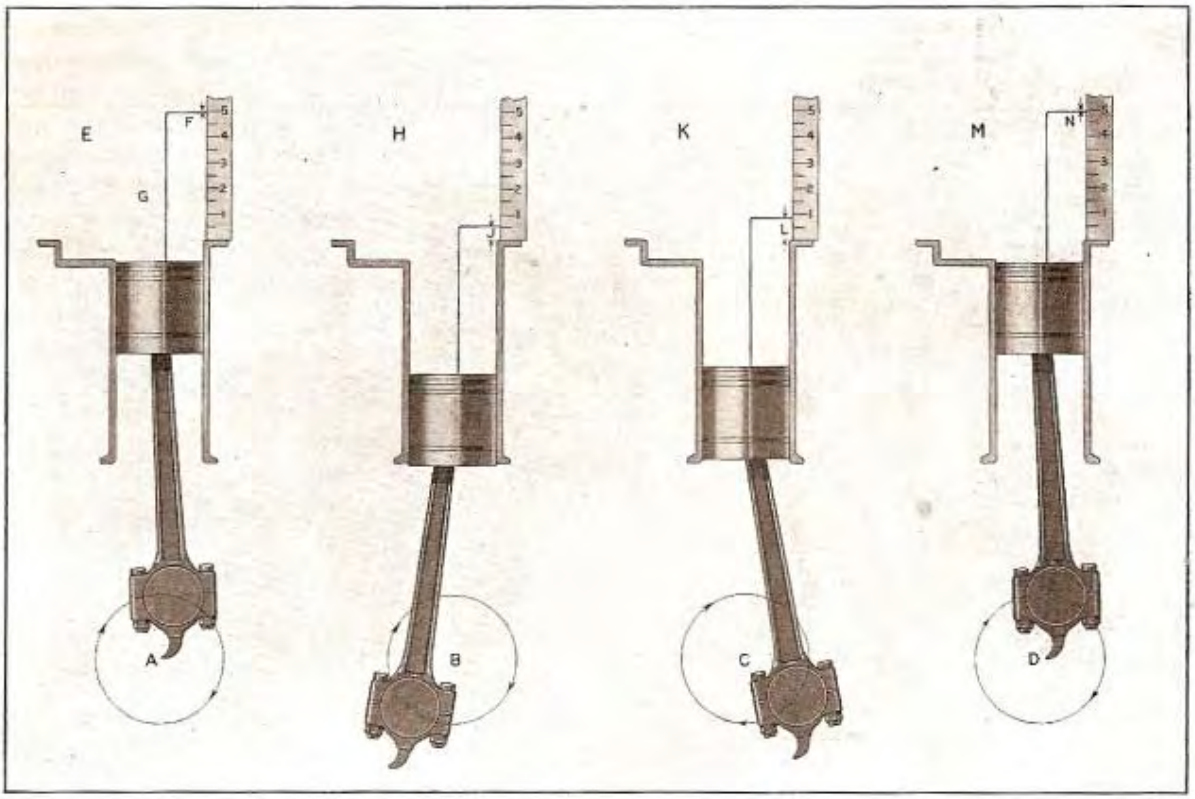
Drain water from cooling system. Remove cover from intake valve rockers on top of motor. Take off valve tappet cover plate on right side of motor and remove valve spring retainers and springs. Remove all cylinder head bolt nuts and lift cylinder head off, being careful not to injure the gasket.

When grinding valves it is advisable to place a spring under them of sufficient tension to hold valve away from seat when not under pressure from the valve tool. A little medium grade emery powder and oil or valve grinding compound should be placed on the valve, and it should be worked into the seat with a to and fro motion, bearing very lightly, being careful not to make more than one-third to one-half a revolution of the valve before reversing directions, otherwise grooves in the valve will result. When all pits and black spots have disappeared and the valve presents a frosty appearance, finish the grinding with the fine compound. The valve should have a uniform surface, free from grooves and pits, but should not necessarily have a polish. The valves acquire the glassy polish while in use. Each valve should be ground and returned to the seat it was removed from. Be very careful of this. Now replace inlet valves, valve springs and retainers and return cylinder head and gasket to place. In tightening head, draw on each bolt a little at a time until all are secure with even tightness or leakage will result. Check over tappet clearances and replace rocker arm cover and oilers.

VALVE TIMING

Below will be found a diagrammatical illustration of a method suitable for timing Essex valves. As will be noted, an ordinary rule is used, together with a piece of wire. When measuring according to drawing, the wire must be perfectly straight and exactly $5\frac{13}{16}$ inches in length. The rule or scale should rest on top of the cylinder, after the head and gasket have been removed. The wire should rest vertically on the top of the piston.

It is possible to take the above measurements without removing the cylinder head if precautions are taken to insure accuracy. The spark plug is removed and the wire allowed to rest on top of the piston head. The lower edge of the rule or scale must be on a line with the top of the cylinder, disregarding the gasket, and both the wire and the scale must be perpendicular. See page 57 for millimeter conversion table.



VALVE SETTING

A. After top dead center.
B. After bottom dead center.
C. Before bottom dead center.
D. After top dead center.
E. Inlet opening 1/64 inch from top dead center.
F. 1/64 inch.
G. Wire 5 13/16 inches long.
H. Inlet closing 17/32 inch from bottom dead center.
J. 17/32 inch.
K. Exhaust Opening 57/64 inch from bottom dead center.
L. 57/64 inch.
M. Exhaust closing 1/32 inch from top dead center.
N. 1/32 inch.

CARBON DEPOSIT

This may be minimized by avoiding a very rich mixture, by using high grade oil, properly adjusted ignition, and maintaining the correct motor temperature by the aid of the radiator shutter equipment. The most thorough method of removing the carbon is by removing the cylinder head and carefully scraping the accumulation off the combustion chamber and adjacent parts. To remove the cylinder head, follow the instructions under "Valve Grinding," page 16.

INSPECTION

Remove spark plugs, clean them, and set the points at .030 inch.

Check tappet clearances. (See page 16.)

Clean distributor points with very fine sand paper and set the points at .018 inch when at their widest opening.

Adjust fan belt tension if necessary.

Change oil in motor. (See page 32.)

Clean storage battery terminals, tighten clamps and cover terminals with vaseline to prevent corrosion.

See that all electrical connections are tight and clean.

Clean motor and carburetor thoroughly with a rag moistened with kerosene.

Add distilled water to battery.

See that carburetor, radiator shutter and spark controls work freely.

See that motor bolts are tight.

Drain sediment from vacuum tank.

Drain sediment from carburetor bowl.

Drain cooling system (when water is used), flush out and refill.

Tighten spring clips.

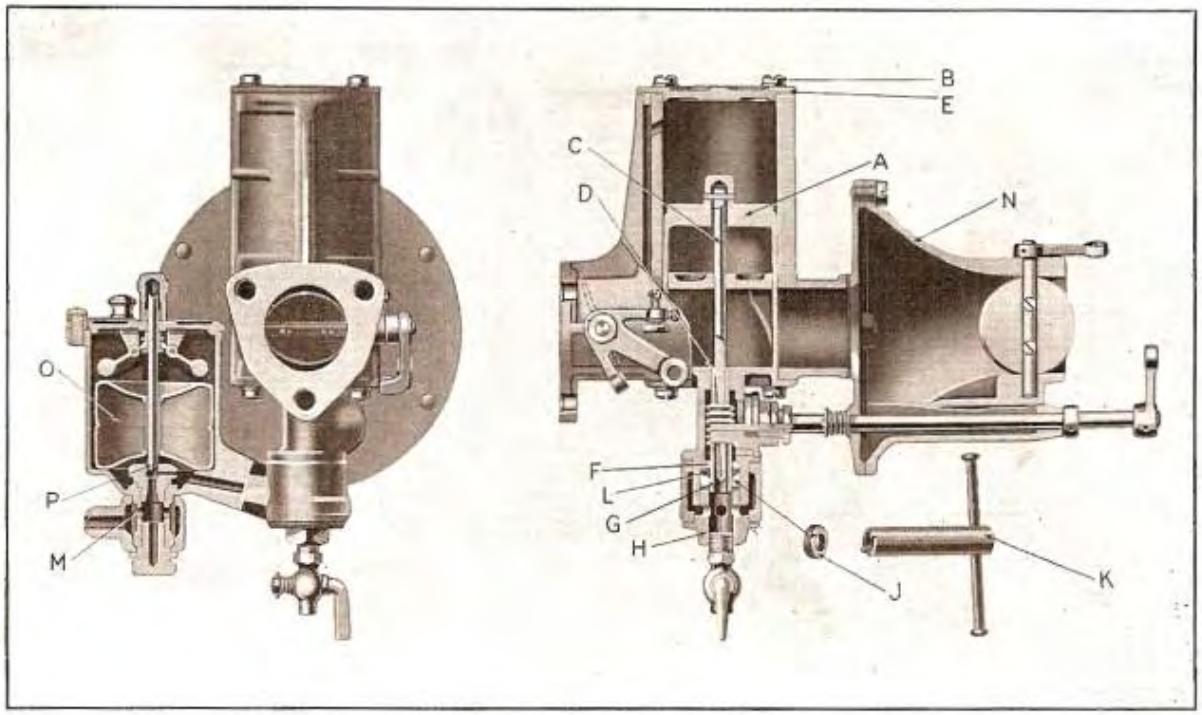
See that spring shackles are tight.

Inspect brakes. (See page 23.)

Lubricate spring leaves.

Lubricate generally. (See page 14.)

Oil all brakes, levers and connections.



CARBURETOR

A. Piston.
B. Cover Screws.
C. Metering Pin.
D. Groove.
E. Cover.
F. Gland.
G. Sleeve.
H. Jet Housing Screw.
J. Gland Nut.
K. Gland Nut Wrench.
L. Packing.
M. Fuel Inlet Screen.
N. Muffler.
O. Float.
P. Needle Valve.

CARBURETOR

The Piston

The piston "A" performs the function of automatically regulating the mixture, and for this reason must at all times work freely in the cylinder. See illustration, page 18.

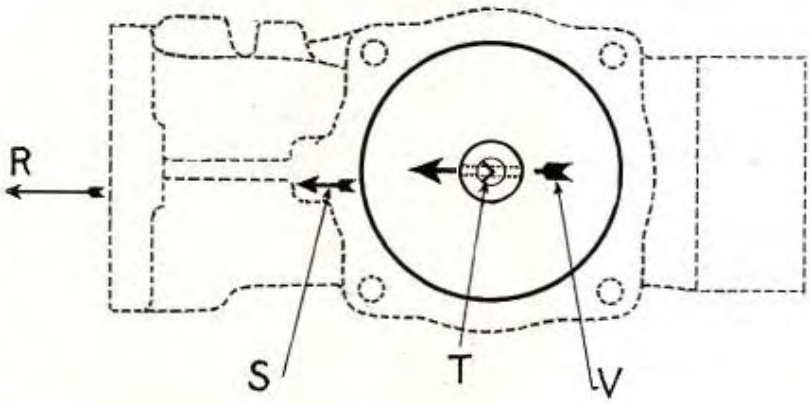
Remove the cover screws "B" from the top of the carburetor. Lift out the piston and metering pin assembly. Carefully polish the surface of the piston with silver polish or whitening, being careful not to scratch or dent it. Clean the walls of the cylinder in which the piston operates. When replacing make sure that the groove "D" in the metering pin "C" points toward the motor and that the cover joint "E" is air tight.

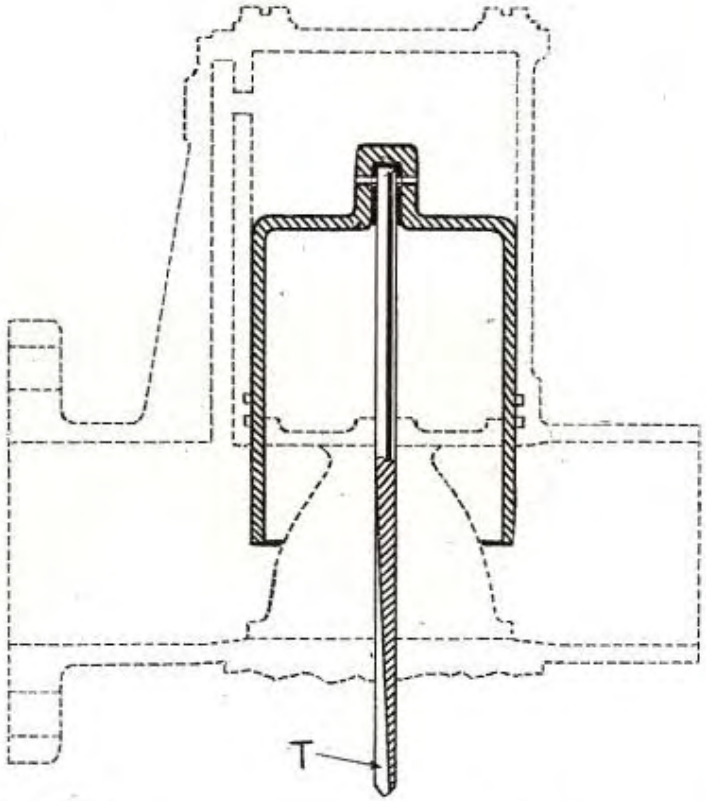
The Packing Gland

The gland "F" should fit properly on the regulating sleeve "G." If it leaks excess fuel will enter the motor by way of the outside of the sleeve instead of being regulated by the metering pin which operates inside the sleeve.

Remove the jet housing screw "H" and the float chamber. The packing gland nut "J" is then accessible and can be removed or tightened by the use of the wrench "K" shown. If a wrench is not available then a broad screw driver can be used. The use of the proper wrench is preferable because it is constructed so that the sleeve can be raised and lowered during the tightening process, thereby assisting in getting the desired result. If necessary remove the old packing "L" and repack with soft candle wicking.

When assembling the float chamber and carburetor body be sure that the fuel inlet screen "M" is perfectly clean before returning the jet housing screw to place.



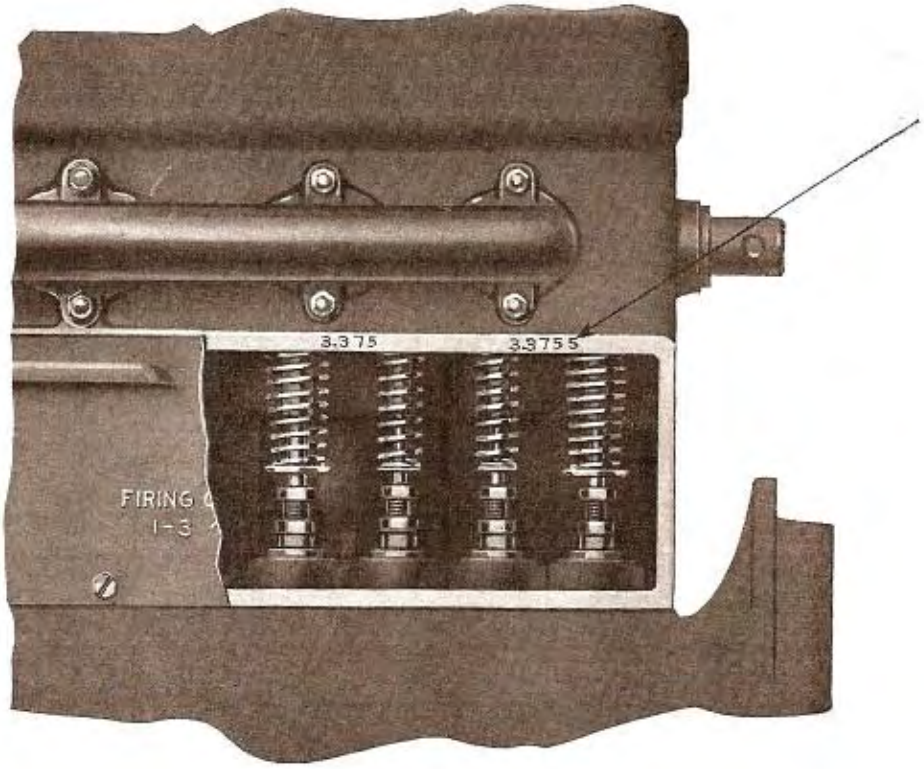


R. To Motor.
S. Arrow in Throttle Body.
T. V Groove.
V. Arrow on the Bell.

R ←

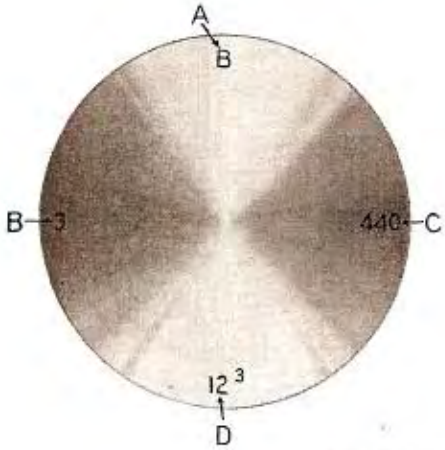
IMPORTANT

When assembling metering pin and also air bell to the throttle body, be sure the arrow on the bell points in the same direction as the open end of the V groove, and that arrow on bell also points in same direction as arrow in throttle body.



PROPER FITS OR CLEARANCES FOR PISTONS

The minimum and maximum clearance allowable for Essex pistons is .008 inch and .009 inch. Every cylinder bore is very carefully measured, and the size is stamped along the valve cover plate side of the motor, opposite each bore. (Note illustration above.)



METHOD OF MARKING PISTON HEADS

A. Piston Size Code Letter.
B. Cylinder Number.
C. Serial Block Number.
D. Weight Code Number.
E. Piston Size Always Measured Here.

Each piston wrapper is plainly marked with the size of cylinder bore to which that particular piston is to be fitted. They will come to you coded as follows:

STANDARD

A indicating 3.366
B indicating 3.3665
C indicating 3.367
D indicating 3.3675
E indicating 3.368
F indicating 3.3685
G indicating 3.369

.020 OVERSIZE

AA indicating 3.386
BB indicating 3.3865
CC indicating 3.387
DD indicating 3.3875
EE indicating 3.388
FF indicating 3.3885
GG indicating 3.389

HOW TO SELECT PISTONS

Cylinder bore 3.375 use A, B, C

Cylinder bore 3.3755 use B, C, D

Cylinder bore 3.376 use C, D, E

Cylinder bore 3.3765 use D, E, F

Cylinder bore 3.377 use E, F, G

Cylinder bore 3.395 use AA, BB, CC

Cylinder bore 3.3955 use BB, CC, DD

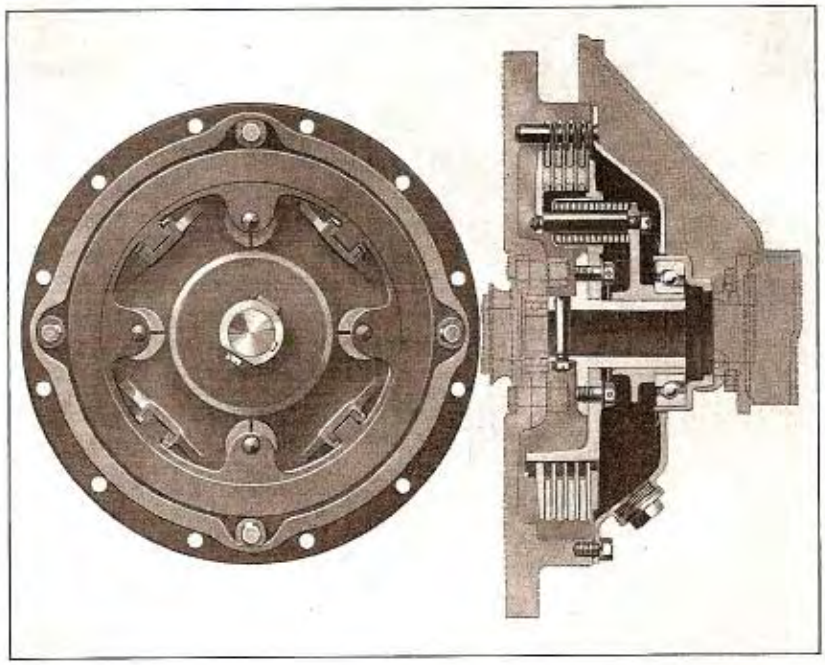
Cylinder bore 3.396 use CC, DD, EE

Cylinder bore 3.3965 use DD, EE, FF

Cylinder bore 3.397 use EE, FF, GG

Piston weights are given in ounces and quarter ounces. Suffixes after 1, 2 and 3 are used to indicate quarter ounces. For instance, the large figure (12 in illustration) indicates the weight in ounces. The smaller one (3 in illustration) stands for quarter ounces. Thus the figure 12^3 means that the piston weighs 12¾ ounces. They range in weight from 11 to 13 ounces.

Note—Before fitting a new piston, dress off any sharp corners which may come into contact with cylinder bore, such as edges of ring grooves, edges of gudgeon pin relief, etc.



CLUTCH

THE CLUTCH

The only care necessary is to renew the clutch oil regularly. The fact that the cork inserts become saturated with oil makes it comparatively difficult to abuse this clutch if our lubricating instructions are strictly adhered to. Always drain the old oil out before filling with fresh oil. Refill with one-half pint only of a mixture of half kerosene or coal oil and half high grade motor oil. Do not experiment with the mixture.

Do not slip the clutch except when absolutely necessary and then only when you are sure it has sufficient lubrification.

The clutch throwout bearing is lubricated from the transmission and requires no attention.

Wear on the cork inserts will in time cause the clutch pedal to drop down slightly. There is a small set screw and lock nut located on the stop in front of the clutch pedal under the floor board, by means of which the wear in the clutch can be taken up.

The pedal should not touch the foot plate when engaged.

Oil pedal shaft and pedal often.

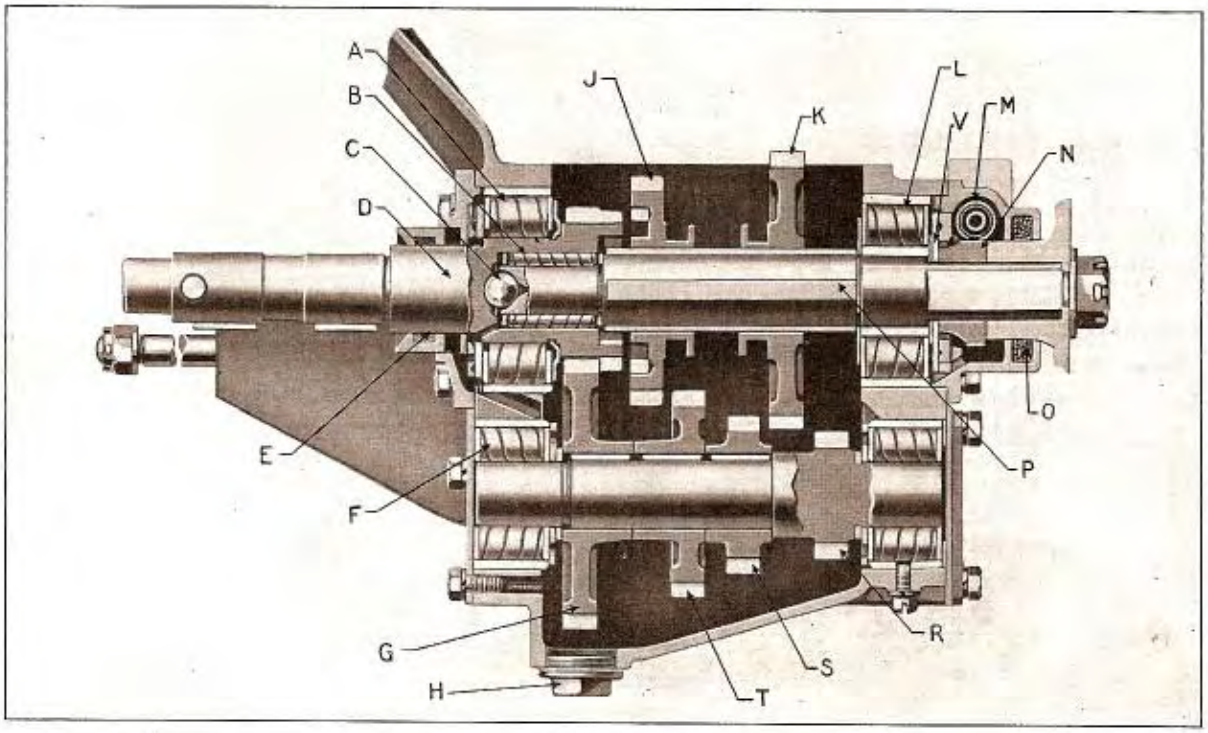
Do not lubricate transmission above overflow plug, or oil may get into clutch and cause it to slip. Should this occur, wash out clutch and refill with clutch oil.

THE TRANSMISSION

The transmission is provided with means of adjustment by which ordinary wear can be compensated for when necessary.

To Adjust Main Shaft

Excessive end movement in the main shaft may cause the gears to slip out of mesh when engaged and will make the transmission noisy. To remove this end movement it is necessary to loosen the cap screws which hold the rear main shaft bearing cap in place and take out one or more of the shims "V." When the cap is tightened in place there should be no more than from .004 inch to .007 inch end movement in the shaft. There should not be less than .004 inch, or the bearing will cut through lack of lubrication.



TRANSMISSION

A. Drive Gear Outer Bearing.
B. Drive Gear Inner Bearing.
C. Mainshaft Thrust Ball.
D. Main Shaft Drive Gear.
E. Felt Washer.
F. Countershaft Bearing.
G. Countershaft Drive Gear.
H. Drain Plug.
J. High and Intermediate or Second Gear.
K. Low and Reverse Gear.
L. Mainshaft Bearing.
M. Speedometer Drive Gear.
N. Speedometer Drive Gear.
O. Felt Washer.
P. Mainshaft.
R. Countershaft and Reverse Gear.
S. Countershaft First Speed or Low Gear.
T. Countershaft Second Speed or Intermediate Gear.
V. Shims.

To Adjust Countershaft

When excessive end play develops in countershaft, it can be removed by removing shims from behind the plate which covers the front bearing "F" and the shaft. Never remove shims from the rear countershaft bearings.

Gears Jumping Out of Mesh

This is caused by excessive end movement in shafts (see above) and can also be caused by the interlocks which engage on the notched shifting shafts failing to enter the notch and hold properly. The spring should be tested and replaced if weak, and the interlocks or plungers should be set so they fully engage with the notches.

THE REAR AXLE

Adjustment of Gears

The bevel gears are adjusted as follows:

1. Remove end movement from bevel pinion shaft.
2. Adjust pinion so that the back face of the teeth on bevel gear and pinion will be flush.
3. Adjust bevel gear to left or right to obtain proper back lash of .006 inch to .008 inch.

To Remove End Movement in Bevel Pinion Shaft

Loosen adjustment lock nut "N" (rear axle diagram) and turn "M" nut to take up play. Adjust until there is no more than .005 inch end play. See that shaft does not bind or turn hard. Then hold adjustment "M" against movement and turn up lock "N" until tight. Try shaft again. If shaft binds, back off adjustment "M" slightly and re-lock until adjusted properly.

To Adjust Pinion so That Back Face of Teeth on Bevel Gear and Pinion Will Be Flush

Remove bevel pinion shaft adjustment lock "D" and screw shaft adjustment in or out until the back face of the teeth are flush. Then lock the adjustment and replace clamp bolt. The gears may be inspected while making this adjustment by removing inspection plug on the left side of the rear axle housing on top.

To Adjust Bevel Gear for Back Lash

Remove differential cover plate on the rear of the axle housing. Take off the differential bearing adjustment locks "G" and loosen cap bolts sufficiently to allow the differential bearing adjusting nuts "F" to turn. Turn nuts up until play is removed, but gear still turns freely. To move ring gear to left, loosen left side nut two notches and turn up right side nut the same. Repeat this operation until the required back lash is obtained. To move ring gear to right, reverse this operation. When completed lock and tighten bolts holding bearing nuts in place.

Adjustment of Wheel Bearings

The wheels should be removed with a wheel puller—not by striking end of shaft with hammer. This will injure the bearing.

Remove adjusting nut lock and locking bolt. Take up the adjusting nut "B" until the drive shafts show about .005 inch to .010 inch end play, but are perfectly free and the bearings do not bind. Do not take up all the play from one side if there is much to adjust. Equalize it by taking up the same amount on each side until the proper result has been obtained.

When returning lock, if the notches do not correspond, back the nuts off until the lock will engage. Never tighten the nut to make lock engage or too much pressure will be placed on the bearings.

Adjustment of Foot Brake

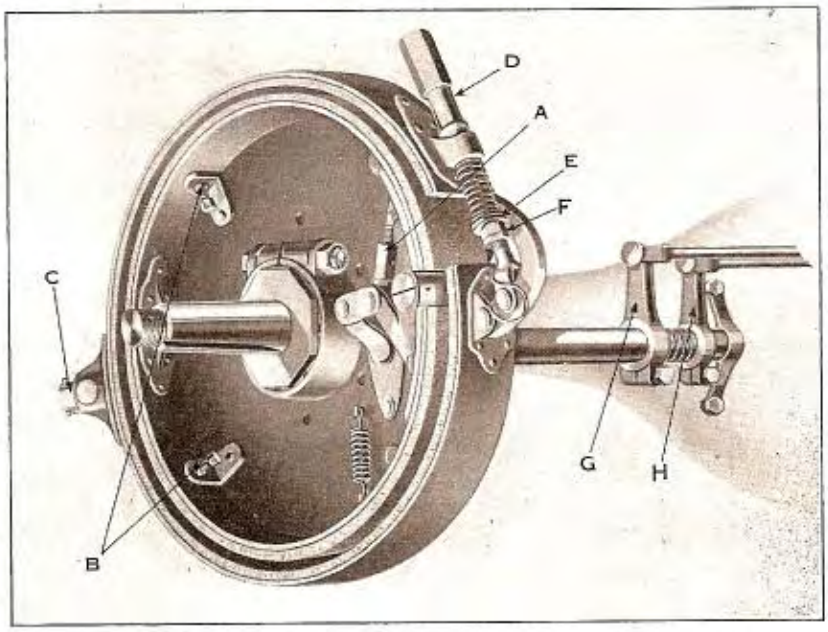
In adjusting brakes you should see that the pull rods which actuate the brakes point backward. The pull rods which connect to the levers "G," "H" and "E" are adjusted so that these levers are to the rear as far as possible.

See that back of brake band is as close to drum as possible without dragging. Band can be adjusted by screw "C." Adjust lower half of band first by backing nuts "F" away from brake; this lets lower half up closer to drum.

Note—Now that upper half has more clearance than before, adjust this by nut "D."

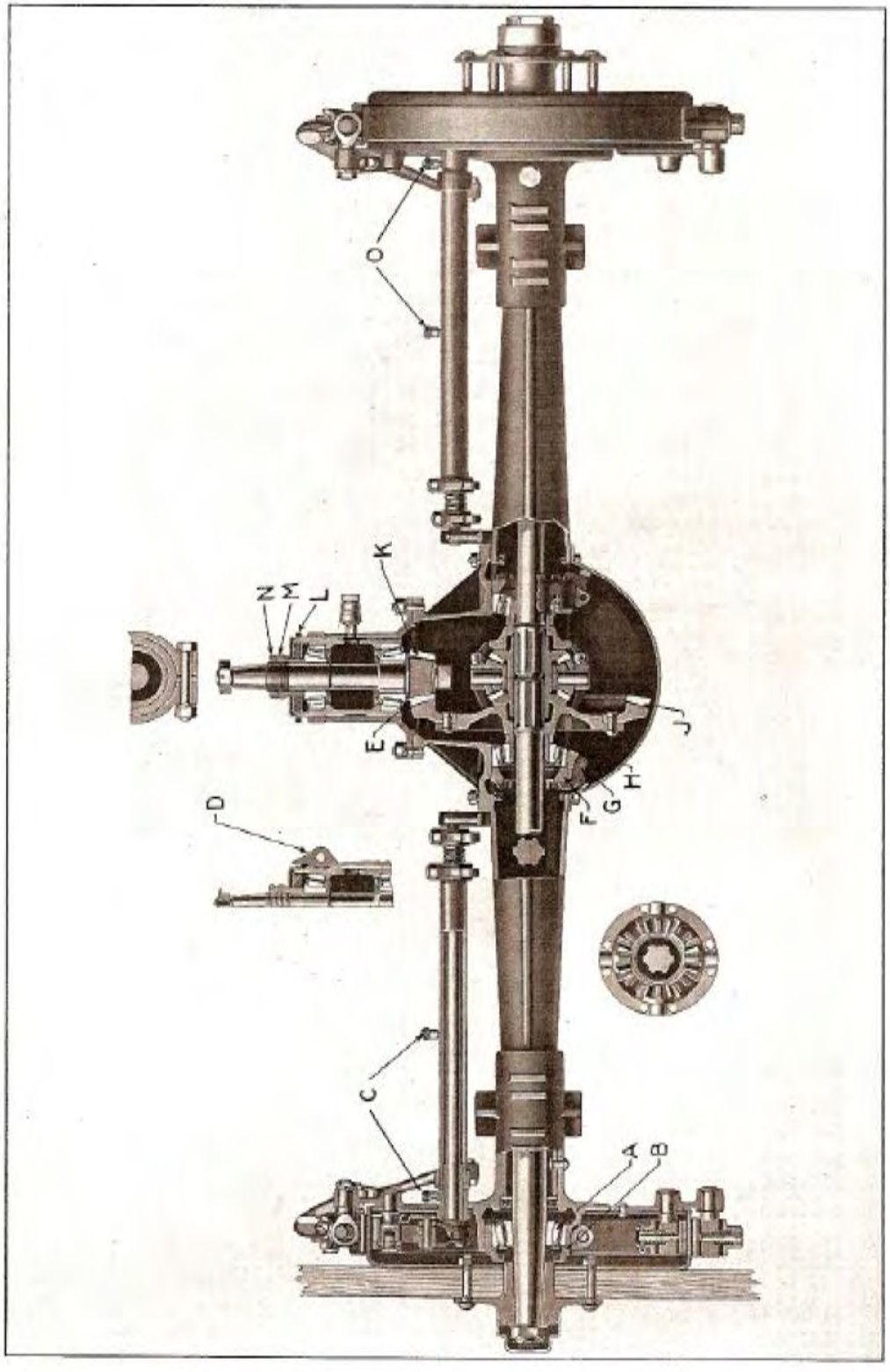
Oil all brake connections and keep them working freely.

Never try to adjust brakes any other way than specified above:



First—Rear. Second—Lower half. Third—Upper half.

THE ESSEX REAR AXLE

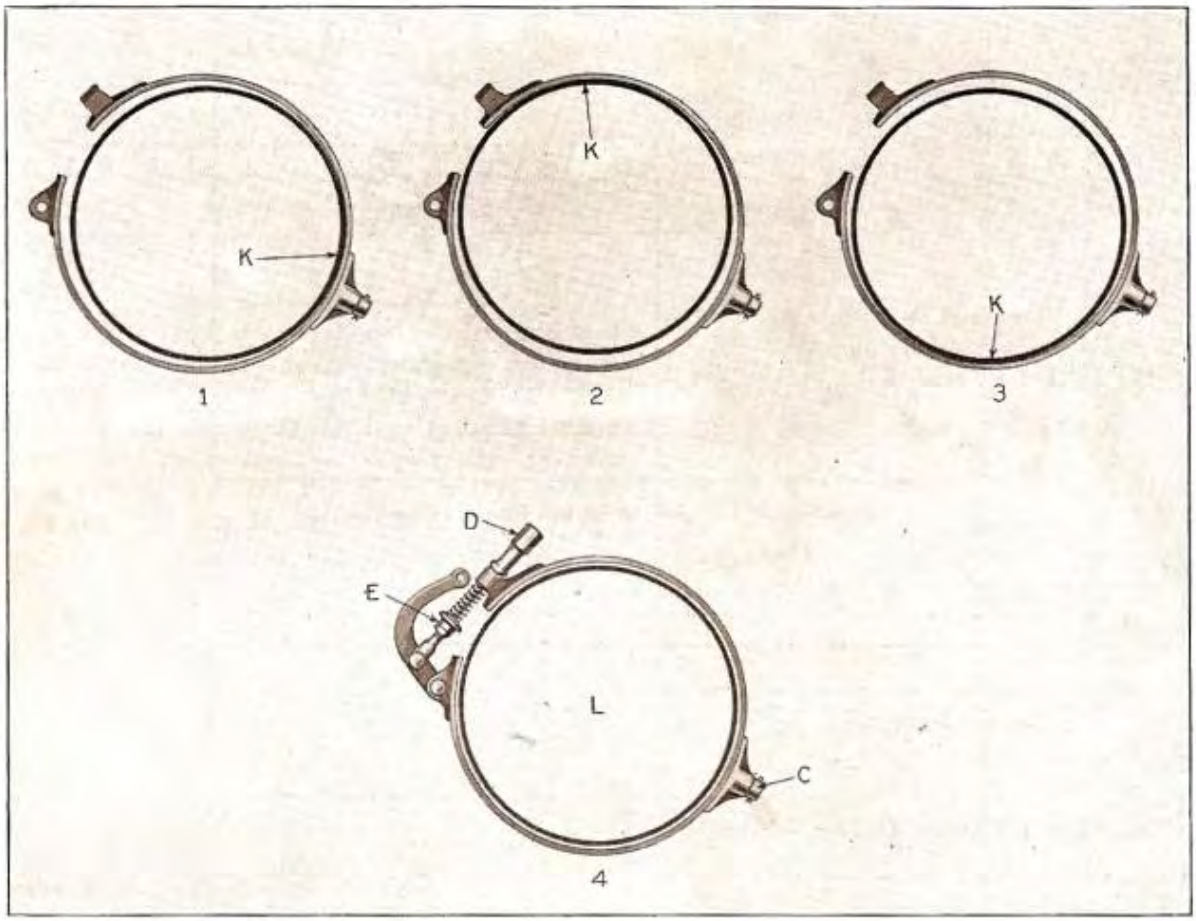


Adjustment of Hand Brake

The wheels should be removed with a puller and the band adjusted by means of the set screws "B" until the band conforms exactly to the inside surface of the drum, with the wheel revolving freely.

When lining becomes worn it will be necessary to remove clevis pins and lengthen the arm "A" by turning out the clevis. Do not lengthen sufficiently to necessitate the drum being forced over the band. Wheel must be free when hand brake lever is in off position. When adjusted return clevis pins and lock with cotter pin.

Keep all connections oiled and free.



BRAKE BAND ADJUSTMENT

K. Wrong. L. Right.

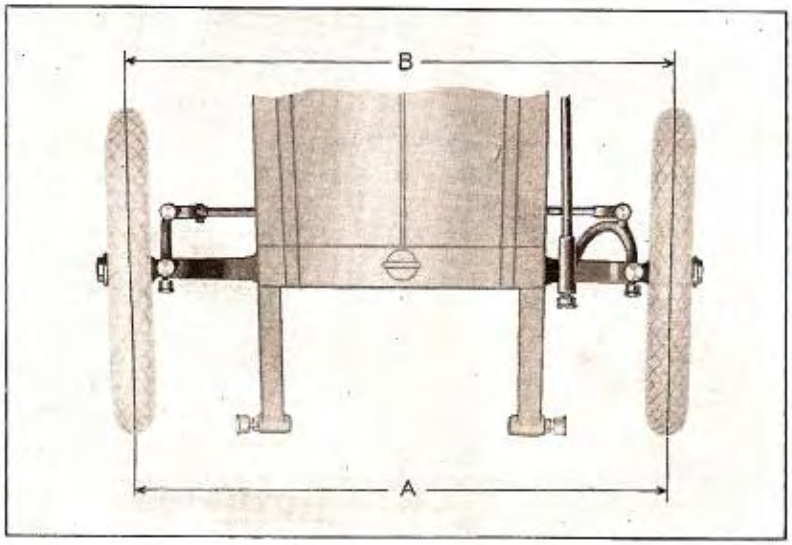
WHEEL ALIGNMENT

Because the alignment of the wheels is an important factor in the life of the front tires, the distance rod is provided with adjustments. The front of the tires should be about $\frac{5}{16}$ inch closer together than the rear, measured at the same height from the ground.

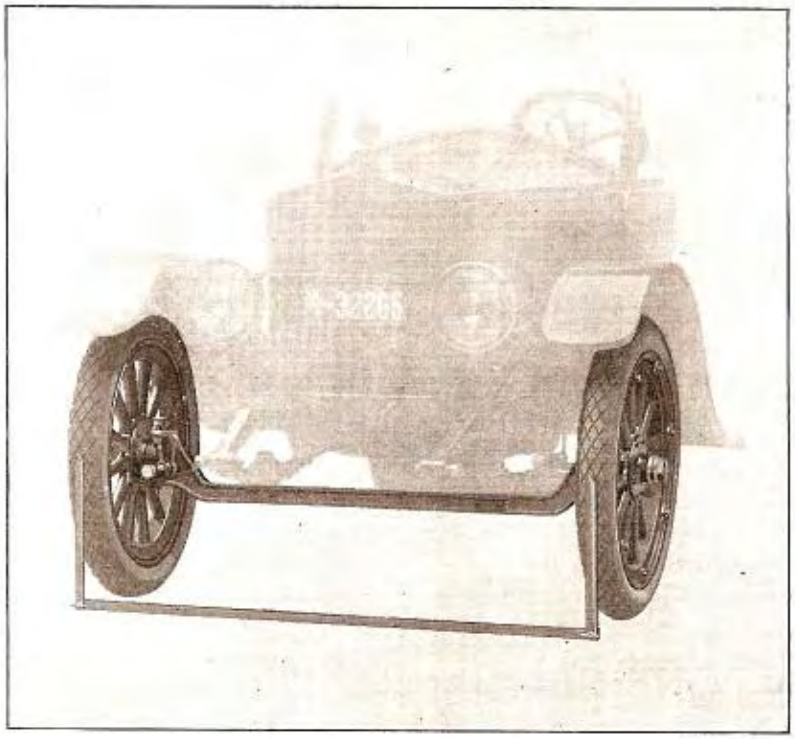
To check this adjustment jack up the front of the car from the center of the axle so that the distance rod is not interfered with. With both wheels free to revolve, a center line may be marked on each tire by holding a soft lead pencil against it when spinning. The pencil must be held steady or the result will not be a straight line. Next, measure with a tape or stick the distance between these lines at a point opposite the hub; turn the wheels half a revolution and measure again. The distance between the two results is the average, allowing for a slight wabble, and should be $\frac{5}{16}$ inch to $\frac{3}{8}$ inch less than the distance measured in the same way at the rear.

The handiest way to check this alignment is with the distance stick shown in the illustration. To adjust the distance rod, remove one of the bolts so that the clamp screw can be loosened and the clevis adjusted by turning on the threads of the distance rod. Any back lash in the axle knuckles and clevises should be taken up by straining the wheels outward in front before setting the distance by the rod.

The job should always be checked after the wheels have been let down on the ground with the weight of the car on them.



Dimension "A" 5/16 inch to 3/8 inch less than Dimension "B"



FRONT WHEEL ALIGNMENT

THE STEERING GEAR

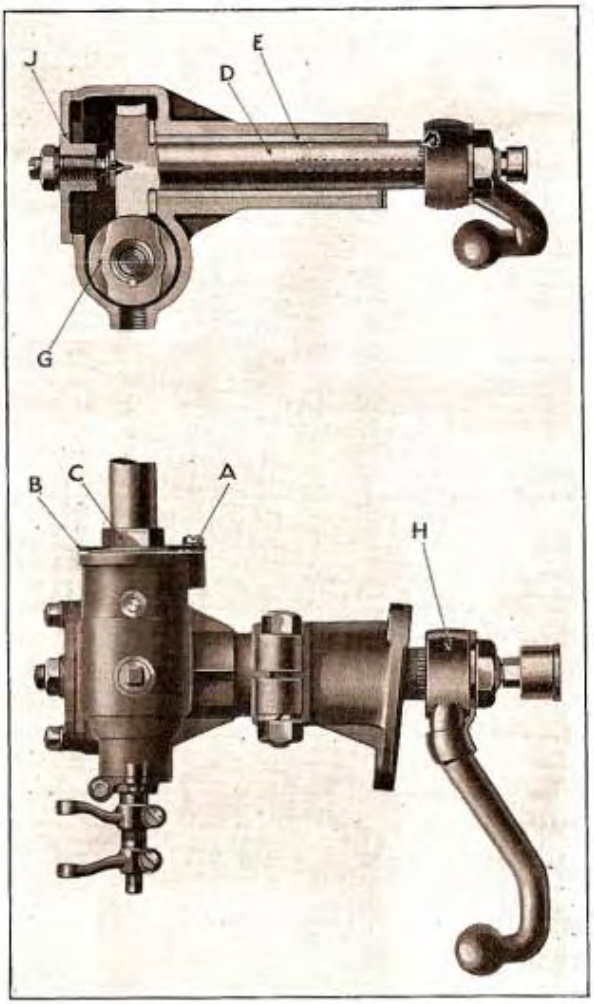
This has all the necessary adjustments for taking up wear of any kind.

End Movement in Steering Post

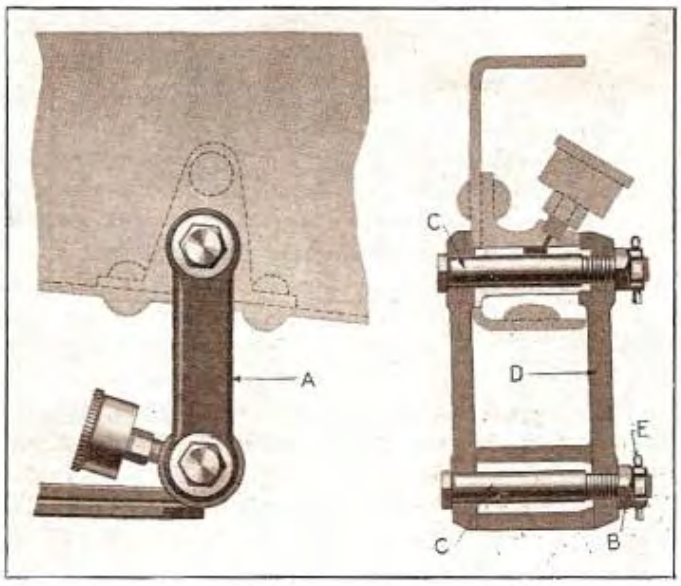
Remove screw "A" and lift locking plate "B" clear of adjusting nut "C." Adjust by turning the nut downwards until play is eliminated. Replace the locking plate in position to bring one of the two holes as nearly in line with the hole in the housing as possible. If necessary back off adjustment until the screw can be entered through one of the two holes in the plate and through the tapped hole in the housing.

Back Lash in Gears

In order to bring the worm wheel deeper into mesh with the worm "G," first remove box from bracket on frame after taking off the arm "H." Remove pin at outer end of box near arm, and turn eccentric bushing "E" until mesh is correct, then replace pin. If worm wheel is worn in one spot, give one-third turn or more and put arm "H" back in new position.



STEERING GEAR



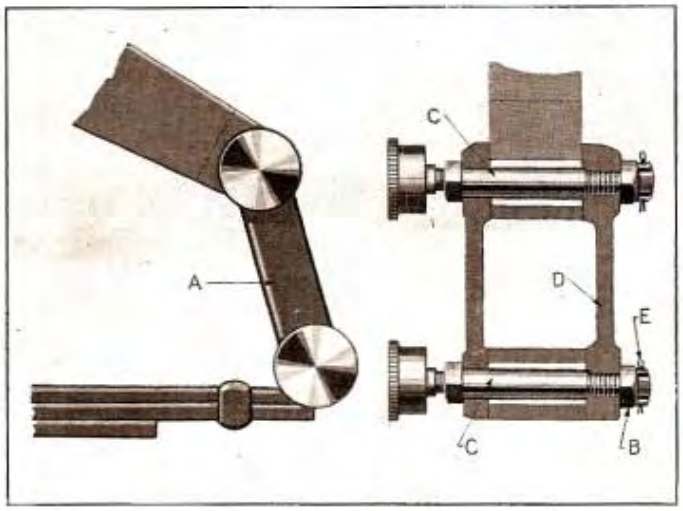
FRONT SPRING SHACKLE

SPRINGS AND SPRING SHACKLES

To get spring action and easy riding qualities the spring should be lubricated every 600 to 800 miles. Constant attention with an oil gun is recommended. The oil should be applied along the sides of the springs themselves.

Spring breakage is often caused by lack of lubrication or loose spring clips—those clips which secure the springs to the axles. The enormous strain under which they are subjected tends to loosen them up. It is therefore necessary that these clips be inspected occasionally for tightness.

The spring eyes and shackles "A" are subject to a certain amount of wear, which in time will cause a rattle or knock. This side play can be eliminated by loosening up shackle bolt nut "B" and turning bolt "C" until the threaded shackle "D" is turned in sufficiently.



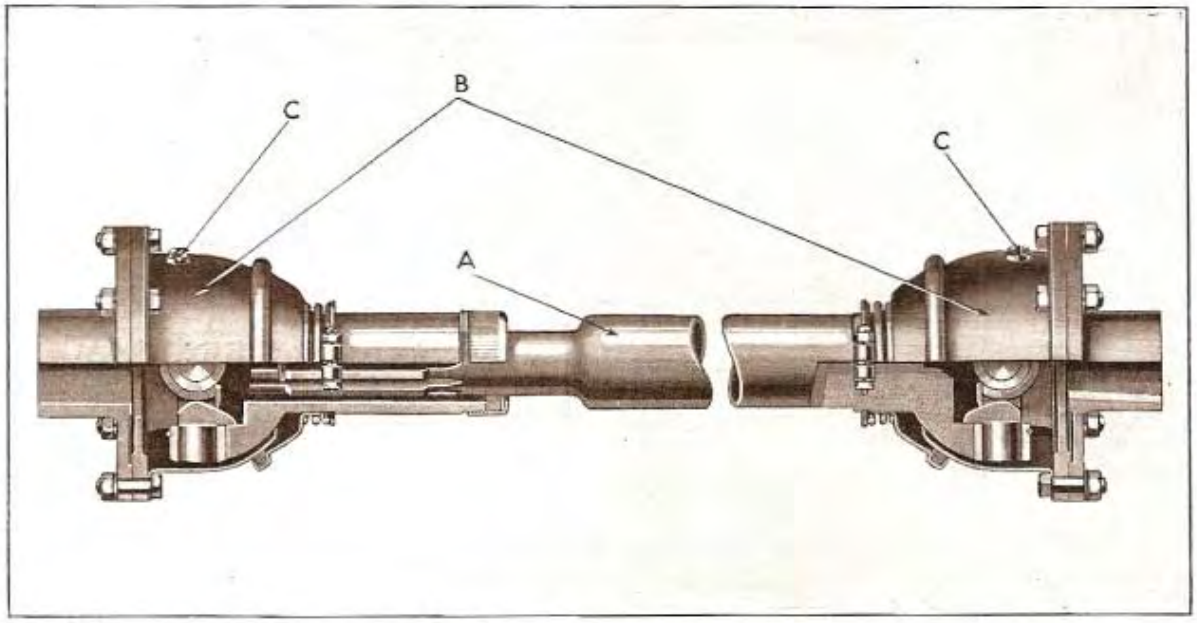
REAR SPRING SHACKLE

To adjust front ends of springs, remove cotter pin and pull spring bolt nut up tight, then back off 1/6 turn and replace cotter pin.

UNIVERSAL JOINTS AND PROPELLER SHAFTS

The universal joints depend upon their dust covers "B" to retain the necessary lubricant, and if the covers are loose the grease will leak and dirt will work into the joint. Dirt causes abrasive action when mixed with grease. The resulting wear will be out of all proportion to ordinary service.

Every thousand miles or more often refill universal joints with a good quality soft grease or heavy steam cylinder oil. Remove pipe plug "C" and insert grease gun and fill, then replace plug.



UNIVERSAL JOINTS AND PROPELLER SHAFT

COOLING SYSTEM

To obtain best results with the cooling system the following precautions must be taken:

1. Have a thorough, practical knowledge of the uses of the radiator shutter and motometer which are described on page 15.
2. The cooling system must always be filled with clear water, preferably rain or soft water.
3. Drain, flush out and refill occasionally to prevent sediment accumulating. Drain plug is located at lower water connection, left hand side.
4. See that there is sufficient tension on the fan belt to drive the fan without slipping.

5. The hose connections must not leak and should present a smooth inner surface.

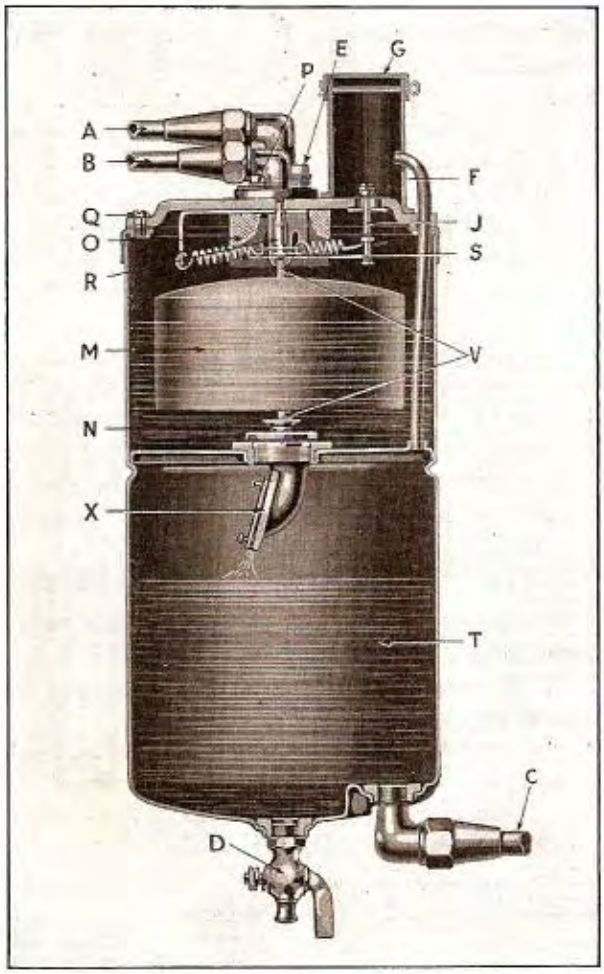
6. Use the anti-freeze solutions which we recommend in cold weather. (See page 35.)

7. Should you damage your radiator, locate the leak and stop it by pinching the tubes together with wooden plugs driven in at front and rear. Don't use meal or anything which will clog the passages.

PETROL SYSTEM

How the Vacuum Tank Operates

There are three pipes leading from the tank (see cut). Two from the top or cover of tank "A" and "B," and one from the bottom "C." Pipe "A" is connected to the supply tank at the rear of car. Pipe "B" is the vacuum line and is connected to the intake passage of motor. Pipe "C" is the outlet pipe and is the petrol line to the carburetor. The bottom of the tank is formed up, and so forms a water and sediment trap, which may be drained at "D."



The suction from engine through pipe "B" draws petrol from rear tank through pipe "A" until the upper or float chamber is nearly full, then float rises and shuts off vacuum valve "B" and opens vent valve "J," which lets in atmosphere pressure that destroys the vacuum. The weight of petrol in upper chamber "M" now opens flapper valve "X" and allows it to flow to lower chamber "T," where it is fed by gravity through pipe "C" to the carburetor.

As the petrol flows from the upper chamber to lower, the float drops with it until when nearly empty the float wire "V" opens vacuum valve "R" and closes vent valve "J," putting tank again into operation. The petrol entering the vacuum tank passes through a filter screen "O," which has ample capacity to take care of car for one season without cleaning.

The petrol system requires little attention other than that of keeping all connections tight and keeping vent hole in filler cap on rear tank open. About every 1,000 miles open drain cock "D" on vacuum tank and allow any sediment or water that has accumulated in the trap to drain out. (Insert wire in drain cock if there is no flow.) If vacuum tank is empty it will be necessary to fill it before motor can be started. This can be accomplished by closing throttle, choking carburetor and turning motor over a few times with the starter. If this does not fill the tank, it may be that a small piece of sediment has lodged on flapper valve "X" and does not allow it to close. Remove pipe plug "E" in top of tank and pour petrol into tank; also remove vent cap "G" and squirt a little petrol in top of vent "F." This will in most cases wash out the dirt and the petrol poured in at "E" will run the engine until tank starts to operate. If petrol runs through valve "J" when squirted in at "F," it is certain that this valve leaks and should be worked in with a screw driver (bearing very lightly) until it holds petrol.

To test the flapper valve "X" for leak, disconnect pipe to carburetor at "C" and with motor turning over with starter hold finger close to, but not touching hole in fitting "C"; also remove cover "G" and plug up all openings in "F." If even a slight suction is felt or draws the bubble of petrol off finger into tank, the flapper valve is leaking, and if after repeated attempts to wash it out, as explained above, it still leaks, it will be necessary to take tank apart in order to clean or repair it.

If engine floods or gets too much petrol when running on usual adjustment, remove pipe plug "E" in top of tank, and if this remedies trouble it is probable that float leaks. Car may be run to where you desire to make repairs by operating the tank with the plug "E" removed. When tank is nearly empty replace

plug and allow it to fill up; then remove plug and proceed as before. To repair float the tank will have to be taken apart and the instructions following should be rigidly adhered to.

Instructions for Dismantling Vacuum Tank

Before attempting to take tank apart, be positive that the trouble is in the tank. Make sure that all pipes are clear and connections tight, and that there is no excess sediment in the screen "O." Sediment may be removed by disconnecting pipe at "A" and screwing out bushing "P"; lift out the sediment with a hairpin or knife blade, being careful not to injure screen.

If all preceding instructions have been followed with no results, and it is necessary to dismantle the tank, follow instructions very carefully.

Remove eight screws at "Q" in top; then insert knife blade between cork gasket and cover (not between tank and gasket) and move blade around cover, using great care not to hurt cork gasket, as this will allow an air leak when re-assembled and cause tank to fail to work. After top has been lifted out, care being taken not to stretch springs "S," you are now ready to make the necessary adjustments. If flapper valve "X" is leaky it can easily be screwed out and cleaned. Do not scrape or otherwise mar valve seat. When cleaned and tight, return to place, being sure that copper gasket is back in place and tight.

If float "M" has sprung a leak, it should be repaired as follows:

First unhook springs, being careful not to stretch them, and also to note how they are hooked into yoke so as to replace in a like manner.

Next dip float in hot water and notice where bubbles rise, as this indicates the leak. After leak has been found, punch a small hole in top of float, also one in the bottom near the outside edge to let the petrol out. After all petrol has been let out, solder up the leak first, then the other two holes. Use as little solder as possible so as not to unbalance the float. While the tank is down thoroughly clean the filter screen. Next see that float wire "V" is smooth and has not been bent; hook springs "S" to yoke as found and lower float into tank. See that float wire is started into wire guide on flapper valve "X." Then tighten down eight screws "Q" a little at a time, going around several times so as not to spring tank or flange.

Best protection against trouble is to drain your main petrol tank often to let out dirt and sediment; plug at bottom.

THE CARBURETOR

The Essex carburetor operates upon the pneumatic principle. A glance at the section view of the carburetor on page 18 will show clearly the operation. When the throttle is opened with the motor running, the suction is communicated to the air chamber by way of the pneumatic control passage. This causes the piston to rise and with it the metering pin. The metering pin has a V-shaped slot cut in it, and as the pin rises or falls, according to the motor's requirements, it changes the area of the slot at the petrol feed regulator, and consequently controls the amount of fuel passing through. The proportioning of the mixture is automatic at all speeds, the piston giving instant response to the demands made on the motor.

Any adjustments necessary can be made entirely with the dash controls. The air control adjustment is used only for starting the motor in cold weather or after it has been standing for any length of time. Once the motor is running it should be operated with the air adjustment valve open.

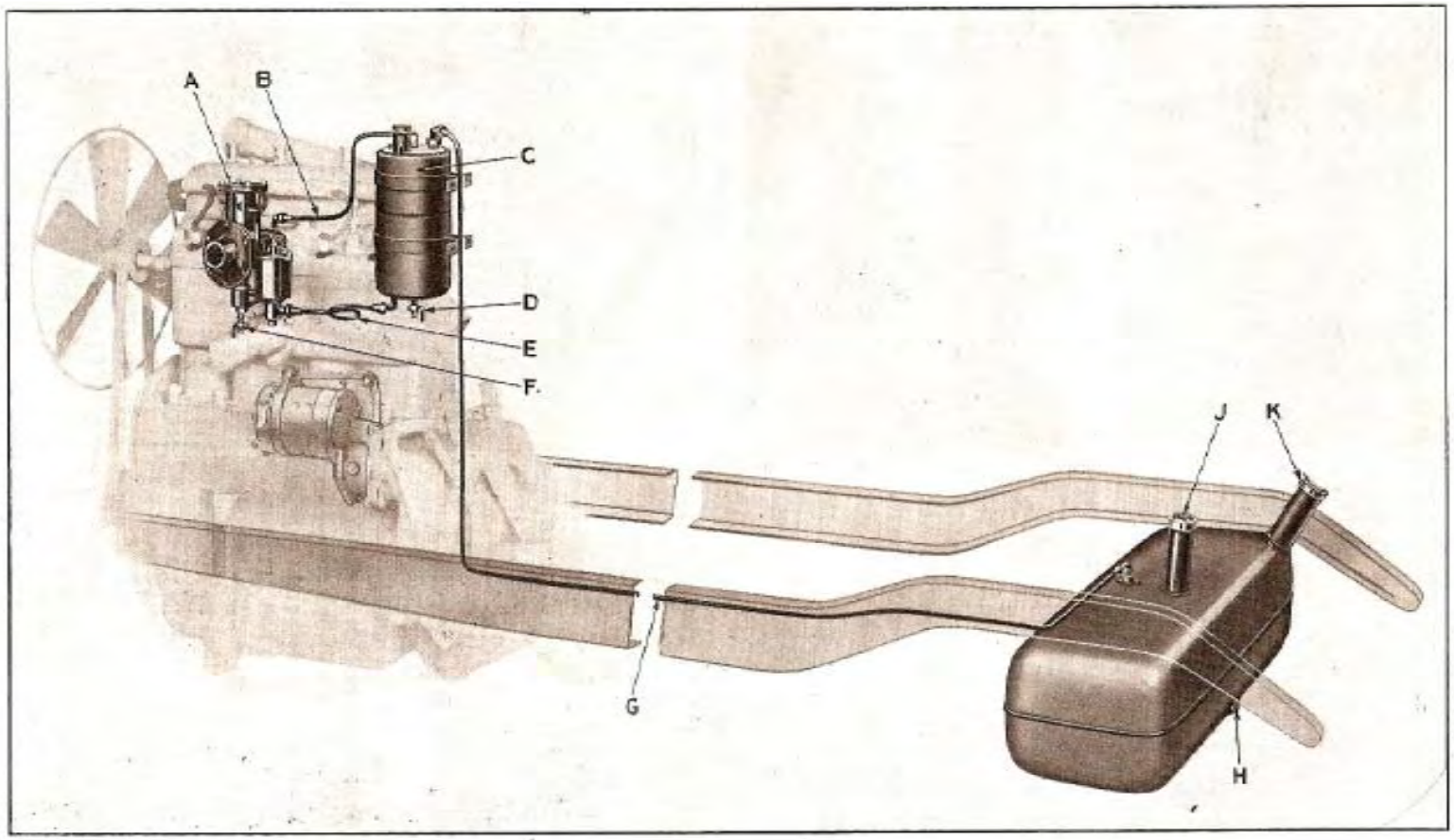
The petrol adjustment enables the driver to have the mixture as rich or lean as desired, by varying the amount of fuel allowed to pass the metering pin. This is done by raising or lowering the petrol feed regulator which surrounds the metering pin. This regulator is actuated by the "Gas" button on the dash.

When the radiator shutter has been adjusted so that the motor temperature maintains the red fluid in the motometer at the center of the circular opening, the motor will operate very economically on a lean mixture. Of course heavier duty placed on the motor, such as hill climbing, pulling through sand, high speed, etc., places proportionate demands upon the amount of fuel, but in ordinary driving at speeds of 20 miles per hour upwards, the carburetor should be adjusted as lean as possible.

Too rich a mixture results in carbonization and misfiring; too lean a mixture gives less power and acceleration at low speeds. The entire range of adjustments are convenient to the driver.

The carburetor requires no attention other than that of making sure, periodically, that the piston is clean and that the packing gland is tight. A sticking piston will seriously interfere with the action of the carburetor and a loose packing gland will permit excessive petrol consumption with its attendant troubles.

See illustration and instructions on page 18.



THE PETROL SYSTEM

A. Carburetor.
B. Vacuum Line.
C. Vacuum Tank.
D. Drain Cock.
E. Carburetor Supply Line.
F. Carburetor Drain Cock.
G. Petro. Supply Line.
H. Petrol Drain Plug.
J. Petrol Gauge.
K. Petrol Filler Cap.

TO MAINTAIN MOTOR EFFICIENCY

The oil in the motor must be changed frequently, preferably every five hundred miles of use.

The best grades of motor oil obtainable will, after use, precipitate a black sediment. This sediment has no lubricating value; in fact, as more and more oil is added to the motor, this deposit seriously impairs the lubricating qualities of the new oil. Operating the motor under these conditions can have but one result—rapid wear of all moving parts.

Tests show that this deposit often assumes such proportions that after five hundred to one thousand miles (depending upon the quality of the oil) it is necessary to drain off the old oil in the crank case and refill with new, preferably flushing and draining out the crank case with a little clean cylinder oil (not kerosene or coal oil) before refilling in order that most of this deposit will be removed. This will keep the floating deposit at a minimum; but an accumulation will gradually adhere to the interior of the crank case, oil screen and oil pan which must be removed and thoroughly cleaned at least twice a year.

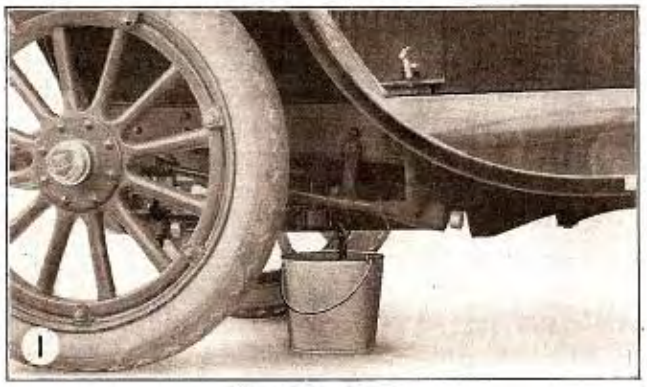


Illustration No. 1

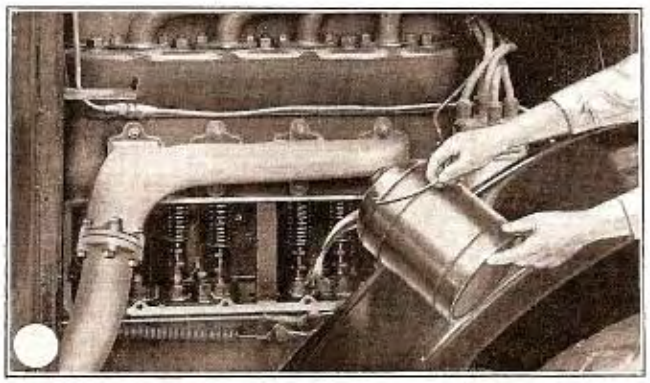


Illustration No. 2

Kerosene or coal oil should never be used unless the oil pan is removed—then clean engine as follows:

1. Drain oil.

2. Pour kerosene or coal oil through tappet chamber.

3. Crank motor for about thirty seconds. Do not let it run on its own power. Let the motor stand ten minutes.

4. Take down oil pan and thoroughly clean it with a stiff paint brush, moistened in kerosene, as shown in Illustration No. 4. Flush out oil screen and drain, making sure that no kerosene remains in pan. Return pan to position and tighten uniformly so as not to spring the pan and cause oil leaks. Replace drain plug. Don't forget to put gasket under screen. See that oil return at rear is not stopped up.

5. Pour two quarts of new, high grade oil of medium light body into motor through tappet compartment. Replace tappet cover plate. Refill crank case with 3 quarts of new oil (making 5 quarts in all).

Do this twice a year at least.

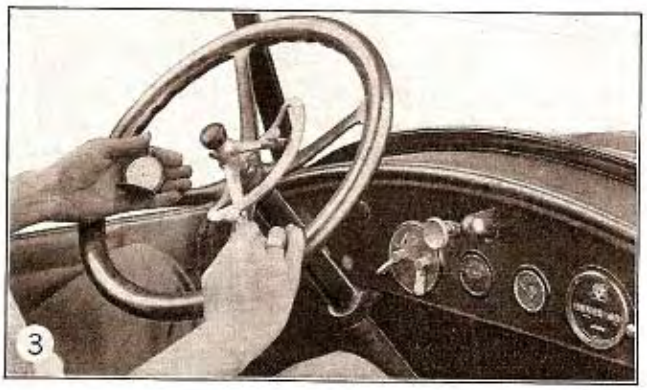


Illustration No. 3

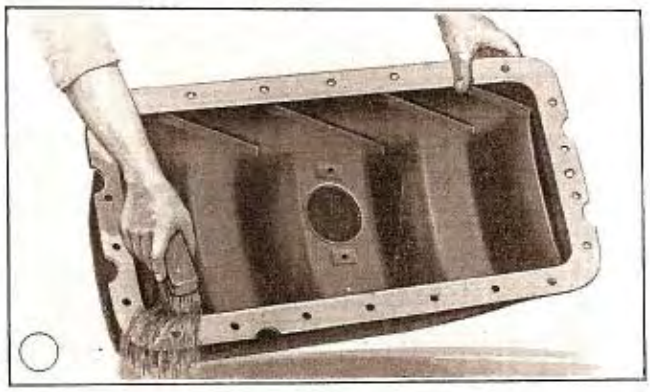


Illustration No. 4

TIRES

Keep tires inflated to pressure recommended by maker.

Clean out tread cuts with petrol. Apply rubber cement and squeeze in a little tire putty as supplied by tire manufacturers.

All cuts or tears should be vulcanized by a tire repairman.

The constant wearing down of the tread, either unevenly or round in circumference, may be caused by quick starting or stopping, or on the front wheels by improper alignment of wheels. (See page 26.)

Brake bands should be tested occasionally to make sure they are equally tight on both wheels.

If you find it necessary to use tire chains, they should be applied fairly loosely. Chains that are too tight cut and tear the rubber; if too loose they will fold under and produce same result.

Tire should be protected from extreme temperatures, bright light, grease and oil. If necessary to drive over oiled roads, tires should be cleaned with petrol upon returning.

When applying a new tire tube, examine the rim carefully. Remove rust with sandpaper and paint with regular rim paint or powdered graphite and petrol.

In applying tubes, dust inside of shoe with French talc.

Inflate tube sufficiently to hold it round so that tube will not be pinched.

Test the valve to make sure that it does not leak. If it leaks, tighten the valve inside with reverse end of valve cap. If this does not stop it, remove inside and insert a new one.

Spare tubes should be carried in the box in which they come, or should be carefully wrapped to prevent chafing or coming in contact with grease or oil. Don't carry them in a tool box over the muffler.

The following tire supplies should be kept on hand:

Extra tire and tube for emergency.

Pressure gauge.

A heavy rim cut or emergency blowout patch and sufficient cement and patch rubber for repairing ordinary punctures.

WIRE WHEELS

When changing a Houk wire wheel, care must be exercised in the removal or replacing of the hub cap. The hub cap wrench must be so applied that it completely grips the cap, at the same time being firmly placed against the shoulder as far as it will go, so that the pawl which locks the hub cap becomes completely depressed beneath the weight of the wrench and allows the hub cap to be turned freely.

Unless the pawl is forced downward by the proper application of the wrench, the hub cap remains locked and must necessarily become damaged as a result of trying to force it off while it is held in the hub of the wire wheel by means of an unreleased locking spring.

When tightening up the hub cap, always be sure that the pawl springs upward as soon as the wrench is removed. Otherwise the cap is not locked and the wheel is likely to come off. It is possible that the pawl may stick tight sometimes if a little dirt gets onto the spring. Be sure to see that the pawl functions properly.

The following instructions must be closely observed when installing wire wheels:

The inner hubs, being the part which is attached to the axle, are marked very distinctly "Right Side" and "Left Side." This marking indicates the proper side upon which these hubs are to be used. The right side of any car is on the person's right when he is sitting in the seat facing forward.

When the proper inner hubs have been selected for the right and left sides, bearings properly adjusted in the front hubs and keys properly fitted in the rear hubs, the locking nuts on the end of the front axle spindles and on the ends of the rear axle shafts should be securely locked by inserting cotter key through the nut and end of spindle or shaft.

The outer caps used for holding the wire wheel upon inner hubs are also marked "Left Side" and "Right Side." In addition to this the Rudge-Whitworth nut is marked showing direction in which nut should be turned in order to remove it. In case of the Houk wheel, the outer nut is marked showing direction in which same should be turned to screw it on. It is impossible to place a nut intended for the right side on the left side if the inner hubs are properly installed. This for the reason that the large nuts are cut with right hand threads on the left side, and left hand threads on the right side.

Always use wrenches furnished with wire wheels for removing outer caps, and before attempting to re-

move caps make sure that you are turning the wrench in the proper direction as indicated on the end of the cap.

WASHING OF THE CAR

The car should be regularly and systematically cleaned and renovated. The varnish on a new car is always benefited by an occasional washing with clear, pure water. The car, even when not in active use, should be cleaned at stated intervals. In summer, preferably the water should be cool. On a new car occasional washing with cold water serves to harden the varnish and increase its brilliancy. During the winter, if the washing is performed in a warm place, the use of cold water for an occasional washing may be continued, but cold water applied in a cold place at a frigid season of the year is injurious to the varnish.

When the car is in daily use or following each period of road service, the varnish should be washed, top cleaned and the interior furnishing of the car renovated.

Things to remember: Never wash the car in bright sunlight. The sun dries the water up too rapidly and causes streaks in the finish. Always use absolutely clean water and change it often to keep it clean. Never turn the hose on the body unless the stream is so broken up that it does no more than spray the body, but we advise the use of the pail and the sponge in preference to the hose.

Clean Top First

The top can be sponged off with clean, tepid water, and when coated with road dust or mud, this water should contain enough Castile soap to provide sufficient alkali to cleanse. Follow this cleaning by drying with a chamois skin.

Washing the Body

Begin washing the body by dipping the sponge well into the water in order to pick up as much water as it will hold, then begin at the top of the panels and gently dash the water obliquely against the panels. Another way is to squeeze the water out of the sponge at the top of the panels to loosen the dirty accumulations and cause them to drop off. These instructions are for cars that are washed immediately after road service.

When Washing is Delayed

Provided the car has been put away for the night unwashed, and the mud and other road refuse allowed to dry onto the finish, it will harm the varnish to apply water and attempt to remove these dry, crusty accumulations at once. All such surfaces should have plenty of fresh, clean water run down in an easy volume over the finish. Continue this practice until the dirt encrusted surface is thoroughly soaked up. Then let the work stand for 15 or 20 minutes for the water to so act on the body of dirt and mud that under a fresh flow of water it will readily run away without injury to the finish.

In all cases the mud and dirt should be floated off by a natural flow of water rather than wiped off. This latter practice usually results in the finish being scratched and disfigured by the grit and dirt. It must be understood that a water-loaded sponge drawn or rubbed over a dirty or mud-bespattered panel develops a scouring effect. This diminishes the brilliancy of the varnish and reduces its capacity for protecting the undercoats.

The Second Washing

After concluding the first or preliminary washing of the surface, a new sponge and a new pail should be taken in hand and the surface again washed with a fresh supply of clean water. A soft wash brush, oval in form and chisel pointed, should be used to tool round the surface ornaments, mouldings and other attached body fixtures. Such places cannot be effectively reached with a sponge.

Use the same care and precautions in washing the chassis and under no circumstances employ the same tools for the body and the chassis, and vice versa. In this way avoid transferring grease and oily stains from one part of the car to the other.

Drying the Body and Chassis

For drying off the water from the body of the car or chassis, use a chamois skin free from lint and absolutely clean. Wring the chamois out after rinsing it in clear water, or if dirty after washing out in a solution of soft water and Castile soap. Begin at the first part of the car washed, proceed to pass the chamois over the surface with just sufficient pressure to take up the water with the exception of a mist, which will quickly evaporate.

To attempt to wipe the car perfectly dry in all parts will result in injury to the luster of the finish. An erosive effect on the surface can be produced under the pressure of the chamois, and this effect must be avoided at all times.

No car should be left unwashed for more than 24 hours.

Finish Cracked and Spotted by Mud

Mud in its various forms, in drying on a body of varnish, takes up the oil from the varnish, and in so doing destroys the luster. Road dirt or dust picked up on highways largely given to horse travel is often saturated with ammonia, and all such accumulations are destructive to the finish. Such road refuse, if allowed to dry upon the finish, not only spots the varnish but fractures the film and causes it to decay and crumble away.

Mud and dirt from the roads traversing lime districts are likewise destructive to both the luster and the fabric of varnish, the latter disintegrating under the effects of lime. Some varnishes, or in fact a great many of them, will spot under the effects of soapy or dirty water, the alkali and capillary mediums contained in these waters going at once at the luster of the varnish.

The car not systematically and regularly washed will have its finish often spotted from the effects of various gases and garage impurities. Many manufacturing cities are so poisoned with deleterious fumes that the finish on the irregularly and too infrequently washed car is spotted and deprived of its luster in a comparatively short time. Moreover, loss of luster is a direct result of improper and infrequent washing.

Care of Enamel on Splash Guards and Fenders

Notwithstanding the extreme care and pains taken in enameling and careful washing, the finish on these parts will show a tendency to dull from service. This is attributed to the fact that enamel has a peculiar affinity for dirt. The fenders are subjected to exposure, to dust and dirt, oil and grease. These conditions in time cause a sort of filmy covering to form, which deadens the original gloss. The longer this condition is allowed to exist the harder it will be to restore the luster. This is brought about by the simple expedient of taking off the greasy substance which is adhering to the surface of the enamel.

There are a number of preparations for removing the dirt and cleaning the enamel which can be secured from any accessory house. Careful washing with mild soap and water, afterwards removing the suds before they are allowed to dry and polishing with a chamois will restore the finish. Fuller's earth and water can also be used to rub off the dirt if it is very obstinate, and will not harm the finish.

Cleaning of Nickel Plated Parts

All nickel plated parts may be cleaned with lamp black or with regular silver cleaner paste. Use only the softest flannel rag or chamois to rub with.

Do not clean lamp reflectors except when absolutely necessary, and then use Putz Pomade, applied with a very soft, clean chamois skin. These reflectors are silver plated and are very easily spoiled by frequent polishing.

To Keep Water from Clinging to Windshield

If you are in a climate where snow and sleet are a common feature of the weather for any lengthy period, you can keep the windshield clean by wiping it over with a solution of water, glycerine and salt. The proportions are:

1 oz. water. 2 oz. glycerine. 1 dram salt.

Pour this on a piece of gauze and wipe the glass with all strokes downward. This will prevent raindrops or water in any form from clinging to the glass.

MISCELLANEOUS INFORMATION

Anti-Freeze Mixtures

For 5 degrees below zero:

Alcohol	15%
Glycerine	15%
Water	70%

For 10 degrees below zero:

Alcohol	18%
Glycerine	18%
Water	64%

or

Alcohol	35%
Water	65%

or

Glycerine	50%
Water	50%

STORING THE CAR

It is essential to observe the following details in order to prevent depreciation during the storage period:

Building

Select a dry building, and preferably one not connected with horse stables. Dampness must be avoided, because in a short time rust will make inroads on the exposed metal parts that are decidedly detrimental.

Preparation

See that the car and chassis are perfectly clean. Drain all the oil from the motor base, replace the plug and pour one gallon of castor oil in the oil reservoir.

Take out the spark plugs and pour one-half cupful of castor oil in each cylinder. Then replace plugs and wires.

Start motor and allow it to run at a moderate rate of speed for about ten minutes.

Drain all water from cooling system by removing plug, lower radiator connection, left hand side.

Turn motor over a few times with starter.

Jack up all four wheels and let the air out of the tires. Cover the tires to exclude light.

Rub a small quantity of vaseline (not grease) on all nickeled parts, hub caps, exhaust manifold and carburetor and spark control rods.

Rub a little vaseline in the joints where the fenders join the splash guards.

Drain off all water and sediment from the carburetor and vacuum tank.

Remove battery from car.

Cover the car completely with some sort of tarpaulin or car cover.

BATTERY

A storage battery gradually runs down when not in use, and if allowed to become exhausted it may be prematurely ruined. If possible allow a service station to take care of the battery during the storage period. If this is not possible, then follow implicitly the rules laid down under "Storage Battery" on page 51.

Electrical Starting and Lighting System

The Delco electrical equipment on the Essex consists of the necessary units connected by a single wire system in which the frame of the car acts as a return circuit. The system consists of the following units:

Starting Unit.
Generator.
Current Indicator.
Distributor.
Ignition Coil.
Combination Ignition and Lighting Switch.

STARTING MOTOR

The starting motor is mounted on the left hand side of the engine, and is attached to the flywheel housing. The purpose of the starting motor is to perform the cranking operation, but it is in no way responsible for the ignition or mixture which must be in the combustion chamber before the actual running of the engine is accomplished. During the cranking operation the energy is supplied by the storage battery. When the starting button is depressed it performs two distinct operations. The first of these takes place when the button is part way down, at which time the starter gear mounted to the rear of the starting motor is caused to mesh with the flywheel. The second action occurs when the button is all the way down, bringing the motor brushes

in contact with the motor commutator, thereby closing the circuit and energizing the motor which results in the revolving of the armature and the consequent cranking of the motor through the overrunning clutch and thence through the flywheel.

Release the starting button as soon as the engine starts.

The brushes on this motor are of a special composition, and must not be replaced with brushes of any other material, as this is almost sure to very materially lower its efficiency. Neither the brushes or commutator should be lubricated, as lubrication of the commutator with compound of any kind is almost sure to cause the brushes to fail to make contact at all, or insufficient contact to permit the cranking operation to be performed.

STARTING MOTOR LUBRICATION

The matter of lubrication has been very carefully taken care of.

Two oilers are provided, one being located at the commutator end bearing, which should receive four or five drops of "3-in-1" or sewing machine oil every two weeks. The other oiler is located at the opposite end of the starting motor for lubricating the armature bearing. This oiler should receive eight or ten drops of oil every two weeks.

The clutch and gears run in grease and require attention once or twice a season. A grease plug on the side of the starting motor is provided for this purpose.

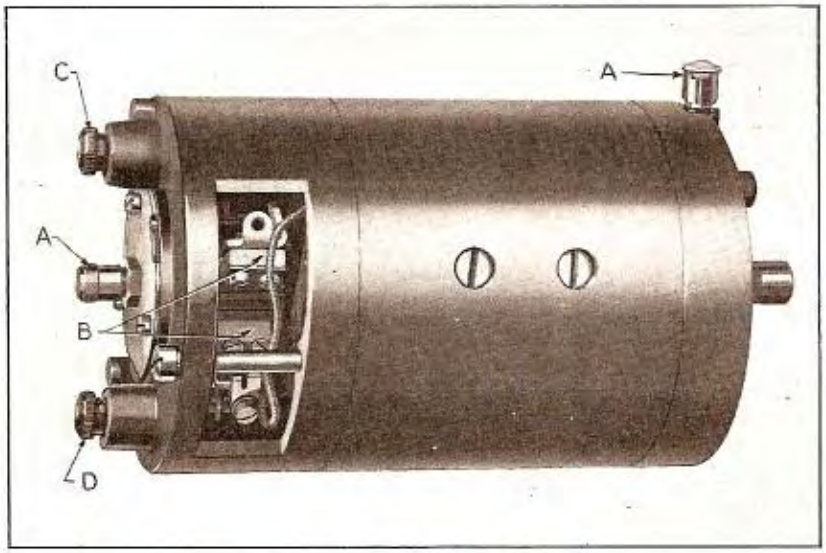
STARTING BUTTON

The proper operation of the button is to depress it fully and quickly, and to hold it completely depressed during the cranking operation. There is no danger of exerting too much pressure on this button.

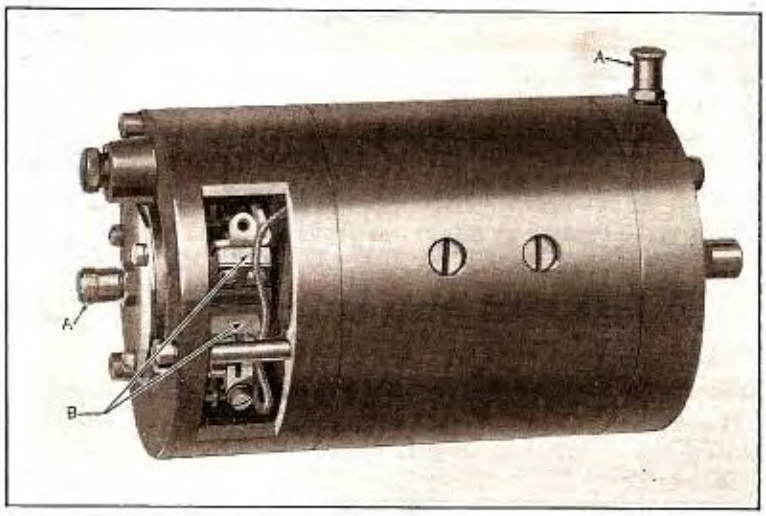
Caution—Do not press starter pedal when engine is running.

GENERATOR

The purpose of the generator is to supply electrical energy for charging the storage battery operating the lights, horn, ignition and starting motor. It is located on the right hand side of the engine and is driven by a shaft from the front gear compartment of the motor. The generator consists essentially of the revolving element or armature which is mounted on ball bearings. The main part of the armature consists of a number of thin, round discs which are clamped together on the armature shaft. These discs have slots on their outer surface in which are wound the copper wire coils which are connected to the commutator. The brushes "B" make contact with the commutator and collect the current which is induced in these armature coils when the armature rotates.



GENERATOR (WITH FIELD TERMINAL)
A. Oiler. B. Brushes. C. Armature Terminal. D. Field Terminal.



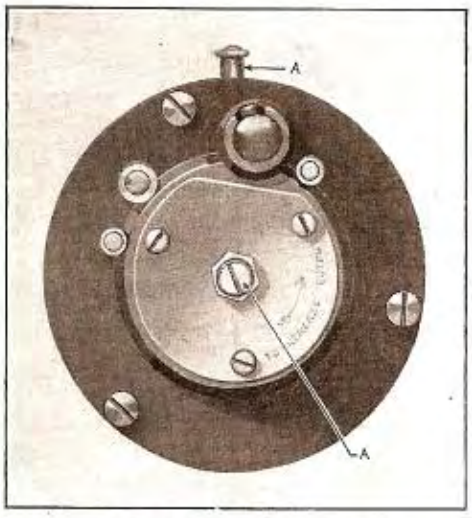
GENERATOR (WITHOUT FIELD TERMINAL)
A. Oiler. B. Brushes.

On each side of the armature are mounted the pole pieces which are secured to the outer frame. These pole pieces are strongly magnetized by the field coils which surround them. As a result the armature is rotated in a strong magnetic field. The operation of any electric generator depends upon the strength of the magnetic field. At very low engine speeds the generator voltage is not equal to that of the storage battery, and a small amount of current may flow from the storage battery through the generator winding, thus a discharge is shown on the indicator on the dash, but at all normal speeds of the engine the voltage of the generator exceeds that of the storage battery. This causes the current to be charged into the storage battery or to be supplied to the other consuming units.

GENERATOR REGULATION

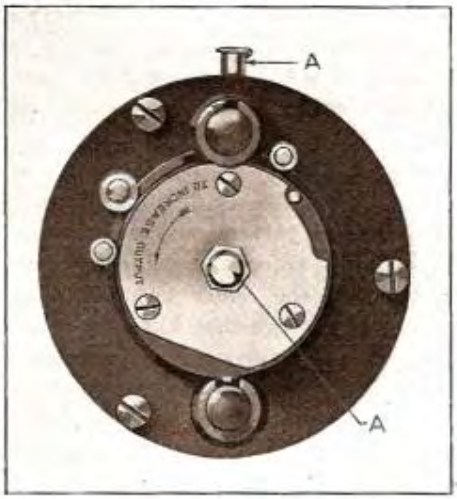
Because of the constantly varying speed at which an automobile is driven, some method of regulating the output of the generator is necessary. This condition is met by what is known as the third brush method of regulation. The shunt field current is conducted through the third brush. The natural function of the generator is such that a heavy current is sent through the shunt field at the lower speeds, thus obtaining the maximum output of the generator. At the higher speeds the amount of current through the field winding is much less. This weakens the field and decreases the output. Upon leaving the factory each generator is adjusted to give an ample charging rate for normal driving conditions. Occasionally, however, cars are operated in such a manner that they require much more current or a great deal less than the average. It is advisable in such cases to change the output of the generator. In order to do this the third brush is mounted in such a manner that its location on the commutator can be changed so as to either increase or decrease the output. Whenever this is advisable the following instructions should be followed:

The three screws which hold the bearing retainer plate in place on the commutator end of the generator should be loosened. Note illustration. When facing the commutator end of the generator the armature rotates in a counter clockwise direction. To increase the output the third brush holder which is held in position by these three screws should be shifted the same direction as the armature rotates, while if it is desirable to decrease the charging rate the brush holder should be rotated against the direction



END VIEW OF GENERATOR (WITHOUT FIELD TERMINAL) SHOWING DETAILS OF CURRENT REGULATION

A. Oiler.



END VIEW OF GENERATOR (WITH FIELD TERMINAL) SHOWING DETAILS OF CURRENT REGULATION

A. Oiler.

of rotation, or in a clockwise direction. The three screws should then be tightened, and a piece of fine sandpaper should be drawn between the commutator and the third brush with the rough side of the paper against the brush. This will seat the brush to the commutator. If the third brush is not properly seated the output will be materially reduced until the proper seating is obtained. After adjusting the charging rate it should be carefully checked by testing with an ammeter. The charging rate should not be in excess of 16 amperes, as serious trouble is very likely to follow.

GENERATOR LUBRICATION

An oiler "A" is provided at each end of the generator for the purpose of lubricating the armature bearings. Each of these oilers should receive from four to five drops of "3-in-1" oil every two weeks.

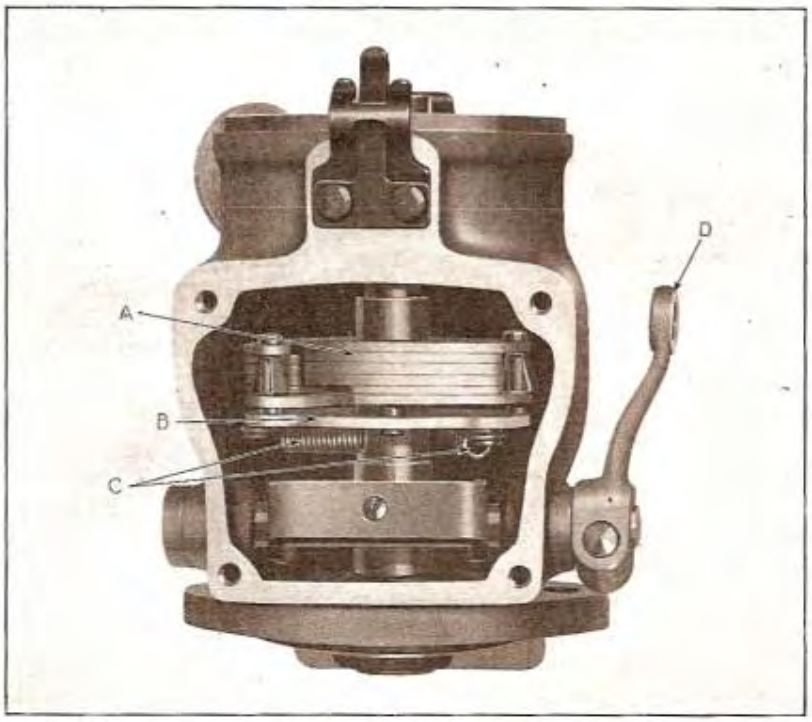
CURRENT INDICATOR

An indicator is provided which is mounted on the dash for the purpose of indicating the charge or discharge of the storage battery.

DISTRIBUTOR

The distributor is mounted on the right hand side of the engine just in front of the generator and is driven by spiral gears. It is for the purpose of securing the proper timing and distribution of the ignition current. Its general construction is shown in the illustrations. The vertical shaft is driven at one-half crank shaft speed. This shaft is mounted on ball bearings and carries the automatic advance mechanism, the breaker cam "J" and the rotor. See illustration, page 40.

The timing of ignition is effected by the interruption of the ignition current through the timing contacts. When these contacts are opened by the breaker cam the high tension current is induced in the



DISTRIBUTOR HOUSING SHOWING DETAILS OF AUTOMATIC ADVANCE

A. Weights.
B. Automatic Advance Ring.
C. Springs.
D. Hand Control Lever.

secondary winding of the ignition coil. The distributor is equipped with both manual and automatic control. The manual control is linked up with the spark lever on the steering wheel sector. This is for the purpose of securing the proper retard of the ignition for the starting operation and very slow idling speeds, and to secure the proper advance required for maximum power at very low engine speeds, over which the automatic feature has no control.

The automatic feature is for the purpose of securing additional advance that is required to get the best operating conditions of the engine at the higher engine speeds. This feature makes it unnecessary to manipulate the spark lever for varying engine speeds in order to secure the best performance of the engine. The rotor is for the purpose of distributing the high tension current from the different spark plugs in the proper time. The high tension current from the ignition coil is conducted to the center terminal of the distributor head. The relation between the rotor and the breaker cam is always such that when the breaker cam causes the contact "M" to open, and when high voltage current is induced in the secondary winding of the ignition coil, the rotor will be in the proper position for conducting this current from the center terminal to one of the terminals which leads to the spark plugs. The breaker cam is secured to the vertical shaft by an arrangement which permits it to be located in any angular position. This is for the purpose of securing the proper timing.

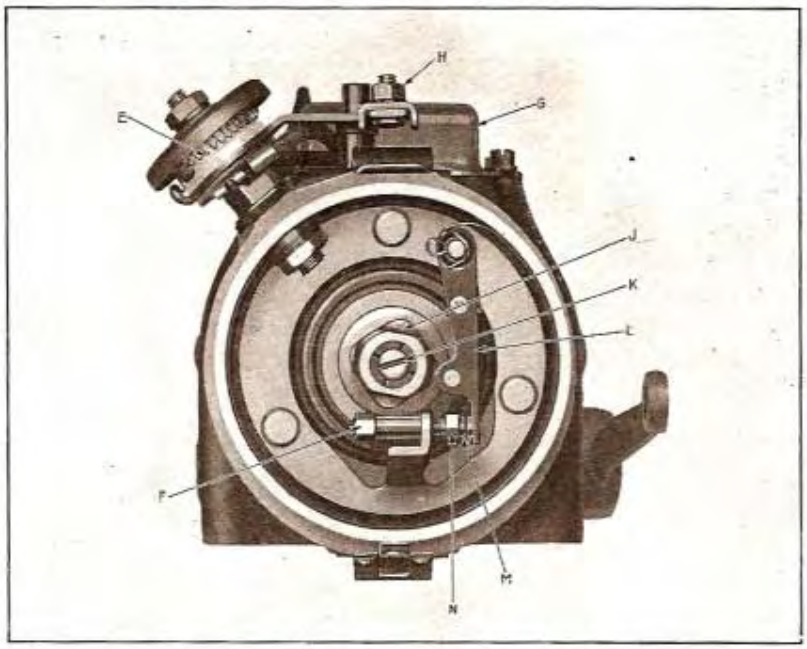
RESISTANCE UNIT

A resistance unit "E" is mounted on the side of the distributor and is connected in series with the primary circuit of the ignition system. It prevents excessive discharge from the storage battery when the ignition switch is in the "on" position when the engine is not operating, and also causes the spark to be more nearly uniform at different engine speeds.

CARE OF THE DISTRIBUTOR

When it leaves the factory, the distributor is packed with grease for lubricating the working units. No further lubrication should be necessary in the distributor housing for at least one season. A few drops of oil may occasionally be applied to the upper ball bearing of the distributor shaft.

The rubber track inside of the distributor head should be lubricated a few times with a very small amount of vaseline until the rotor button polishes this track. The rotor button should be kept polished, smooth and bright. The center terminal in the distributor head should always make contact with the rotor.



TOP VIEW OF DISTRIBUTOR SHOWING CONTACT POINTS

E. Resistance Unit. H. Terminal. L. Breaker Arm.
F. Locking Screw. J. Cam. M. Contact Points.
G. Condenser. K. Cam Adjustment Screw. N. Adjusting Nut.

CONDENSER

The condenser "G" is mounted on the side of the distributor casting. It consists of two long strips of tin foil insulated from each by strips of paraffine paper. These strips are laid together in alternate layers of tin foil and paraffine paper, and are folded up into a very compact form, then sealed in a moisture-proof metal case. One of the strips of tin foil is connected to the ground while the other is connected to the plate on which the contact screw is mounted. The breaker arm "L" of the distributor is grounded to the distributor body. This being the case, the condenser is connected directly across the breaker contacts. It is for the purpose of decreasing the amount of burning in the contacts and increases the voltage induced in the secondary winding of the ignition coil.

ADJUSTING TIMING CONTACTS

The timing contacts "M" should be adjusted so that when they are opened by the breaker cam "J" they will be apart the thickness of the gauge on the distributor wrench marked "Distributor." This is .018 inch. Due to the wearing to a seat of the fibre rubbing block of the breaker arm against the cam, the contacts will require one or two adjustments during the first season's driving, after which no attention is necessary. The timing contacts are of tungsten metal and are very hard. They should require no other attention than to maintain the proper adjustment.

TIMING THE IGNITION

The ignition system is carefully timed when the car leaves the factory, and under ordinary conditions will not require any attention, but should it become necessary to re-time the ignition for any reason, it can be done as follows:

1. Place the spark lever on the steering wheel sector in the fully advanced position.
2. Turn the engine with a hand crank until No. 1 piston starts to come up on the compression stroke. The marking of the flywheel should then be observed through the hole in the flywheel housing on the right hand side of the engine until the marking D. C. 1-4 appears at the pointer on the flywheel housing.
3. Loosen the timing adjustment screw "K" in the center of the distributor shaft and turn the breaker cam "J" so that the rotor button will be in a position under No. 1 high tension terminal, or that which leads to No. 1 cylinder, when the distributor head is down in place. Locate the breaker cam carefully in this position so that when the slack in the distributor driving gears is rocked forward, the contacts "M" will be opened by the breaker cam, and when the slack in the gears is rocked backwards, the contacts will just close.
4. Tighten the adjustment screw, securing and replacing the rotor and distributor head.

ADJUSTING SPARK PLUGS

The gauge on the distributor wrench marked "Spark Plug" should be used for adjusting the spark plugs. This gauge is approximately thirty-thousandths of an inch thick (.030 inch). On spark plugs having more than one gap, all but one gap should be made very wide, and the closest gap adjusted to this gauge. An exceptionally wide adjustment may cause missing at the highest speeds. Too close an adjustment will cause the ignition to be very poor at very low speeds and when idling.

IGNITION COIL

The ignition coil is mounted on the engine side of the dash. This is for the purpose of converting the low voltage current from the storage battery or generator to a current of very high voltage that will jump the gaps in the spark plugs. It consists primarily of an iron core made up of a number of soft iron wires. Wound around and insulated from this core is the primary winding, which consists of a comparatively few turns of copper wire. This is connected in series with the resistance unit mounted on the side of the distributor. It is through this winding that the current from the storage battery or generator is conducted. The current through this winding magnetizes the iron core, and when the current is interrupted by the timing contacts in the distributor, the magnetism dies out. This dying out of the magnetism in the iron core induces the high voltage current in the secondary winding. The secondary winding is wound over the primary winding and insulated from it. It consists of several thousand turns of very fine copper wire, one end of which connects to the primary winding, and the other to the high tension terminal in the center of the coil. It is from the center terminal that current is conducted to the distributor head, rotor and spark plugs.

COMBINATION SWITCH

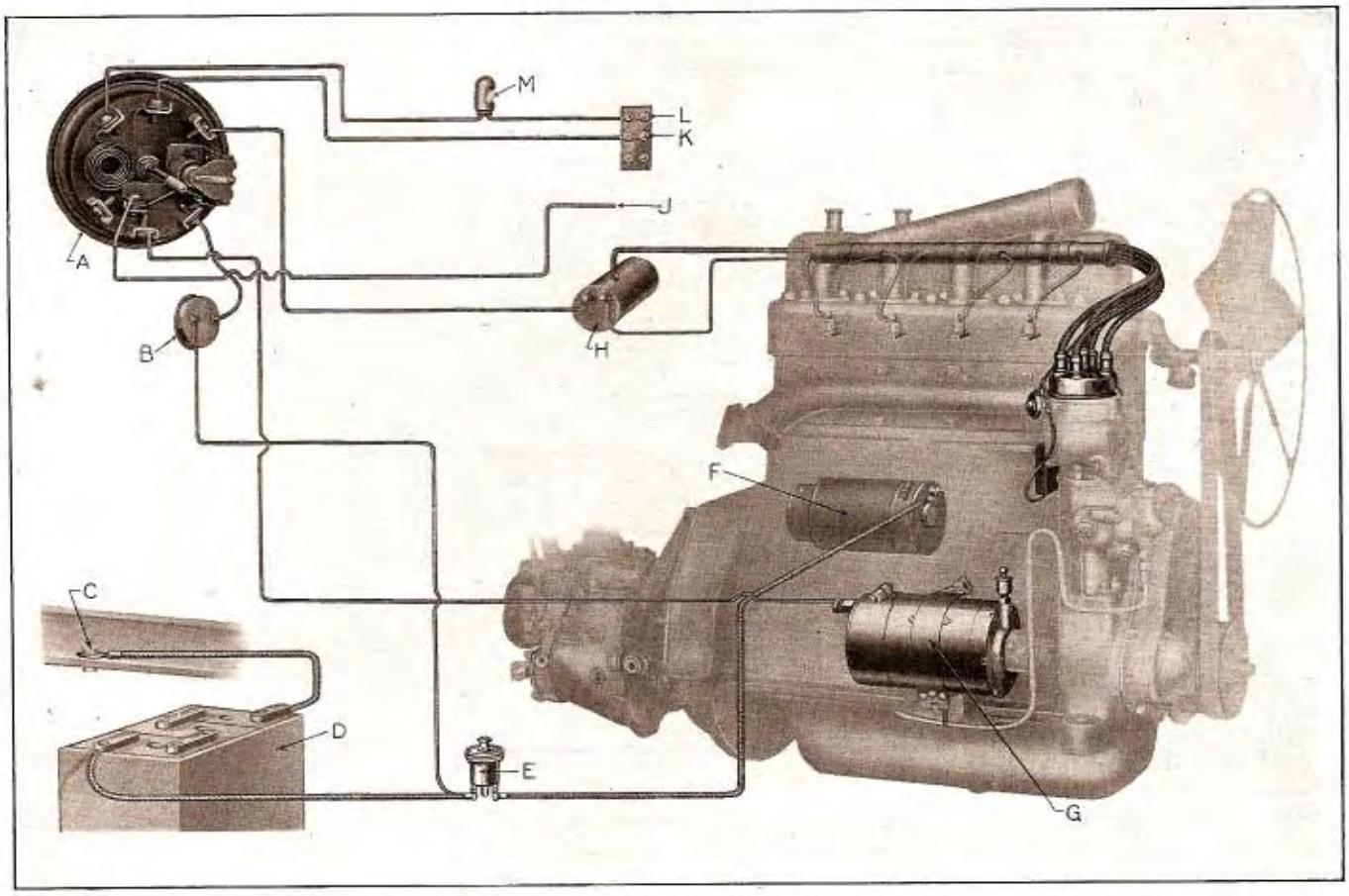
The combination switch is located in the cowl. It is for the purpose of controlling the lighting and ignition circuits, and the circuit between the generator and storage battery. The lever on the left controls the ignition and generator circuit. The lever on the right controls the lights and has three positions—off, dim lights and bright lights. The cowl and tail lights are lit when the headlights are either dim or bright. These lights are connected in series, and should the tail light go out from any cause, the cowl light will also go out, in this manner acting as a signal. By controlling the circuit between the generator and storage battery with the ignition switch lever, an automatic cut-out which is commonly used for this purpose is not required. The ignition button should never be left in the "ON" position when the engine is not operating as the storage battery would run down.

CIRCUIT BREAKER

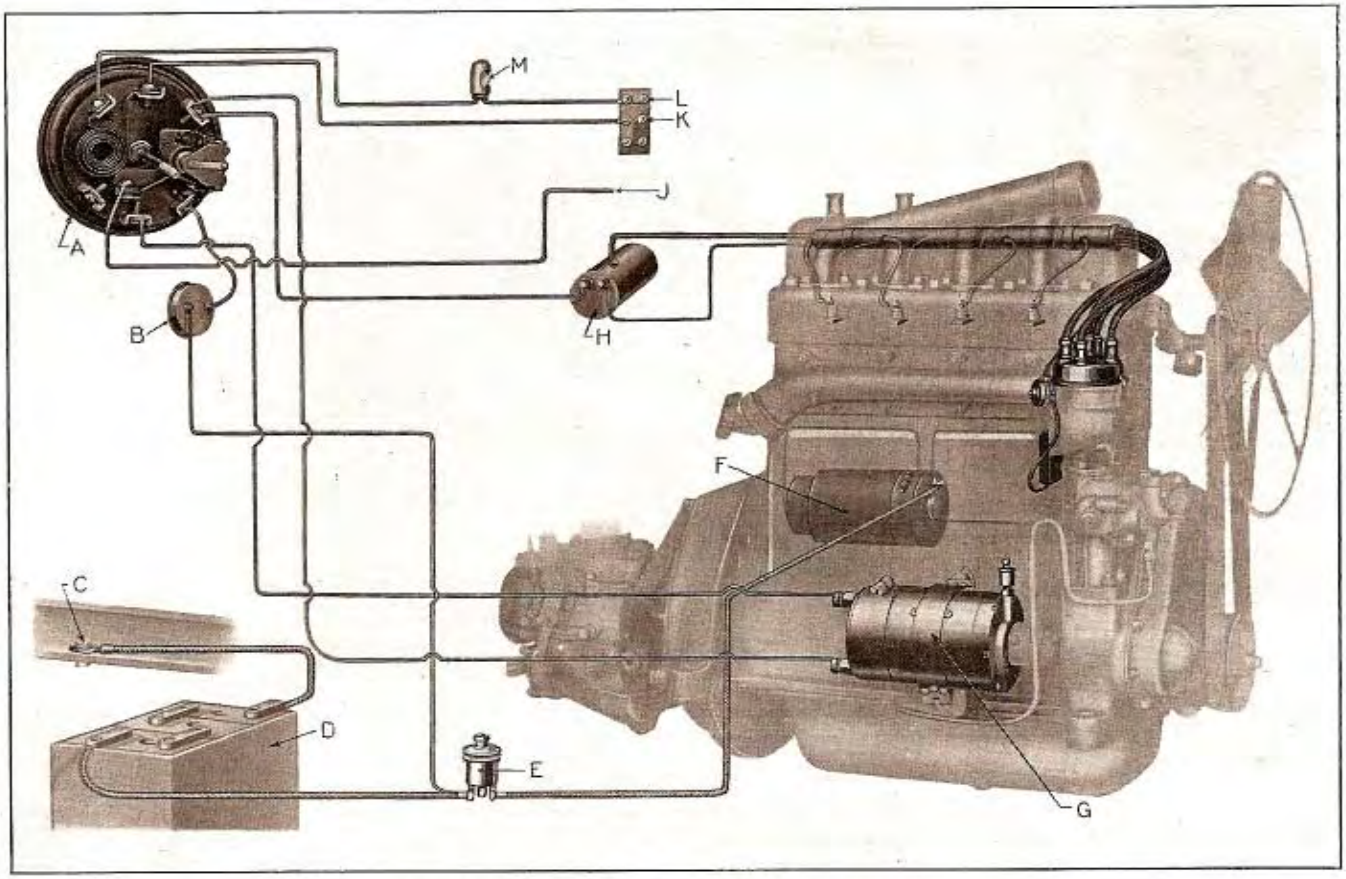
On the back of the combination switch is located the circuit breaker. This is a protective device which takes the place of fuses which are commonly used for this purpose. The normal current to the lighting circuits does not affect the circuit breaker, but in the event of an abnormally heavy current, such as would be caused by a ground on any of the lighting circuits, it flows through the circuit breaker. This current causes the circuit breaker to operate and intermittently cut off the flow of current, thus causing a clicking sound. This will continue until the ground is removed, or the switch is operated to cut off the circuit on which the ground exists. In this manner the circuit breaker protects the wiring, switch and storage battery. As soon as the ground is removed, the circuit breaker restores the circuit and there is nothing to replace.

LAMP BULB SIZES

Headlight 6-8 volt, 15 c. p., 2½ amp., style G, Ediswan base.
Dash and tail, 3-4 volt, 2 c. p., 84 amp., style G-6, Ediswan base.

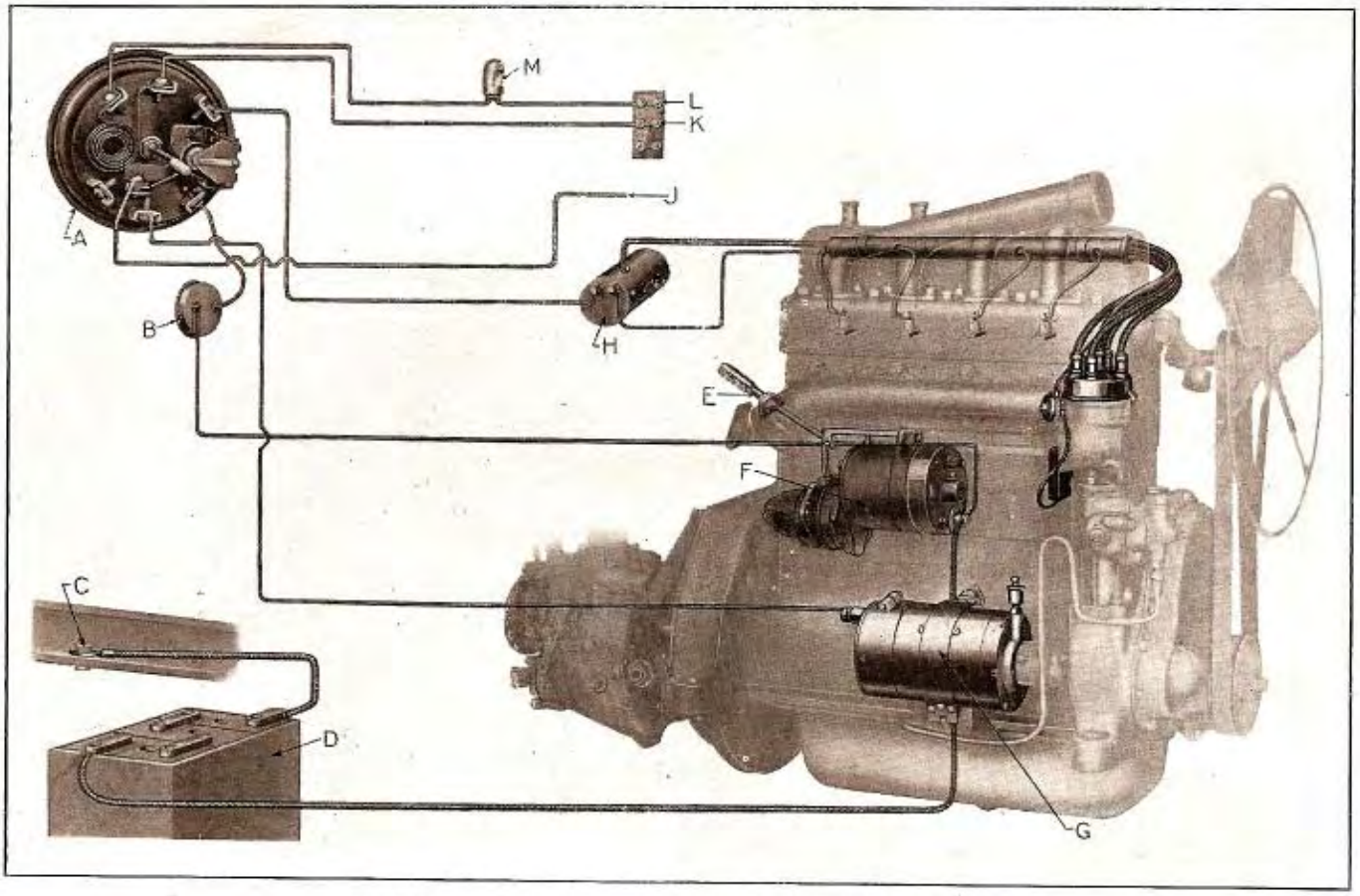


BENDIX STARTER—SINGLE TERMINAL ON GENERATOR

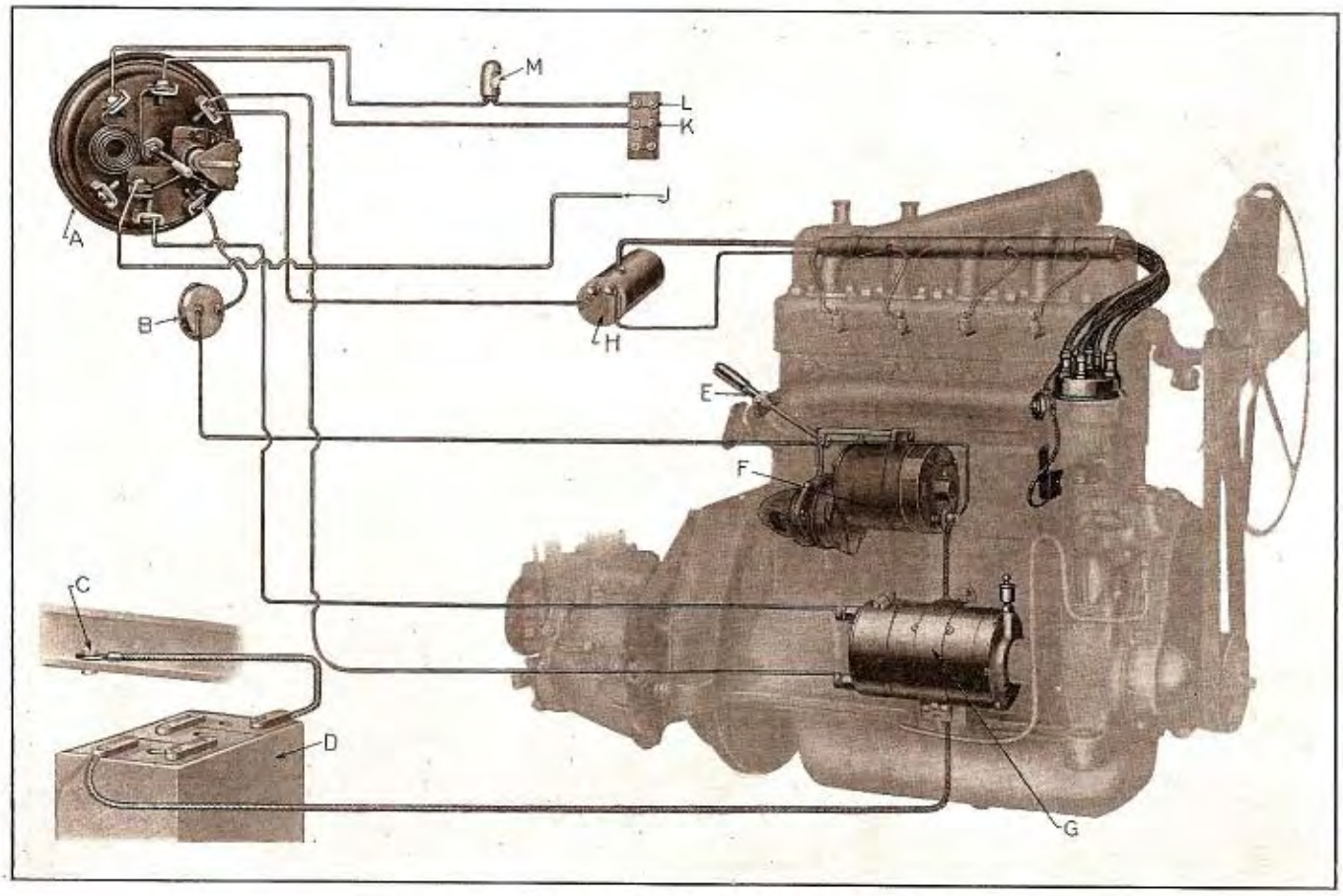


BENDIX STARTER—TWO TERMINALS ON GENERATOR

A. Switch.
B. Current Indicator.
C. Ground to Frame.
D. Storage Battery.
E. Starter Switch.
F. Starter Motor.
G. Generator.
H. Coil.
J. To Horn.
K. To Headlights.
L. To Tail Lights.
M. Dash Light.



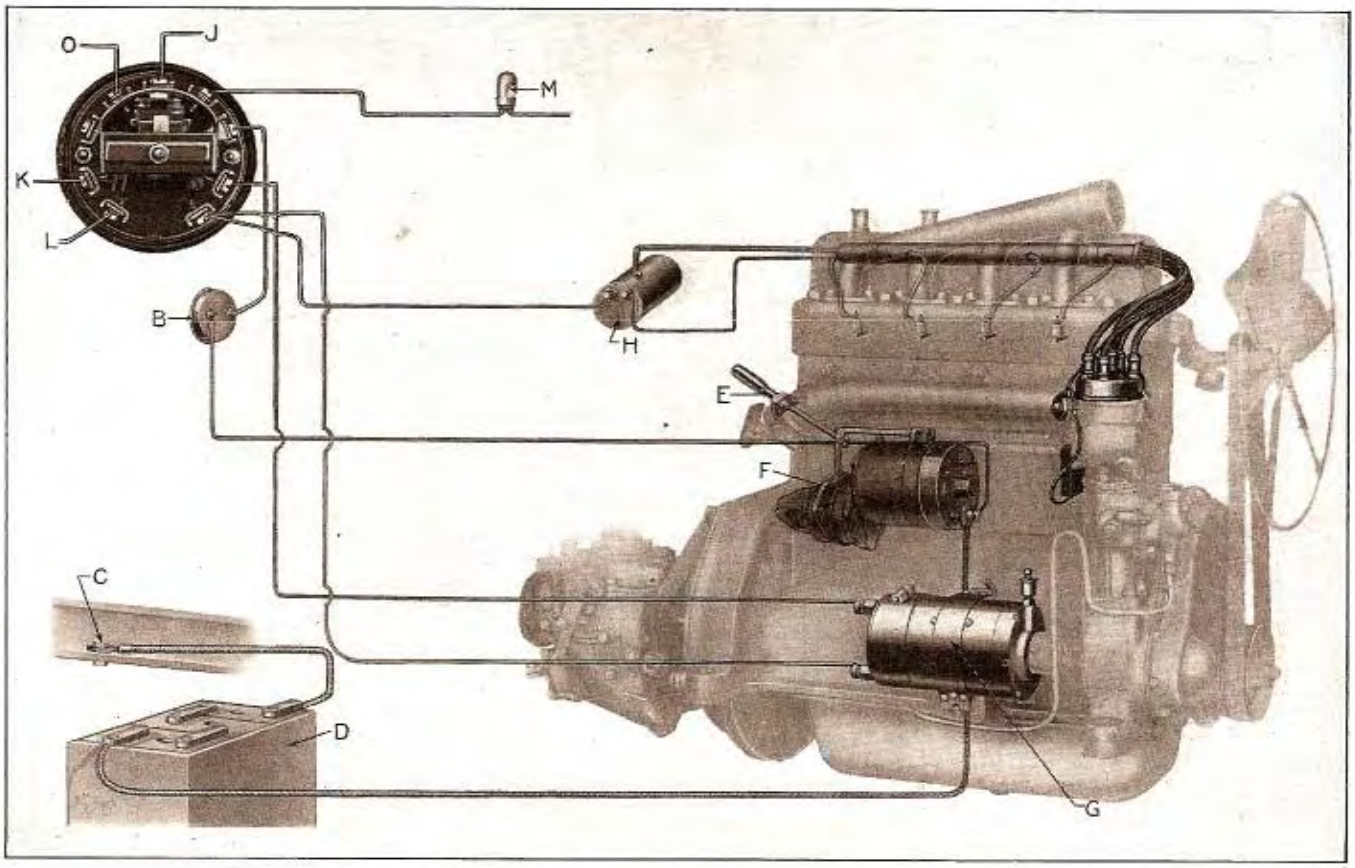
MANUAL SHIFT STARTER—SINGLE TERMINAL ON GENERATOR



MANUAL SHIFT STARTER—TWO TERMINALS ON GENERATOR

A. Switch.
B. Current Indicator.
C. Ground to Frame.
D. Storage Battery.
E. Starter Pedal.
F. Starter Motor.
G. Generator.
H. Coil.
J. To Horn.
K. To Headlights.
L. To Tail Lights.
M. Dash Light.

WIRING DIAGRAM



MANUAL SHIFT STARTER AND COMBINATION SWITCH

B. Current Indicator.
C. Ground to Frame.
D. Storage Battery.
E. Starter Pedal.
F. Starter Motor.
G. Generator.
H. Coil.
J. To Horn.
K. To Headlights.
L. To Tail Lights.
M. Dash Light.
O. To Side Lights.

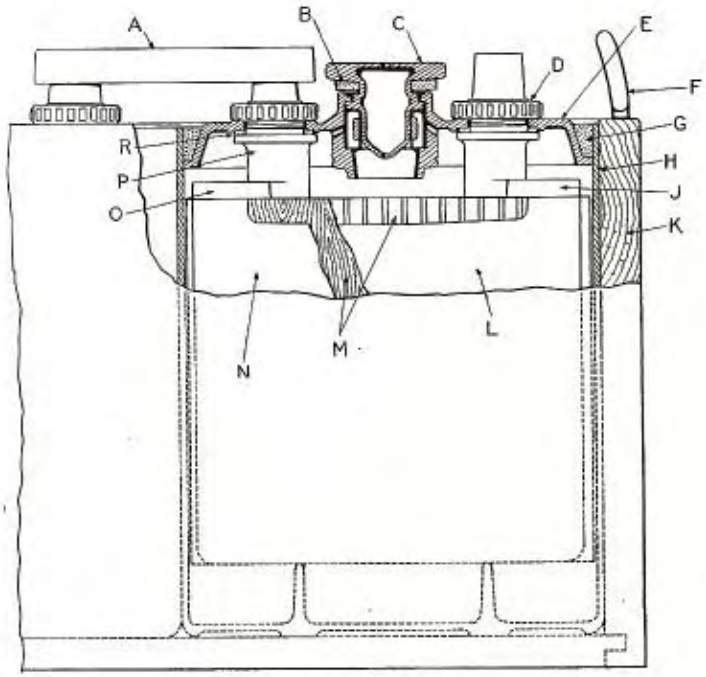
Accumulators or Storage Batteries

The battery on an exported car is shipped unfilled (without electrolyte), and before being put into service the cells must be filled with electrolyte and given a long charge, which is called the initial charge. The results obtained from a storage battery depend largely upon the way the initial charge is given, and the attention the battery receives after it is put into commission. It is therefore necessary that the following instructions be carried out in detail. The battery may be seriously damaged or totally ruined if these in-instructions are not followed out implicitly.

FILLING CELLS WITH ELECTROLYTE

The specific gravity of the electrolyte used for filling depends upon the climate where the battery is used. In tropical climates, that is, places where freezing of water never occurs, the electrolyte used for filling should be 1.260 specific gravity (30° Baume), and if this cannot be procured it can be made by mixing chemically pure sulphuric acid of 1.835 specific gravity (66° Baume, oil of vitriol), which can be obtained from a reliable druggist, and distilled water in proportion of three parts of water to one of acid by volume. In temperate climates, that is, places where freezing of water may occur, the electrolyte used for filling should be 1.350 specific gravity (38° Baume), and if this cannot be procured it can be made by mixing chemically pure sulphuric acid of 1.835 specific gravity (66° Baume) and distilled water in proportion of two parts of water to one of acid by volume. When mixing use glass, earthenware or other acid-proof vessels thoroughly cleansed; pour acid into water, not water into acid, and allow the solution to cool before using.

Remove the filling plugs and with a rubber syringe or small china or glass pitcher fill the cells with electrolyte until level with the bottom of the filling tubes, then replace the filling plugs and tighten by giving a quarter turn. Never charge a battery with the filling plugs out, as the automatic vents are then closed and flooding will result. After filling allow the battery to stand at least ten hours before starting the initial charge.



STORAGE BATTERY

A. Cell Connector.
B. Filling Plug Gasket.
C. Filling Plug.
D. Sealing Nut.
E. Cell Cover.
F. Handle.
G. Sealing Compound.
H. Rubber Jar.
J. Pos. Strap.
K. Wood Case.
L. Pos. Plate (Brown).
M. Wood Separator.
N. Neg. Plate (Gray).
O. Neg. Strap.
P. Post.
R. Post Gasket.

CHARGING CIRCUIT

(See Illustration on Page 47.)

Direct current only must be used, never alternating. The positive terminal of the battery marked + must connect with the positive charging circuit and the negative of battery with negative of charging circuit. If connected reverse serious injury will result. Arrange resistance in series with battery so that the charging rate will be 4½ amperes. Use either lamps in parallel or rheostat for resistance. To determine the polarity of the charging circuit, if a suitable voltmeter is not at hand, dip the end of the two wires from the charging circuit into a glass of water into which a teaspoonful of salt has been dissolved. Fine bubbles of gas will be given off from the negative wire. If direct current is not available, charging can be done from an alternating current system, provided suitable apparatus is used for converting the alternating into direct current. This can be accomplished by a motor generator set or a current rectifier of either the vibrating or mercury arc type.

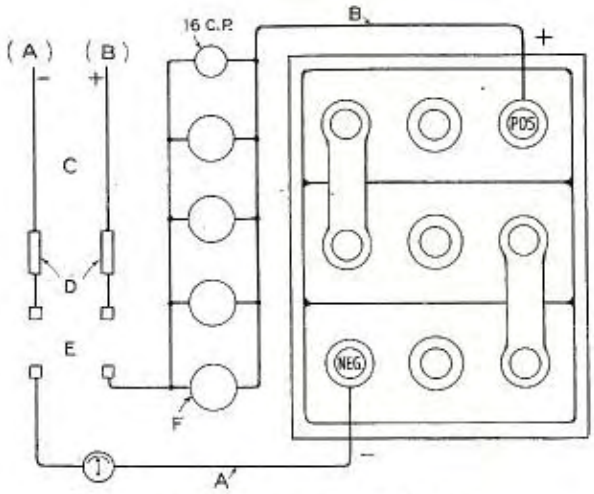
INITIAL CHARGE

Not sooner than ten hours after filling remove filling plugs, add water to restore level of electrolyte if it has fallen and replace filling plugs, screwing them tight. Start charging and continue at 4½ amperes for at least four days (96 hours), or until the battery has received at least 432 ampere hours. In tropical climates, if temperature of electrolyte approaches 125° F. (52° C.) or in temperate climates, if temperature approaches 110° F. (43° C.) stop charging until it lowers. In tropical climates the gravity of each cell at the end of charge should be between 1.200 and 1.230 (24° and 27° Baume), while in temperate climates the gravity should be between 1.270 and 1.300 (31° and 33° Baume).

GENERAL

The care of a battery in service is summed up in the four following rules, which, if observed with reasonable care, will result in the best service being obtained:

1. Add nothing but pure water to the cells and do it often enough to keep the plates covered.
2. Take frequent hydrometer readings.
3. Give the battery a special charge whenever the gravity readings show it to be necessary.
4. Keep the filling plugs and connections tight and the battery clean.



CHARGING CIRCUIT DIAGRAM

A. Negative.
B. Positive.
C. 110 Volt Direct Current Circuit.
D. Fuses.
E. Switch.
F. 110 Volt 100 Watt Lamps. (32 C. P. Carbon Lamps.)

ADDING WATER—WHEN NECESSARY

Water must be added often enough to keep the plates covered. If the plates are exposed for any length of time, they may be seriously damaged.

The length of time a battery can go without the addition of water will depend upon the season of the year, water being required more frequently in summer than in winter.

The best plan is to make it an invariable rule to remove the filling plugs once each week and add water if level of electrolyte is below bottom of filling tube.

Never bring an open flame, such as a match or candle, near the battery.

Always add the water regularly, though the battery may seem to work all right without it.

In freezing weather, when necessary to add water, always do it just before running the car.

If temperature is extremely low, start the engine so that the battery is charging before adding water.

The reason for this is that water being lighter than electrolyte will remain on the surface and will freeze in cold weather. If the engine is run however, the gassing, due to the charging current, will thoroughly mix the water with the electrolyte; also the motion of the car when running will have a similar effect. Thoroughly mixed electrolyte will not freeze solid except at very low temperatures.

The electrolyte in a fully charged battery (gravity about 1.270) freezes at about 80 degrees below zero Fahrenheit; while in a normally discharged battery (gravity 1.150 to 1.175) it freezes at about zero Fahrenheit. Therefore, it is especially important to have the battery well charged when the car is standing in a very cold place.

HOW TO ADD WATER

Remove filling plugs by turning to the left, and if level of electrolyte is found to be below bottom of filling tube (Fig. 1), add water by means of the hydrometer syringe or a very small pitcher until the level begins to rise in the tube.

After adding water, be sure to replace filling plugs and tighten by turning to the right. If filling plugs are not tightened, the electrolyte will flood out of the battery and cause damage.

KIND OF WATER TO USE

Wipe off the top of the battery after adding water.

The water used must be of reasonable purity, as the use of impure water, if persisted in, will injure the plates. Distilled water, melted artificial ice or rain water collected in clean receptacles is recommended.

ADD NOTHING BUT WATER

Nothing but water must be put into the cells. If acid of any kind, alcohol, or in fact anything but water, is added to the cells, it will result in very serious injury to the plates and may ruin them.

The electrolyte in a cell consists of a mixture of sulphuric acid and water. Sulphuric acid does not evaporate; water does. When the level of the electrolyte in a cell becomes low, it is due, under normal conditions, to the evaporation of water, which should be replaced with water only.

There being no loss of acid, it is never necessary, during normal service, to add acid to a battery.

If electrolyte has been spilled from the battery by accident, the loss may be replaced with electrolyte, but this work should only be done by an experienced battery man.

HYDROMETER READINGS—VALUE OF HYDROMETER READINGS

Take frequent hydrometer readings, for they show whether the battery is receiving sufficient charge.

WHEN TO TAKE READINGS

Take a hydrometer reading of each cell with the hydrometer syringe at least once a week and just before adding water.

If hydrometer readings are taken after adding water and before the car is run, they are of no value, as only water or very weak electrolyte will be drawn into the syringe. This is due to the water being lighter than the electrolyte, and therefore remaining on the surface until thoroughly mixed by running the car.

Take hydrometer readings at any time that any part of the electric system on the car does not work properly, as they may indicate the trouble.

The method of taking hydrometer readings is fully explained on page 52.

WHAT READINGS INDICATE

Specific gravity above 1.225 (1.155 in tropical climates) indicates that the battery is more than half charged.

Gravity below 1.200 (1.130 in tropical climates), but above 1.150 (1.080 in tropical climates) indicates battery less than half charged, i. e., is approaching exhaustion.

Such condition may be due to excessive use of lights, together with slow running of the car, which cuts down the charging current from the generator, or it may be due to trouble in the system.

The remedy is to use lights sparingly until the gravity rises above 1.200 (1.130 in tropical climates). If gravity will not rise above 1.200 (1.130 in tropical climates) within a reasonable time, look for trouble in the system.

Gravity of 1.150 (1.080 in tropical climates) or below indicates battery completely discharged (exhausted).

An exhausted battery should be removed from the car and given a full charge at once.

If, after the battery has been fully charged, the gravity again falls to 1.150 (1.080 in tropical climates), it indicates there is trouble somewhere in the system which must be located and corrected.

The specific gravity readings of all cells of a battery should normally rise and fall together, as all cells of a battery as used with most systems are connected in series so that the charging and discharging current passes through all alike.

If the hydrometer reading of one cell should be considerably lower than the reading of the other cells in the battery, and if this difference should increase from week to week, it is an indication of trouble in that cell.

The trouble may be due to short circuit, causing the cell to discharge itself, or it may be due to an impurity in the cell or to a leaking jar, a slight leak will allow electrolyte to escape, and if not noticed the addition of water to replace its loss will lower the gravity.

A short circuited or leaking cell must be attended to at once.

CHARGING—GENERAL

A battery charge is complete when, with charging current flowing at the normal rate (see page 49) all cells are gassing (bubbling) freely and evenly and the specific gravity and voltage of all cells have reached a maximum; that is, have shown no further rise during a period of 5 hours.

Such a charge, as above described, can be given by running the engine idle if in connection with charging generator system. On account of the length of time required, however, it is usually preferable to remove battery from the car and give the charge from an outside source. In either case, such a charge is termed a "special charge."

SPECIAL CHARGING—WHEN NECESSARY

When the hydrometer readings indicate the battery to be exhausted, or approaching exhaustion, it should be charged.

When lamps burn dimly (running on battery), the battery should be charged.

When voltage with lamps burning has fallen below 1.80 volts per cell, the battery should be charged.

When the car is not in use, the battery should be charged at least once every two months if at all practicable to do so.

If battery is not giving satisfactory service, and, owing to low level of electrolyte, it is not possible to obtain a hydrometer reading, water should be added and the battery should be charged.

Sometimes a battery will be completely discharged, as shown by low voltage and dim lights, but the hydrometer readings will show the gravity to be well above 1.200 (1.130 in tropical climates). This is one of the evil effects of adding acid or electrolyte. In such cases, the battery should be charged at once, and the specific gravity reduced to the proper point.

Remove the filling plugs and add water if necessary. Then replace and tighten filling plugs to prevent flooding. Never charge a battery with the filling plugs removed.

Connect the battery to the charging circuit as described hereafter. The positive terminal of the battery marked "POS" must be connected to the positive wire from the charging source.

HOW TO CHARGE

The battery should be charged at the rate of seven amperes.

INDICATIONS OF COMPLETE CHARGE

Continue the charge until the gravity has risen to a maximum.

Near the end of the charge, remove the filling plugs to make sure that the cells are all gassing (bubbling) freely, as this is also an indication of full charge. Be careful to replace and tighten the plugs or flooding will result.

If battery becomes very warm during the charge (temperature of electrolyte above 110 degrees Fahrenheit—125 degrees in tropical climates) either stop the charge or reduce the rate until temperature lowers.

QUICK CHARGE

To charge a completely discharged battery (gravity 1.150—1.080 in tropical climates—or thereabout), will require in the neighborhood of 24 hours at the normal rate. If it is very urgent that the battery be charged in quicker time than this, the first part of the charge may be given at twice the normal charge rate, but great care must be taken to reduce the rate to normal when the cells start gassing, also the temperature must be watched very carefully and the rate must be reduced when it approaches 110 degrees Fahrenheit (125 degrees in tropical climates). Serious damage may be done by charging a battery at a high rate after the cells are gassing.

After the charge is completed, take and record the hydrometer reading of each cell, as these readings taken at full charge are useful as a standard for comparison when subsequent readings are taken.

If, during the charge, it is noticed that the temperature of the battery rises very rapidly and the gravity does not rise to at least 1.250 (1.180 in tropical climates) and there is little or no gassing in one or all of the cells, it is an indication of trouble in the cells. If, after the charge, the battery soon becomes exhausted again, have it examined, as it is probably in need of repairs.

Replace and tighten filling plugs, be sure that all connections are clean and tight.

CHARGING CIRCUIT

A storage battery must be charged with direct current; never use alternating current for this purpose, as it will ruin the battery.

If alternating current only is available, it will be necessary to provide apparatus for converting it into direct current. Several forms of apparatus are on the market for this purpose, either motor generator sets or rectifiers. Consult your city electrician regarding the matter.

TO CHARGE ONE BATTERY FROM A DIRECT CURRENT CIRCUIT

Always connect the positive terminal of the battery to the positive wire of the charging circuit and the negative battery terminal to the negative wire of the circuit.

To determine the polarity of the charging circuit, if a suitable voltmeter is not at hand, dip the ends of the two wires into a glass of water in which a teaspoonful of salt has been dissolved, care being taken to keep the wires at least an inch apart. When the current is turned on, fine bubbles of gas will be given off from the negative wire.

RESISTANCE REQUIRED

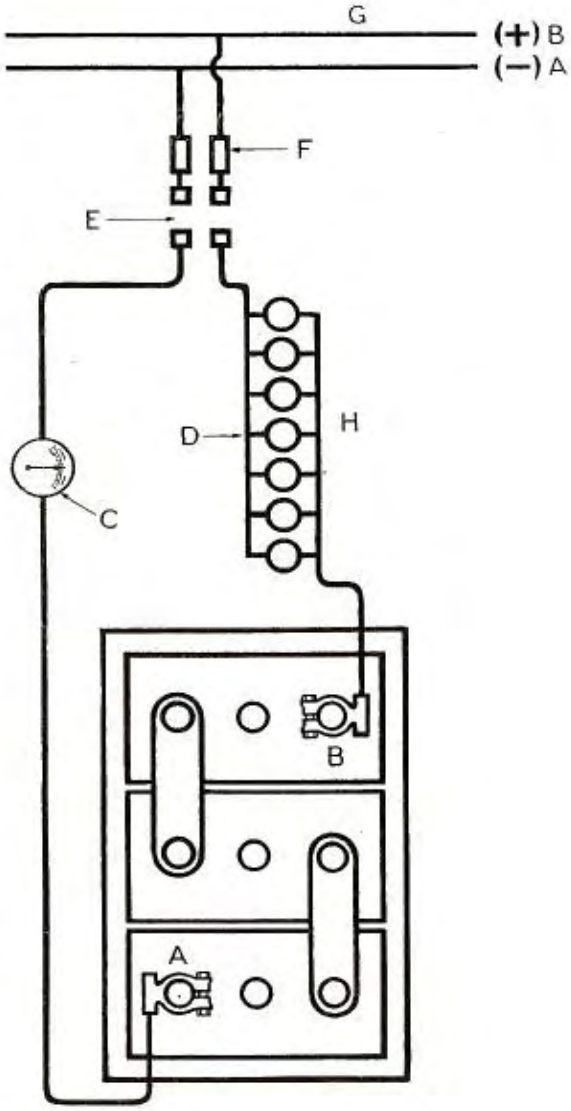
When the battery is to be charged from a 110 volt direct current circuit, resistance must be used in series with the battery to reduce the voltage of the circuit to that of the battery. The most convenient resistances to use are 110 volt, 32 candle power carbon filament lamps connected in parallel with each other, and the combination in series with the battery. With this arrangement each lamp will allow one ampere of charging current to pass through the battery. Therefore the number of lamps required to charge the battery will be seven.

If 32 candle power lamps are not available, then double the number of 16 candle power lamps will be required.

If tungsten or other high efficiency lamps are used, more will be required than if carbon filament lamps are used, owing to the lower current rating of the former.

If the battery is to be charged from a 220 volt circuit, use two lamps in series in place of each of the lamps necessary when charging from 110 volts.

If only a 500 to 600 volt circuit is available, it is necessary to use five lamps in series in place of each of the lamps when charging from 110 volts.



CHARGING CIRCUIT DIAGRAM

A. Negative.
B. Positive.
C. Ammeter.
D. Lamps.
E. Double Pole Single Throw Switch.
F. Fuses not less than 10 Amp.
G. 110 Volt Direct Current Circuit.
H. For Charging Use:
7-110 Volt 32 C. P. 100 Watt Carbon Filament Lamps, or
14-110 Volt 16 C. P. 50 Watt Carbon Filament Lamps, or
18-110 Volt 40 Watt Tungsten Lamps, or
28-110 Volt 25 Watt Tungsten Lamps.

CLEANLINESS—NECESSITY

As with mechanical apparatus, cleanliness is essential to obtain the best results. Care must be taken to keep exposed portions of the battery and its connections clean and dry.

If reasonable attention is given to this requirement, much annoyance from trouble with the starting, lighting and ignition system will be avoided.

CARE OF BATTERY CASE

If water or electrolyte is spilled upon the battery or in the compartment, wipe dry with waste. If electrolyte is present in any quantity, use waste moistened with weak ammonia in order to neutralize the acid in the electrolyte. Do not allow electrolyte to collect upon the woodwork, as it will cause deterioration.

Once a week, when adding water, inspect all the battery connections and make sure that they are tight and clean. A loose or dirty connection may cause trouble when least expected.

"EXIDE" STARTING AND LIGHTING BATTERY—Type 3-XC-15-1

CARE OF CONNECTIONS

If signs of corrosion of any brass or copper parts should appear, clean the parts thoroughly with weak ammonia and apply vaseline.

Connections through the system must be examined periodically and kept tight and clean. Sometimes a connection, even if tight, will give trouble, due to foreign matter, such as paint or varnish, on the contact surfaces. This must be removed with a file or sandpaper. The connections to the generator and the grounding connections to the frame of the car must not be neglected.

BATTERY NOT GIVING SATISFACTORY SERVICE —HOW TO LOCATE TROUBLE

If trouble should develop, as shown by the engine not cranking properly, lights burning dimly or "missing" of the engine when battery is used for ignition, look for the cause as indicated below.

Make sure that all connections are tight and that all contacts are clean.

Take a hydrometer reading of each cell. If battery is found to be exhausted (gravity 1.150—1.080 in tropical climates—or thereabouts), give a special charge.

If, after having been fully charged, the battery is soon exhausted again, there is trouble somewhere else in the system, which should be located and corrected.

If a broken jar or short circuited cell is indicated (gravity considerably lower than in other cells), have the battery repaired.

Examine battery. If there is a broken connection, terminal, jar or cover, have the battery repaired.

ADDITIONAL TESTS

When lamps burn dimly and a low reading portable voltmeter is at hand, turn on all the lamps and read the voltage of each cell or of the battery. If the voltage per cell is 2 volts or thereabout, the trouble is in the connections. If cell voltage is low (1.80 volts or lower), the trouble is in the battery.

FAILURE TO START

When lamps burn brightly, but engine will not crank, notice, when attempting to start engine, whether lamps become very dim or go out; if they do, the trouble is in the battery. If they continue to burn brightly, the trouble is in the motor or motor circuit.

WIRING GROUNDED

The wiring may have become grounded to the frame of the car, and cause a leakage of current, which in time may completely discharge the battery. This may be tested for as follows: At night or in a dark garage, turn on all the lamp switches, but remove the bulbs from the sockets and disconnect the battery ground wire at the ground plate. Then strike the bare end of terminal of the ground wire against the ground plate; if sparks are noticed, there is a ground in the wiring, which should be looked for and removed.

CARE OF BATTERY OUT OF SERVICE

When a car is to stand idle for any considerable period, as when it is laid up for the winter months, the battery should not be left on the car without attention.

When a car is likely to be out of service as long as one month, but less than two, be careful to add water to the cells just before the last time the car is used and endeavor then to run the car (using lamps sparingly) so that the battery will be as nearly fully charged as possible, the specific gravity of the electrolyte reading between 1.270 and 1.300 (1.200 and 1.230 in tropical climates). Disconnect the wires of the battery, as even a slight leak in the wiring will cause the battery to discharge.

When a car is likely to be out of service for two months or longer, send the battery to a reliable garage where it will receive proper attention. If this is not practicable, the battery should be taken out of the car and treated as follows:

Remove the filling plugs and add pure water until the level reaches the bottom of the filling tube. Replace the filling plugs, turning them as far as they will go to insure their being firmly seated. Never charge a battery with the filling plugs out, as the automatic vents are then closed and flooding will result.

PRELIMINARY CHARGE

Put on charge at a current rate of seven amperes.

Continue the charge until the specific gravity of the electrolyte in all cells, as shown by the hydrometer syringe, has held at a maximum (ceased to rise) for a period of five hours and all the cells are gassing freely. When fully charged, place the battery where it will be dry, cool and free from dust.

FREEZING

The electrolyte in a fully charged battery freezes at about 80 degrees below zero, while in a normally discharged battery it freezes at about zero Fahrenheit. Therefore, if a battery is fully charged before being laid aside, and water is not added except immediately before charging, as directed above, there is no danger of freezing. Should water be added without being followed by a charge, it will not mix with the electrolyte, but, being lighter, will remain on the surface and be subject to freezing. The gassing at the end of the charge causes the water to become thoroughly mixed with the electrolyte.

ADDING WATER

Once every two months during the out of service period, remove filling plugs and add water, replace plugs and give the battery what is known as a "freshening charge," that is, charge until all cells have been gassing freely and evenly for one hour. Then the battery may be allowed to stand for another two months.

The Hydrometer and Its Use

TYPE IN GENERAL USE

The specific gravity or density of the electrolyte is measured by an instrument called the "hydrometer" (see below), S-1 type. This consists of a closed glass tube in the form of a short barrel with a longer stem of small diameter. Inside of the stem is a graduated scale. The hydrometer floats upright in the liquid and the point on the scale at the surface of the liquid shows the specific gravity, usually called "gravity."

HYDROMETER SYRINGE

For greater convenience, the hydrometer is usually placed inside of a large glass barrel provided with a rubber bulb on top and a suitable nozzle on the lower end. This combination is known as the "hydrometer syringe" (Fig. 4).

METHOD OF USE

By squeezing the bulb, inserting the nozzle into the electrolyte and releasing the bulb, electrolyte is drawn up into the glass barrel. Sufficient electrolyte should be drawn up to float the hydrometer clear of the rubber plug in the bottom (Fig. 5).

Fig. 5. TAKING HYDROMETER READING

To prevent the hydrometer from sticking to the side of the barrel, it is necessary that the syringe be held in a vertical position. The reading is taken at the surface of the electrolyte and when there is no compression on the bulb.

In recording the gravity of the different cells, it is customary to begin with the cell at the positive end.

When the readings have been taken, be careful to put the electrolyte back into the same cell from which it was taken. Failure to do this often leads to trouble; that is, electrolyte is often taken out of one cell, the gravity noted and the electrolyte put back into another cell. The result is that the amount of electrolyte

put back into another cell is eventually replaced with water, leaving the electrolyte weaker; whereas the electrolyte which was taken out and put into another cell would make the electrolyte of that cell stronger, resulting in irregularity in the different cells.

Fig. 4
HYDROMETER SYRINGE

OUTLINE OF THE ACTION IN A STORAGE BATTERY

General

A storage battery consists of one or more cells.

A cell consists essentially of positive and negative plates immersed in electrolyte.

The electrolyte of the "Exide" cell consists of a mixture of sulphuric acid and water.

The voltage of one cell is about two volts.

The voltage of a battery (with cells in "s eries") is the number of cells multiplied by two.

When a cell is put on discharge, the current is produced by the acid in the electrolyte going into and combining with the lead of the porous part of the plates called "active material." In the positive plate the active material is lead peroxide, and in the negative it is metallic lead in a spongy form.

FORMATION OF LEAD SULPHATE

When the sulphuric acid in the electrolyte combines with the lead in the active material, a compound, lead sulphate, is formed.

DROP IN VOLTAGE

As the discharge progresses, the electrolyte becomes weaker by the amount of acid that is used in the plates, producing the electric current and incidentally producing the compound of acid and lead called "lead sulphate." This sulphate continues to increase in quantity and bulk, thereby filling the pores of the plates. As the pores of the plates become thus filled with the sulphate, the free circulation of acid into the plates is retarded; and since the acid cannot then get into the plates fast enough to maintain the normal action, the battery becomes less active, as is indicated by the drop in voltage.

DROP IN SPECIFIC GRAVITY DURING DISCHARGE

During a normal complete discharge, the amount of acid used from the electrolyte in "Exide" cells will cause the specific gravity to drop about 150 points (0.150 sp. gr.). Thus if the gravity of a fully charged cell is 1.300 (1.230 in tropical climates) it will, at the end of discharge, be about 1.150 (1.080 in tropical climates). The battery should receive charge before it is discharged below this point.

CHARGING

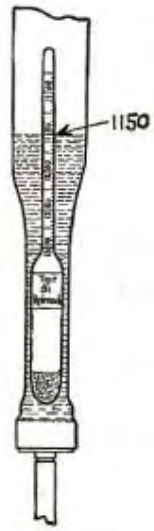
To charge, direct current is passed through the cells in a direction opposite to that of discharge. This current, passing through the cells in the reverse direction, will reverse the action which took place in the cells during discharge. It will be remembered that during discharge the acid of the electrolyte went into and combined with the active material, filling its pores with sulphate and causing the electrolyte to become weaker.

ACTION OF CURRENT

Reversing the current through this sulphate in the plates restores the active material to its original condition and returns the acid to the electrolyte. Thus, during charge, the electrolyte gradually becomes stronger as the sulphate in the plates decreases, until no more sulphate remains and all the acid has been returned to the electrolyte. It will then be of the same strength as before the discharge and the same acid will be ready to be used over again during the next discharge. Since there is no loss of acid, none should ever be added to the electrolyte.

OBJECT OF CHARGING

The acid absorbed by the plates during discharge is, during charge, driven from the plates by the charging current and restored to the electrolyte. This is the whole object of charging.

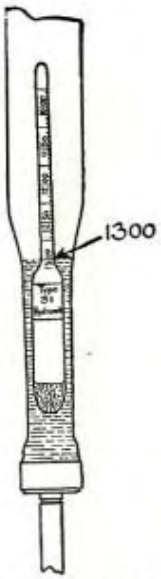


HYDROMETER READING, 1.150

GASSING

When a battery is fully discharged, it can absorb current at the highest rate. As the charge progresses, the plates can no longer absorb current at the same rate and the excess current goes to form gas. In a battery which is charged or nearly charged, the plates can absorb current without excessive gassing only at a low rate and a high charge rate will be almost entirely used in forming gas, resulting in high temperature and wear on the plates.

In starting and lighting systems, the aim is to provide sufficient current under average running conditions so that the battery will not be "starved" and yet the charge will be at a rate which will not cause injurious gassing.



HYDROMETER READING, 1.300

NORMAL SULPHATE—ABNORMAL SULPHATE

The sulphating which takes place during an ordinary discharge is entirely normal. If, however, charging is insufficient, the sulphate increases and becomes hard and the plates become lighter in color, lose their porosity and are not easily charged; this is the abnormal condition usually referred to as "sulphated." This condition is usually the result of "starvation" of the battery.

HIGH RATES OF DISCHARGE

A very general misapprehension has existed in the past as to the effect on a lead storage battery of discharging at very high rates. The fact that a starting battery will spin one of the big modern engines, which a strong man can scarcely turn over, shows what its capabilities are; and the length of time it will, with proper charging and care, continue to do this heavy work without giving out, shows that it is not injured thereby.

OVER-DISCHARGE

It is not "discharge" at any rate which injures a battery, but "over-discharge," or what in time amounts to the same thing, undercharge or "starvation."

"STARVATION"

If a car is so run that the battery gets insufficient charge and is "starved," it cannot be expected to do its work properly.

OVERCHARGE

Persistent overcharging not only tends to wash out the positive active material, but also acts on the positive grids, giving them a scaly appearance.

LOW TEMPERATURE

Temperature has quite a marked effect on a battery. Low temperature temporarily both lessens the ampere hour capacity which can be taken out of the battery and lowers the discharge voltage. It is as if the battery were numbed by the cold and unable to make the same effort as at normal temperature. The effect of cold is only temporary, the battery returning to its normal state upon its return to normal temperature even without charge. Starting batteries are usually designed with sufficient margin over the ordinary requirements so that they will still perform their functions under reasonably low temperature conditions. It is just as well, however, to bear in mind the effect of cold weather and to aim to keep the battery unusually well charged in winter and not expose it unnecessarily to low temperatures. There is no danger of the electrolyte freezing in a fully charged cell; but in one which is over-discharged or has had water added without subsequent charging this is liable to occur in cold climates.

HIGH TEMPERATURE

High temperature is to be avoided from the standpoint of life. 110 degrees Fahrenheit (125 degrees Fahrenheit in tropical climates) is usually given as the limiting temperature, and even this would be harmful if maintained steadily. Heating is ordinarily the result of charging at too high a current rate. If the temperature of the electrolyte in a battery is found to run consistently high, the system should be inspected; it may be out of adjustment and be charging the battery at too high a rate.

The effects of continued high temperature are to distort and buckle the plates, to char and weaken the wood separators, to soften and sometimes injuriously distort the jars and covers.

Diagnosis of Trouble

ELECTRICAL CRANKING FAILS

1. Loose battery connections. The clamps on the battery post should be kept tight and the parts coated with vaseline in order to prevent corrosion.
2. Depleted storage battery.
3. Brush contact faulty in starting motor.
4. Transmission gears engaged.
5. Faulty switch contact.

FAILURE OF MOTOR TO START

1. Water in petrol. Drain from bottom of vacuum tank and carburetor.
2. Faulty ignition. Contact points out of adjustment or dirty. See page 41.
3. Resistance coil on distributor broken.
4. Water on coil or wires.
5. Broken down condensor or poor connections.
6. Motor flooded with petrol, caused by continued use of choke. Crank with air and gas buttons all the way in until motor fires; then adjust petrol button.

IF MOTOR STOPS

1. Out of petrol. Check main tank.
2. Vacuum tank failing to work. Open drain cocks at bottom of vacuum tank and see if fuel flows. If not, remove pipe plug on top of tank and pour some petrol in tank. This will wash dirt off flapper valve. See Petrol System, page 29.
3. Vent in petrol tank plugged. Keep this vent open at all times.
4. Loose electrical connections. (See also Nos. 2. 3, 4 and 5 under "Failure of Motor to Start.")
5. Out of motor oil, indicated usually by a knocking in the motor, followed by an abrupt stop. Do not attempt to use motor until the oil supply has been replenished and the motor examined by a competent mechanic.

REASONS FOR MOTOR MISSING

1. Driving with a cold motor. To thoroughly vaporize the fuel, it is necessary to adjust the shutter so as to maintain the motor at its most efficient temperature. (See page 15.)
2. See that gas button on instrument board is adjusted to lean position.
3. Short circuited spark plug. Clean the plugs and adjust the points to .028 to .030 inch gap.
4. Improperly adjusted distributor points or poor electrical connections.
5. Tappets not adjusted properly, causing the valves to ride.
6. Valves may need regrinding.
7. Valve springs may be weak or broken.
8. The valve on the vacuum tank which shuts off suction from intake pipe may not be seating properly. This will cause continual missing on Nos. 3 or 4 cylinders. See instructions on Vacuum Tank.
9. Packing gland nut in carburetor loose, causing excess petrol to be drawn into the intake passage. Retighten gland according to instructions under "Petrol System."
10. Water in petrol, causing the engine to run spasmodically. (This is difficult to distinguish from other causes and should be one of the last things looked for.) Drain some of the fuel from the vacuum tank and carburetor and note if any improvement in running occurs. If so, it is advisable to drain all the fuel from the tank, strain through a chamois skin and replace.

IF MOTOR LACKS POWER

1. Loss of compression, due to leaky valves.
2. Too rich a mixture. See that petrol button is carried as close to the instrument board as possible.
3. Late ignition. See directions for timing the distributor, page 41.
4. Lack of oil in motor or improper motor oil. Use nothing but a high grade medium-light oil and change it frequently.

5. Dirt in the petrol, causing impeded flow of fuel to carburetor. Thoroughly clean the screen at the petrol inlet at the base of the carburetor and drain sediment from vacuum tank.

6. Dragging brakes or improper lubrication, adjustment of wheel bearings, etc. The car should be rolled easily by hand when placed on a level surface. If brakes drag, the brake drums on the wheels will become hot. This can be detected by placing your hand on the parts.

7. Low tire pressures. The pressures advised by manufacturer should be adhered to. Partially deflated tires present such a large surface to the road that a great deal of power is lost in friction.

8. Cylinders badly carbonized. This will be indicated by a knocking in the motor when endeavoring to climb grades. The remedy is, have the carbon removed immediately and the valves ground if necessary.

CAUSES OF SPARK PLUG FOULING

1. Running on rich mixture. Owners should operate their cars on as lean a mixture as possible and carburetor packing gland nuts should be kept tightly packed.

2. Diluted crank case oil. This is the result of operating on too rich a mixture. Completely change oil in motor every seven to eight hundred miles.

3. Weak ignition. Distributor breaker points should be kept flat and adjusted at .018 inch when at their widest opening. All connections should be clean and tight. Distributor head and connections should be clean. Spark plugs set at a clearance of .030 inch.

4. Loose or defective spark plugs. Plugs should be compression tight. If a leak exists a drop in mean pressure will result which will allow more oil to enter combustion chamber than is normally possible.

5. Tappets out of adjustment. Tappets should be adjusted .006 inch on the inlet and .008 inch on the exhaust, or more. Tappets too closely adjusted will ride when the motor is warm, causing misfiring.

6. Oil pump out of adjustment. Refer to page 11.

7. Piston rings not fitting properly. The rings should have a slot clearance of about .005 inch, and should turn in ring grooves with a clearance of .0015 to .002 inch clearance, or what is known as a sliding fit. The surface of the ring should have full bearing on the cylinder walls. This can be obtained by lapping the rings in the cylinder bores with rotten stone and oil.

8. Poor compression. Valves need grinding.

IF MOTOR KNOCKS

1. Spark advanced too far. (See directions for timing the distributor, page 41.) Always retard the spark lever on the steering wheel quadrant if necessary when climbing grades at low speed.

2. Motor speed too low for the work the car has been called upon to perform. Transmission gears are placed there for a purpose, and the gears should be shifted to intermediate on any indication that the motor is laboring.

3. Loose timing gears.

4. Loose connecting rod bearings. Light knock at high speeds.

5. Crank shaft bearing loose. Heavy pounding at low motor speeds and under heavy loads.

6. Worn valve tappets. Light tapping sound.

7. End play in cam shaft, noticeable at low engine speeds. Can be detected by placing hand on timing gear cover. To remedy, remove timing gear cover and place shims behind thrust button in end of cam shaft to take out play.

8. Carbonized cylinders.

REASONS FOR OVERHEATING

1. Water supply low.

2. Cooling system clogged with impurities. Remedy for this is to obtain about two pounds of sal or washing soda, dissolve it in hot water and pour in cooling system. Drive car with this mixture for about one-half hour, then drain and flush out with pure water and refill.

3. Carbonized cylinders.

4. Lack of motor oil.

5. Ignition timing set too late, or owner driving with spark lever on steering wheel quadrant retarded.

6. Cells in radiator stopped up with mud. When cleaning the cells do not poke a wire or other sharp instrument between them. Force the mud out with a hose by directing a stream of water from the motor side of the radiator.

7. Loose or broken fan belt, or fan blades having become bent so that they do not circulate the air properly.

8. Too lean a mixture of petrol. Do not carry the petrol button all the way in very hot weather if motor shows any tendency to overheat.

9. Using too heavy an oil. Use nothing but high grade medium light oil and change it frequently.

GENERAL

1. Transmission change speed lever slipping out of gear or jumping when the car is in motion. This is caused by excessive end play in the main transmission shaft which can be corrected by removing the necessary amount of shims from the rear main bearing cap. (See page 22, Transmission.)

2. If the lever slips out of gear, the interlocks which operate in the notched control shaft should be examined. The springs may be weak or broken and should be replaced if necessary. See that the interlock seats properly in the notched shaft.

3. Clutch slipping. This may be caused by clutch out of adjustment, or the clutch oil having become gummed. Drain the oil out of the clutch by way of the plug in the flywheel. Flush out with kerosene and refill with one-half pint of a mixture of kerosene and light lubricating oil in equal proportions. For adjusting clutch pedal mechanism, see page 21.

4. Play in driving mechanism when the clutch is engaged. This is usually caused by loose spring clips on the rear axle. The springs absorb the torque or drive of the car, and it is necessary that these clips be frequently inspected and tightened if necessary.

5. Rear axle noise. Usually caused by insufficient lubricant. See that the rear axle contains the necessary amount of oil and make sure that the pinion shaft, immediately forward of the differential, is thoroughly lubricated. This shaft runs at the same speed as the motor and unless properly lubricated will wear the bearings rapidly. If the rear axle is noisy on coast, or noisy when the throttle is closed preparatory to slowing down, there is a possibility that end play exists in the pinion shaft or that the pinion shaft has cut through lack of lubrication. Full instructions will be found under the heading of "Rear Axle" for adjusting the pinion shaft and bearings.

MILLIMETER CONVERSION TABLES

Fraction of an inch	Millimeters	Fraction of an inch	Millimeters	Fraction of an inch	Millimeters	Fraction of an inch	Millimeters
1/64	0.3968	17/64	6.7467	33/64	13.0966	49/64	19.4465
1/32	0.7937	9/32	7.1436	17/32	13.4934	25/32	19.8433
3/64	1.1906	19/64	7.5404	35/64	13.8903	51/64	20.2402
1/16	1.5874	5/16	7.9373	9/16	14.2872	13/16	20.6371
5/64	1.9843	21/64	8.3342	37/64	14.6841	53/64	21.0339
3/32	2.3812	11/32	8.7310	19/32	15.0809	27/32	21.4308
7/64	2.7780	23/64	9.1279	39/64	15.4778	55/64	21.8277
1/8	3.1749	3/8	9.5248	5/8	15.8747	7/8	22.2245
9/64	3.5718	25/64	9.9216	41/64	16.2715	57/64	22.6214
5/32	3.9686	13/32	10.3185	21/32	16.6684	29/32	23.0183
11/64	4.3655	27/64	10.7154	43/64	17.0653	59/64	23.4151
3/16	4.7624	7/16	11.1122	11/16	17.4621	15/16	23.8120
13/64	5.1592	29/64	11.5091	45/64	17.8590	61/64	24.2089
7/32	5.5561	15/32	11.9060	23/32	18.2559	31/32	24.6057
15/64	5.9530	31/64	12.3029	47/64	18.6527	63/64	25.0026
1/4	6.3498	1/2	12.6996	3/4	19.0496	1	25.3995

Thousandths of an inch	Millimeters	Thousandths of an inch	Millimeters	Thousandths of an inch	Millimeters
.001	.025	.006	.152	.020	.508
.002	.051	.007	.178	.030	.762
.003	.076	.008	.203	.040	1.016
.004	.102	.009	.229	.050	1.270
.005	.127	.010	.254		

Explanation of Battery Electrical Terms

Acid. As used in this book refers to sulphuric acid (H_2SO_4), the active component of the electrolyte.

Alternating Current. Electric current which does not flow in one direction only, like direct current, but rapidly reverses its direction or "alternates" in polarity so that it will not charge a battery.

Ampere. The unit of measure of the rate of flow of electric current.

Ampere Hour. The unit of measure of the quantity of electric current. Thus, 2 amperes flowing for ½ hour equals 1 ampere hour.

Battery. Any number of complete cells assembled in one case.

Battery Terminals. Devices attached to the positive post of one end cell and the negative of the other, by means of which the battery is connected to the car circuit.

Case. The containing box which holds the battery cells.

Cell. The battery unit, consisting of an element complete with electrolyte, in its jar with cover.

Cell Connector. The metal link which connects the positive post of one cell to the negative post of the adjoining cell.

Charge. Passing direct current through a battery in the direction opposite to that of discharge, in order to put back the energy used on discharge.

Charge Rate. The proper rate of current to use in charging a battery from an outside source. It is expressed in amperes and varies for different sized cells.

Corrosion. The attack of metal parts by acid from the electrolyte; it is the result of lack of cleanliness.

Cover. The rubber cover which closes each individual cell; it is flanged for sealing compound to insure an effective seal.

Discharge. The flow of electric current from a battery through a circuit. The opposite of "charge."

Electrolyte. The fluid in a battery cell, consisting of specially pure sulphuric acid diluted with pure water.

Filling Plug. The plug which fits in and closes the orifice of the filling tube in the cell cover.

Flooding. Overflowing through the filling tube. With the "Exide" automatic filling tube, this can usually occur only when a battery is charged with the filling plugs out.

Freshening Charge. A charge given to a battery which has been standing idle, to insure that it is in a fully charged condition.

Gassing. The bubbling of the electrolyte caused by the rising of gas set free toward the end of charge.

Gravity. A contraction of the term "specific gravity," which means the density compared to water as a standard.

Hold-Down Clips. Brackets for the attachment of bolts for holding the battery securely in position on the car.

Hydrometer. An instrument for measuring the specific gravity of the electrolyte.

Hydrometer Syringe. A glass barrel enclosing a hydrometer and provided with a rubber bulb for drawing up electrolyte.

Jar. The hard rubber container holding the element and electrolyte.

Maximum Gravity. The highest specific gravity which the electrolyte will reach by continued charging, indicating that no acid remains in the plates.

Oil of Vitriol. Commercial name for concentrated sulphuric acid 1.835 specific gravity. This is never used in a battery and would quickly ruin it.

Plates. Metallic grids supporting active material. They are alternately positive (brown) and negative (gray).

Polarity. Electrical condition. The positive terminal of a cell or battery, or the positive wire of a circuit, is said to have positive polarity; the negative, negative polarity.

Rectifier. Apparatus for converting alternating current into direct current.

Resistance. Material (usually lamps or wire) of low conductivity inserted in a circuit to retard the flow of current. By varying the resistance, the amount of current can be regulated.

Sealing Compound. The acid-proof compound used to seal the cover to the jar.

Short Circuit. A metallic connection between the positive and negative plates within a cell. The plates may be in actual contact or material may lodge and bridge across. If the separators are in good condition, a short circuit is unlikely to occur.

Specific Gravity. The density of the electrolyte compared to water as a standard. It indicates the strength and is measured by the hydrometer.

Starvation. The result of giving insufficient charge in relation to the amount of discharge, resulting in poor service and injury to the battery.

Sulphated. The condition of plates having an abnormal amount of lead sulphate caused by "starvation" or by allowing battery to remain discharged.

Voltage. Electrical potential or pressure, of which the volt is the unit.

Foreign Representatives for "Exide" Batteries

AUSTRALIA
Sydney—Sutherland and Ashman
Melbourne—Sutherland and Ashman

NEW ZEALAND
Wellington—Hope, Gibbons, Clarkson & Co.

CANAL ZONE
Panama City—W. A. Torbet, Panazone Garage

CUBA
Havana—Russell Spaulding, Apartado 1975, Calle Cuba 10

PHILIPPINE ISLANDS
Manila—Pacific Commercial Co.

SOUTH AFRICA
Johannesburg—Kittleson and Rees, Ltd., P. O. Box 1094, 29-38 London House, Loveday Street

SIAM
Bangkok—Siam Electricity Company

PORTO RICO
San Juan—J. H. Cerecedo and Co., 17 San Justo Street

HAWAII
Honolulu—Von Ham Young Co., Ltd.

ARGENTINA
Buenos Aires—The Anglo-Argentine General Electric Co., Ltd.

ENGLAND
Manchester—Chloride Electrical Storage Co., Ltd.

List of Foreign Branches and Agents

WHITMORE MANUFACTURING CO.

GEORGE H. ALEXANDER,
Coleshill Street,
Birmingham, England

RINTOUL & DAVIS,
24-36 Cullinan Building,
Johannesburg, South Africa

WHITMORE AUSTRALASIAN SALES CO., Ltd.
G. P. O. Box 2557,
Sydney, New South Wales, Australia

GRAHAM-ROWE & CO.,
Apartado 589,
Lima, Peru, South America

GRAHAM-ROWE & CO.,
Callao, Peru, South America

GRAHAM-ROWE & CO.,
P. O. Box 921,
Valparaiso, Chile

BUXTON, OLDITCH & CO.,
Calle Suipacha, 602 Esquina Tucuman,
Buenos Aires, Argentine

LANGE & CO.,
Calle 25 No. 5,
Havana, Cuba

DAVIS CO., Ltd.
Singer Building,
New York City (Attention Mr. A. C. Potosky)