SUPER-SIX SERVICE MANUAL

for HUDSON MECHANICS

MODELS
H, J & M

HUDSON MOTOR CAR CO.
DETROIT - - - MICHIGAN

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HUDSON SUPER SIX REG. U.S. PATENT OFF.

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Introduction

This book explains the numerous adjustments which are built into the Super-Six Models H, J and M, to make it economical of upkeep.

It is intended mainly for the benefit of our dealers' mechanics, or those upon whom the work of adjusting Hudson cars devolves.

It is also issued to Hudson owners so that they may be guided thereby should they be unable to take advantage of the assistance offered by our numerous dealers throughout the country and to enable them to direct and supervise repair work or adjustments which it may be necessary to have done in local repair shops where Hudson experts are not at hand.

Hudson cars are so widely distributed and are found in so many remote districts where service of any kind—hotel, railroad, telephone, etc., included—is almost entirely absent, that we recognize the obligation of thoroughly posting such owners as to the construction of their cars.

The Hudson Motor Car Company is endeavoring to place this book in the hands of every mechanic working on Hudson cars in order that he may not be required to work out problems for himself but rather that he may be able to adjust and repair a car along the lines detailed by experts in that work.

Oiling System

High speed and excessive power impose proportionately greater strains and stresses upon the moving parts of a motor; hence it has become necessary to develop an entirely new and improved oiling system. On the Hudson motor, this is most suitably termed a circulating, constant level, splash system.

The oil pump is mounted at the front of the motor, well above the frame line and in a position where it may be instantly inspected, removed, or tested without recourse to special tools or other appliances. Furthermore, it is of such simple and sturdy construction as to be easily comprehended by the layman.

It takes its oil from the pressed steel reservoir, drawing all of it through a filter or metal screen of fine mesh. The oil is 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 large splasher on the end of the connecting rod practically empties this oil trough at every revolution, throwing the oil into suitable channels or gutters on the side of the reservoir and crank case. The upper gutters feed the main bearings in a continuous stream. The lower gutter feeds the oil directly into No. 2 oil trough. The splash from No. 2 oil trough feeds No. 3, and so on until No. 6 oil trough is reached, at which time the oil flows back into the reservoir. The connecting rod dipper is sufficiently effective to permit a very high level being maintained, thus insuring lubrication on all grades without excessive oil consumption. The two center bearings are fed by two troughs each. The front bearing is fed from the timing gears and one trough, and the rear bearing is fed by two large troughs.

It is therefore immediately apparent that 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 reservoir contains over two and one-half gallons of oil in the troughs and in the reservoir itself. On account of its being of such large capacity and of pressed steel, having such an exposed position under the motor affords excellent cooling facilities. The large quantity of oil insures a slow enough circulation to allow of the proper cooling before the oil is recirculated through the bearings and troughs.

As the connecting rod dippers would splash more oil at the high speeds than at low speeds, it was necessary to control the stroke of the pump so that the flow might be proportionately increased to cope with the more rapid circulation. To accomplish this the carburetor throttle has been connected with the oil pump in such a way as to regulate the stroke of the oil pump plunger. While this may sound complicated, it is nevertheless an extremely simple device, the action being obtained by means of an eccentric and a very large pump plunger. At low speeds this eccentric holds the plunger away from the cam which actuates it, but allows it to come closer to the cam as the motor speed is increased. The pump has a short stroke when the motor is idling at the curb or running slowly, but the minute the throttle is opened wide, the pump plunger stroke is immediately increased in proportion. Before the motor has had time to pick up speed, the pump is delivering the amount of oil necessary to lubricate all moving parts under increased pressure.

The reservoir is fitted with a float indicator which shows the level of the oil by means of a red button working in a glass tube. This is on the left-hand side of the motor.

On page 11 there is a diagram showing the manner in which the oil circulates through the various parts of the motor.

In this illustration it will be seen that the oil pump, while of the conventional type and operated by a plunger bearing on the eccentric, has a driving mechanism which is connected to the carburetor throttle. The purpose of this regulation has already been explained. Its adjustment, however, should be understood by all.

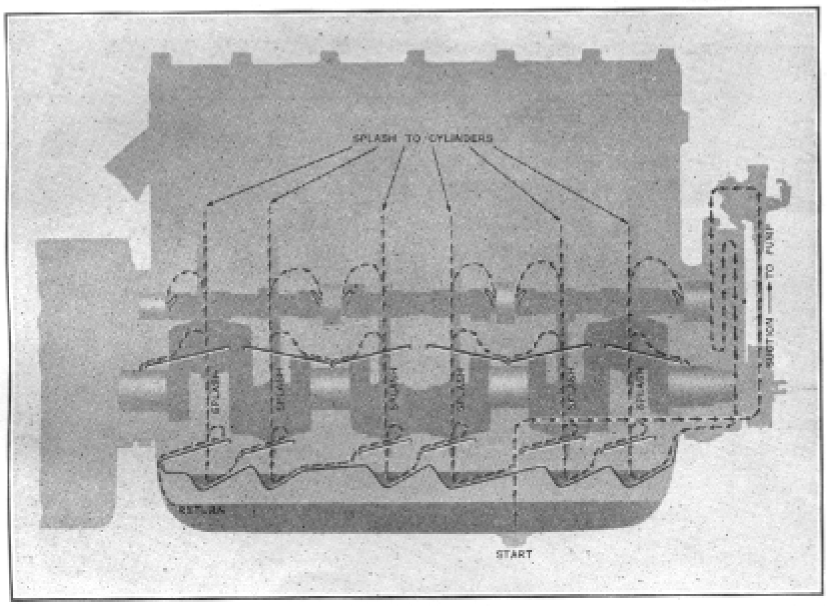
The hand control eccentric, which keeps the plunger from operating on the cam, should be set so that the plunger has a stroke of $\frac{1}{16}''$ at approximately 200 r. p. m. As the throttle is opened, the eccentric is turned away from the plunger so as to allow it a greater amount of travel from the cam action. When the throttle is wide open, the eccentric should be in such a position as to permit a full travel of the pump plunger.

By this adjustment, the oil pressure shown on the gauge will gradually increase as the car speed increases.

If, for any reason, the oil gauge does not act in this manner, the pump control mechanism should be investigated to make sure that none of the levers have become disconnected or are slipping on the shafts. Failure of the oil pump may cause serious trouble and result in burned out bearings.

Upon the first indications of the oil pump being inoperative make sure that there is plenty of oil in the reservoir and that the motor is getting sufficient lubrication by splash alone, irrespective of the pump. If you are any distance from the nearest Hudson dealer or a repair shop and have good reasons for deciding not to make any further investigation until such a place is reached, be sure that the oil reservoir contains an excess of oil and on no account drive the car at a speed of more than 25 miles an hour. It is very unlikely that you will ever experience trouble of this nature, but we believe a warning is worth while.

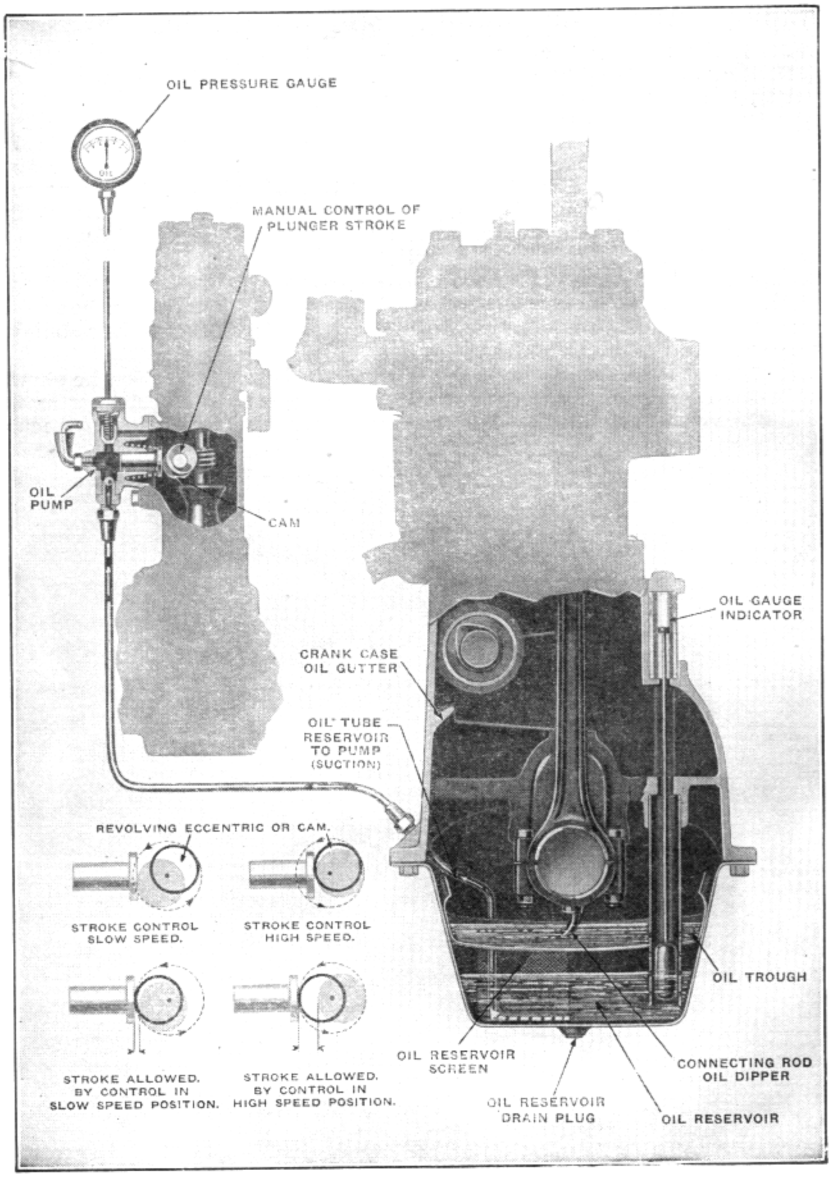
Endeavor to teach the new owner that for the first 1,000 miles, he should never drive the car at a speed exceeding 30 miles an hour. A new motor requires more oil than one that has been in service as there are a great many



Oiling System Diagram

pockets and pores to be filled up before a good polish and glaze is given to the working parts. This wearing in assures smooth and perfect action.

Racing a motor when it is new tends to cut and otherwise damage the bearings before they have had a chance to get run in. No matter how great the temptation to see how fast the car will go, wait until you have run at least 1,000 miles.



Details of Oiling System

Explaining Why a Frequent Change of Oil is Necessary—How to Do it Properly

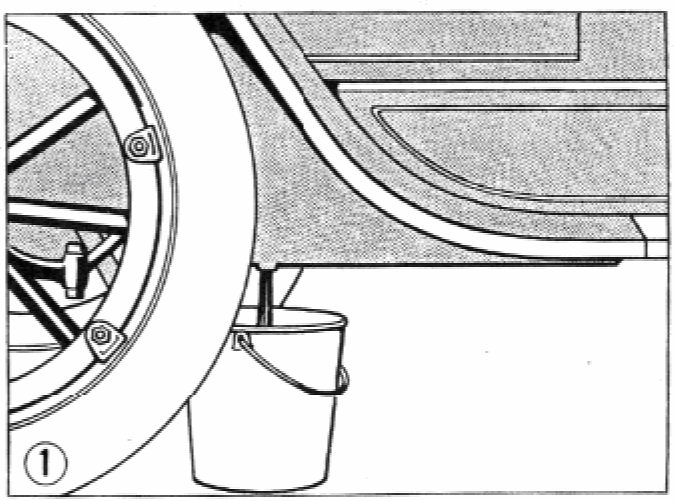
Just as the human body depends upon good heart action, proper blood pressure, and the necessary qualities in the blood to nourish and sustain the nerves and tissues which govern our movements, so a motor needs sufficient circulation of good quality oil to eliminate friction and prevent wear to its moving parts. It must be borne in mind that the motor represents the entire source of energy for your car. It does an enormous amount of work and will stand a great deal of abuse before it wears out. Just how long it takes to wear out depends largely upon the grade of oil you use, the functioning of the oil pump, and the frequency with which you clean out the system and refill with new oil.

On the new Hudson, the oil reservoir is large and contains sufficient lubricant for many hundred miles. In the case of a new car, it is absolutely essential to drain off the reservoir after the first 500 miles and fill to the correct level with new, clean oil. There is a plug in the oil base for the purpos of draining and it is such a simple matter to perform this item of maintenance that there is really no excuse for an owner not doing it himself or having it done locally in time.

Pouring fresh oil into a reservoir containing a small quantity of dirty, used up oil, is not economy. The dirty oil, which contains sediment and carbon and is therefore black in color, mixes with the fresh oil and depreciates it in proportion to the amount of dirty oil mixed in. Thus, if you buy good quality oil at 80c a gallon, and pour in a gallon of it on top of a half-gallon of dirty oil, you are doing no better than filling the motor with the cheapest grade of oil you can obtain and you have depreciated the value of the new oil at least fifty per cent. At least once a year, or after 6000 miles of running, the oil reservoir should be removed and thoroughly cleaned out. At least every 1000 miles, the reservoir should be emptied, flushed out with a quart or so of new oil to remove sediment and dirty oil remaining in troughs, and then refill with new oil.

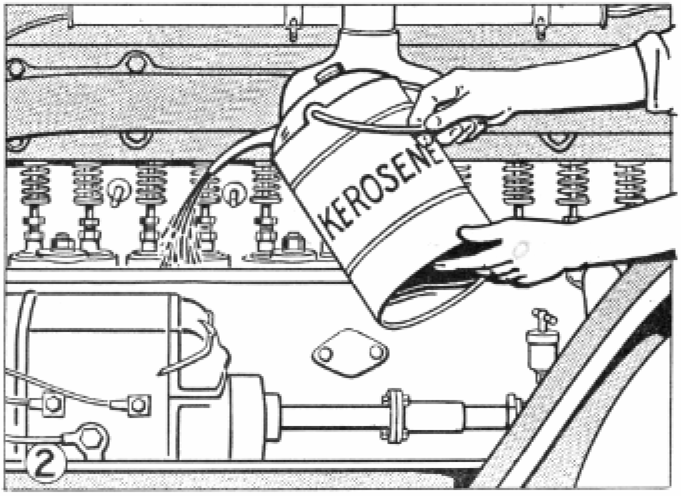
To do this proceed as follows:

1. Remove the drain plug from the bottom of the oil reservoir, drain off all oil. Replace drain plug. See illustration below.



Draining Off Old Dirty Oil

2. Remove the valve cover plates and pour about one quart of kerosene into each tappet compartment.



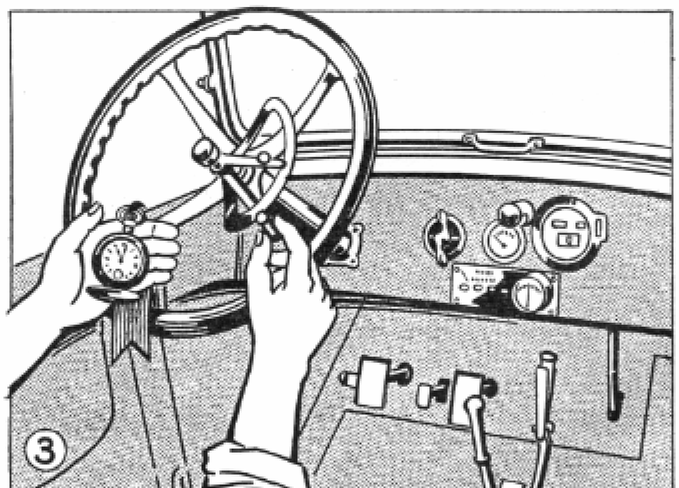
Pouring Kerosene In Tappet Compartments

3. Crank motor with starter for about 30 seconds, but do not let motor run under its own power. This will wash down all sediment and dirt from the inside walls and oil troughs.

4. Remove the drain plug and drain off all kerosene, allowing at least 3 minutes for draining.

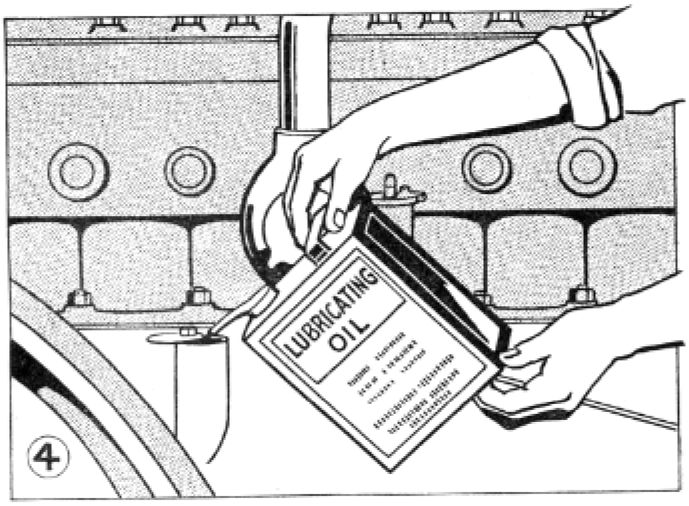
5. Pour clean oil into the tappet compartments slowly. This being heavier than the kerosene, causes the kerosene to run over the troughs and into the lower compartment. Watch the drain until yellow oil appears instead of kerosene, and then replace the plug.

6. Refill with seven quarts of clean oil.



Cranking with Starter for Thirty Seconds

After this operation has been performed, we would suggest that you make a test run over a familiar road, including steep hills and straight level stretches. You will find that your motor has acquired new pick-up and hill-climbing ability. The motor will be more silent and the mileage on both oil and gasoline will be increased.



Refilling with Fresh Cylinder Oil

Always bear in mind that putting new oil into a dirty reservoir is no better than using cheap or dirty oil to refill it; that the crank case should be drained and thoroughly flushed out every 1000 miles; that the cheapest kind of insurance against motor troubles and repair bills for overhauling is the cleaning out of the reservoir and refilling with new oil of good quality.

Use Good Motor Oil

We cannot lay too much stress upon the importance of using a good quality of lubricating oil.

Advise owners whenever possible to buy their oil in cans. Not to accept bulk oil from a garage unless they are certain of its origin. Remember that motor oils are made from crude petroleum and the refineries are all operated by large corporations. These corporations sell to jobbers all over the country, who are free to sell it under any name they please. They do not always buy from the same source, consequently, oil bearing the same trade name may vary greatly in quality when purchased in different parts of the country.

It is not economical to buy cheap oil. Always buy the best and use it as we recommend.

We suggest you consult the nearest Hudson dealer and obtain his recommendations before purchasing oils offered you by local jobbers. If, for any reason, you are unable to obtain satisfactory advice locally, write the factory. We will give you the benefit of our experience.

Remember that in winter a thinner grade of oil must be used, owing to the tendency to congeal at low temperatures. In summer, a medium grade of oil must be used on account of the higher temperature at which the motor operates.

A tendency to overheat, indicated by rapid evaporation of water from the cooling system or laboring of the motor under heavy loads, may often be eliminated by using a different grade of oil or washing out the oil reservoir. See lubricating chart at end of book.

Carbon

The owner who rarely drives at speeds exceeding fifteen to twenty miles an hour, never brings the motor of his car up to an efficient temperature. This is also true of the driver who uses his car for trips a very few miles at a time.

Such owners are more troubled with excessive oil consumption, sooted plugs, carbon deposit and smoking at the exhaust, than are the owners who ordinarily drive at higher speeds and over distances greater than those covered by the usual city driving. The latter get their motors heated up more often.

In any motor which is continually driven at slow speed, the vacuum in the combustion chambers at the beginning of the suction stroke is very high. This is due to the fact that the throttle is at all times nearly closed. There is a tendency, therefore, for this vacuum to draw up the oily mist from the crankcase, resulting in the troubles mentioned.

From this explanation, it will be understood why the driver who is accustomed to traveling at a varying range of speed has less annoyance from these troubles than the habitually slow driver. The more rapid dipping of the connecting rods tends to distribute the oil to better advantage, keeping the troughs at a more uniform level; and at times when short spurts of speed are made, the heat will burn out any excessive carbon and thus has the effect of cleaning the plugs.

Frequent stopping allows the oil to drain back into the troughs and give a semi-overdose of oil each time the motor is started up. This happens in any motor.

Frequent Filling—The Main Cause of Carbonization

To take care of the slow driver, and without endangering the speedy ones, we have provided the filler tube, which reaches down to the oil reservoir itself, filling it DIRECT rather than through the troughs. In this way, the oil level in the troughs is not increased by filling. The oil reaches the troughs only by means of the oil pump; therefore the motor never receives lubricant in excess of its requirements.

Check the Oil Pump

It is most important that the oil pump be set for the proper stroke. To set the pump is but a few moments' work and can be easily accomplished in the following manner:

Cut off about nine inches of ordinary hay wire and bend at 90° about half an inch from one end. After removing the ⅛" pipe plug in the end of the plunger barrel, insert the wire through one of the radiator cells in line with the pump body. The end will then rest against the plunger while the other bent end forms an indicator by which, with the use of a scale resting against the front of the radiator, the exact travel of the pump plunger may be determined.

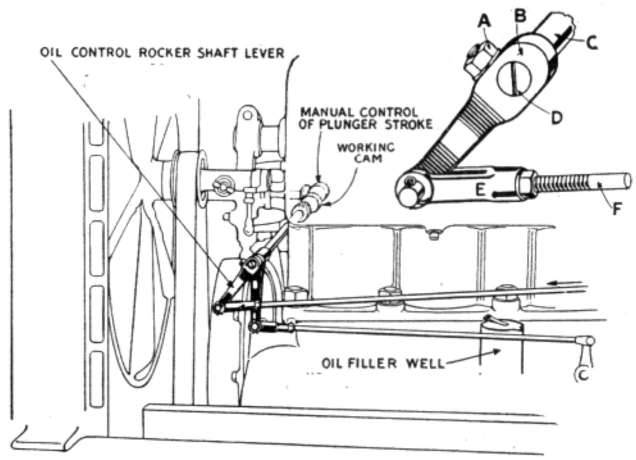
To adjust the pump, loosen the nut "A" on the upper end of the oil pump rocker shaft lever, as shown in the upper right hand section of Illustration page 17.

By means of a screw driver placed in the slot "D" at the end of the rocker shaft "C," adjustment may be made.

Turn slightly counter-clockwise (right to left) to reduce the stroke of the pump, and clockwise (left to right) to increase the plunger travel. Lock the lever "B" on to the shaft "C" by tightening up nut "A."

Check up your adjustments by momentarily speeding up the motor and noting the plunger travel to insure its increase in proportion to the throttle opening.

Adjust the pump to suit conditions. Where smoking prevails, a stroke of 1/32" with the motor idling, is advisable. For ordinary cases, 1/16" should be used, and for cars which receive exceptionally hard driving, 3/32" may be allowed.



Heat affects oil consumption and carbonization. Run the motor at its most thermally efficient point. This lies between 130° and 170° Fahrenheit, as shown by the Boyce Motometer. If this heat is maintained, the trouble from carbon deposit will be minimized.

Use good oil of medium body, and do not fill the reservoir too often. Let it run down to nearly empty before refilling.

Any of the following oils are satisfactory for summer use in the Super-Six motor:

Veedol—Medium.
Monogram—Medium.
Vacuum—A.
Harris—Medium.
Texaco—Medium.

Caution

When a motor has had the oil reservoir removed for cleaning out the oil pan or for other purposes, **always fill the oil tray before putting back in place. Remove the valve cover plates and pour about a quart of oil into each tappet compartment.** This will then run down through the breather holes into the oil pan troughs.

If this is not done, the motor is liable to run dry and burn out bearings before the oil pump can fill the troughs.

Also, when starting the motor after cleaning the oil pan, see that the oil gauge on the dash registers pressure. If it does not, immediately slow down the motor and prime the oil pump. This may be done by removing the cap from the pump, taking out the spring and the auxiliary plunger, and pouring in oil with the motor idling, until the oil is seen to pulsate in time with the oil pump plunger. Replace the plunger, spring and cap, and, if right, the gauge will shortly record the pump action.

In case the gauge does not register, disconenct the line leading from the pump to the gauge. This line being sealed at the gauge end, contains no oil whatever. The gauge is therefore operated by the air pressure resulting from the oil distribution by the plunger in the pump.

If the pipe connection at the gauge is loose, the oil will displace the air and, having an exit, will leak at this point. The line should then be drained of all oil and the union tightened up. This will restore the system to its original condition.

Other Causes of Carbon Deposits

The removal of a spark plug affords an excellent opportunity to inspect the cylinder for excessive carbon deposits. If excessive carbon is found to exist, the owner should be notified and his authority obtained for removing the carbon as it is obvious that a motor cannot be expected to operate satisfactorily if the cylinders are clogged in this manner.

The formation of carbon in the cylinders may be due to incomplete combustion of the gasoline, or the quality of the lubricating oil used, or both. Usually when such deposit is on account of a poor grade of lubricating oil, the difficulty may be eliminated by the use of a better grade, but when the formation is due to incomplete combustion of the fuel, the cause is usually of a mechanical nature and may be obviated. Leaky valves or pistons aggravate the conditions which cause carbon, because compression is thereby reduced and rate and completeness of combustion are impaired. Rapid and complete ignition is impossible at ordinary motor temperatures without proper and sufficient compression.

A weak spark may also give similar results although perhaps not to the same extent as poor compression.

Incorrect carburetor adjustments, especially those which will increase the amount of gasoline drawn into the cylinders, are also responsible for carbon formation, and lastly, the timing of the ignition has an important bearing on the same subject.

Poor compression rarely exists on account of piston or piston ring trouble, but is more likely due to the carbon itself, which tends to accumulate on the exhaust valve seat, preventing tight closing of the valve and causing subsequent escape of the charge during the compression stroke. The weak compression not only results in lack of power but also in further deposit.

Grinding of the valves will therefore usually result in bettering conditions materially. We do not suggest to our owners the advisability of carrying out this operation themselves, although many who are mechanically inclined can obtain sufficient information from their mechanics to carry out the work successfully by observing the operations performed.

Weak ignition is usually due to depleted battery or poor contact of the generator brushes on the commutator, and may also be due to misadjustment or accumulation of dirt on the distributor points, or improper setting of the spark plug gaps. Weak ignition can always be remedied and should not be tolerated.

We have gone to such length on this subject because we believe it advisable for all owners and mechanics to thoroughly appreciate the danger of allowing the motor to remain in a carbonized condition. Cleaning out the carbon is a matter of maintenance and to be expected periodically on any automobile. The average car, if maintained in accordance to our instructions and supplied with a high grade of oil, will run at least 2,000 miles before carbon deposits become in any way excessive. Where a good grade of gasoline is also used, it will be possible to run as much as 4,000 miles without any signs of carbon, provided the other conditions are correct. If you neglect to use good oil or to drain it out at specific periods, and if you do not conform to the instructions relative to the operation of the carburetor, etc., it is only reasonable to suppose that it will be necessary to remove the carbon more frequently.

The actual work required to perform this operation is not great since the removable cylinder head affords an excellent opportunity for doing a good job in a short space of time. It is to be borne in mind that in replacing the cylinder head, the holding down nuts should be tightened equally all over so as to avoid putting excessive pressure on any portion of the head at one time. This is only in accord with good practice and is generally understood by mechanics. The gasket between the cylinder head and the cylinder proper, need not be destroyed if due care is exercised. It is better to leave this gasket in place, taking the necessary precautions to prevent heavy tools falling upon it and denting it, rather than attempt to remove it and the cylinder proper. Should you remove it, be sure to replace it with the copper face up. No compounds or packing materials are necessary in order to make the gasket tight, but it is **necessary** to have a clean surface between the cylinder head and the gasket. It is recommended that the water pipe on the cylinder head be removed to facilitate tightening the holding down nuts.

Carburetor

The Super Six carburetor is of a special type adapted only to our particular design of motor. It is essentially a carburetor for high speed work, although it has a wide range. It is nevertheless necessary to see that the throttle is set so that the motor will idle steadily without completely shutting off the mixture when the hand throttle is closed. This adjustment is accomplished by means of a set screw in the butterfly lever, the manipulation of which is immediately apparent upon investigation.

It has been necessary to develop a special type of carburetor which can be depended upon to accurately proportion the mixture of gasoline and air at all speeds so that there will be no "starving" at the higher speeds and no tendency to "load" or flood the intake pipe at low speeds.

This special type carburetor may be said to be "pneumatically controlled" since no action of the driver can possibly alter the proportioning of gasoline and air. The butterfly valve, commonly called the throttle, is nothing more than a cock, or faucet, for delivering a certain amount of the mixture to the cylinders. The proportion of mixture delivered controls the speed of the motor or the power delivered, and therefore must be regulated by the driver.

The mixing chamber of the carburetor, wherein the gasoline and air are proportioned and vaporized, is of such design as to control itself by the amount of mixture passing through the throttle valve. In this way it will be seen that, upon opening the throttle suddenly at low motor speed, the requirements of the motor are comparatively small and the suction is comparatively weak. This suction controls the mixing of the gasoline and air pneumatically by lifting a piston measuring device in the mixing chamber, thus allowing only the correct amount of mixture to pass through. The necessary velocity or vacuum at the mixing device is controlled by the piston and gives perfect vaporization without having to use an excess of gasoline to obtain that result.

To sum up, the driver may stamp on the accelerator pedal and open the throttle valve with impunity; but the mixing device takes care of itself, proportioning the gasoline and air to the requirements of the motor with a precision which only a pneumatically controlled device can attain.

This improvement, which may rightfully be regarded as an improvement in the motor itself, is largely responsible for the great torque or pulling ability of the motor at low speeds.

The illustrations show very clearly the principles upon which this carburetor functions.

Aside from the periodical cleaning out of the screen at the base of the float chamber and draining off any water or sediment which may have accumulated below the regulator, there is absolutely no maintenance or intricate adjustment necessary.

The gasoline measured out by the measuring pin, may be varied by the gasoline feed regulator which is connected to the lever on the dash. In cold weather it is to be expected that a little richer mixture will be required. In warm weather, it may be set to a leaner mixture.

For high altitudes, where air is at a lower atmospheric pressure, proportionately less gasoline will be required. These adjustments are immediately accessible to the driver.

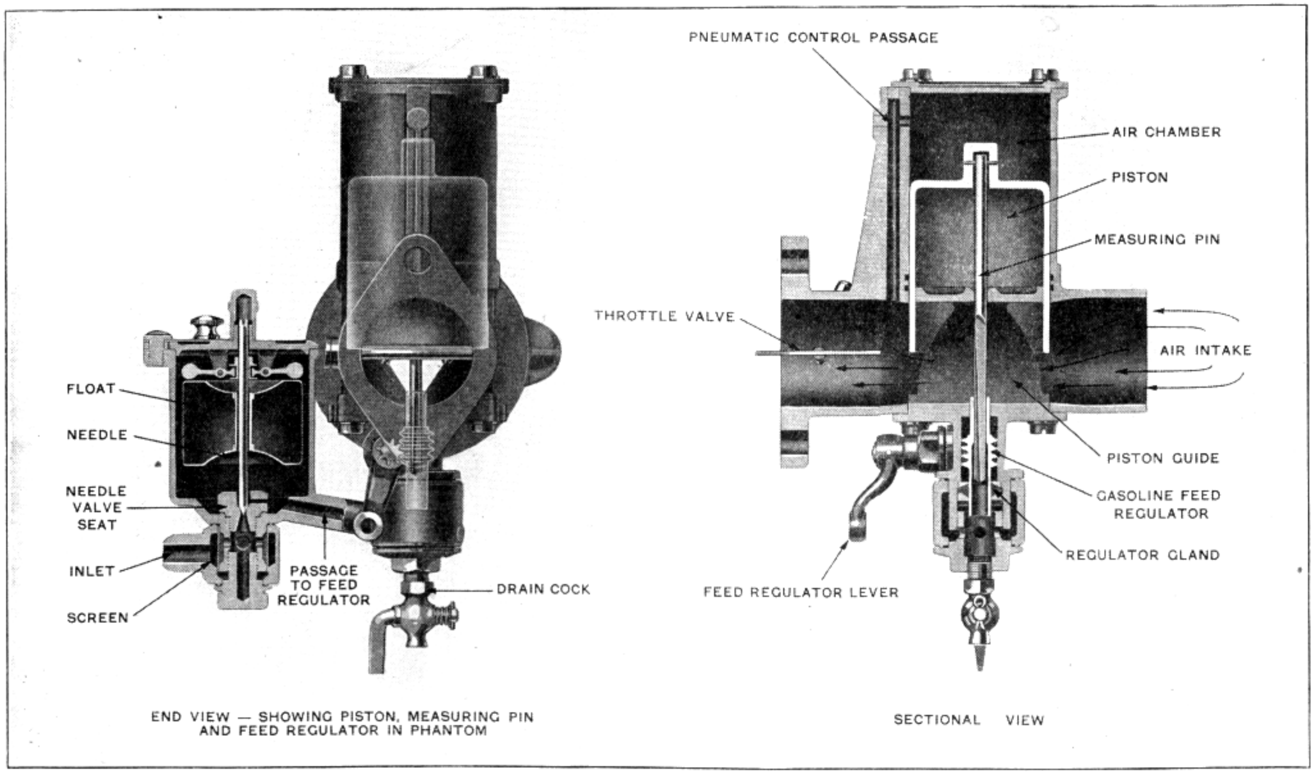
There are no nozzles to change, no matter what the conditions require.

The gasoline consumption of this carburetor depends entirely upon the performance of the car and the ability of the driver to regulate the feed to meet his requirements.

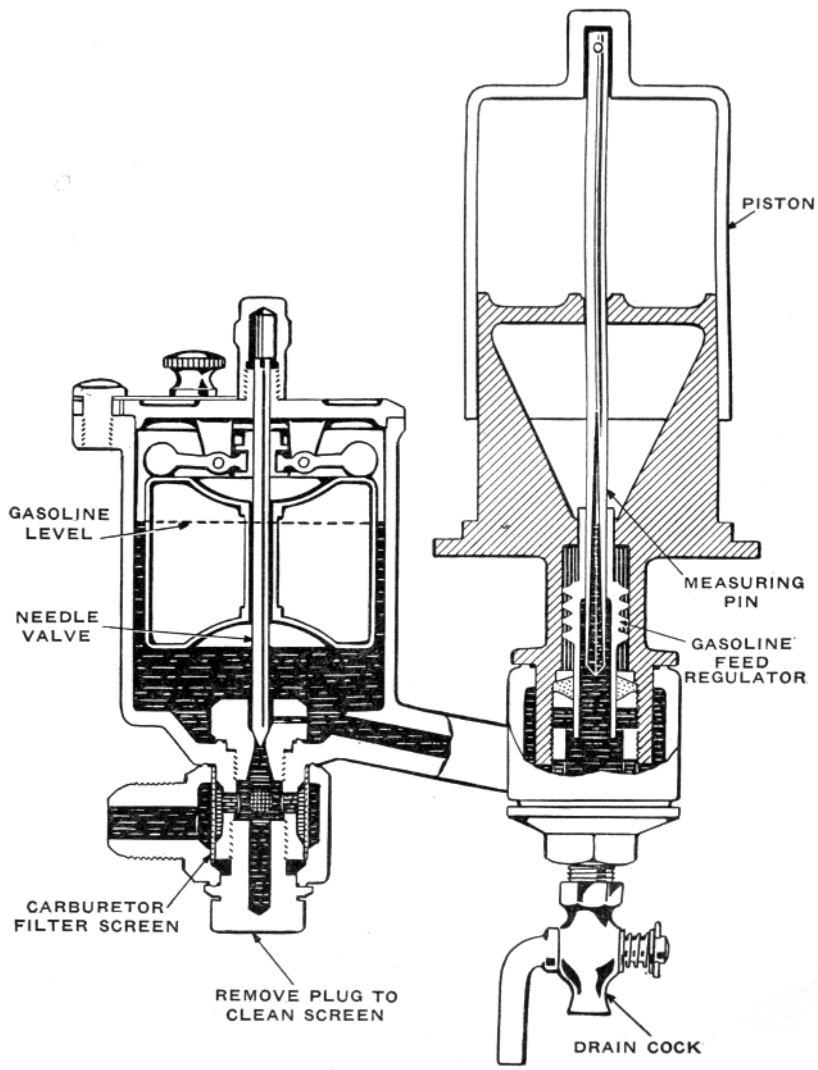
It is obvious that if the maximum performance is needed, more fuel will be required to obtain that performance.

For the average user, or for the man who is interested in obtaining great economy, the mixture may be set to run as lean as the driver desires.

Bear in mind, however, that reducing the proportion of gasoline to air, gives a little less power and acceleration. Setting it in the right proportion, (which must be found by adjustment, according to climatic conditions) results in maximum power, and consequently a little higher fuel consumption than some owners wish to tolerate.



The Super-Six Carburetor



Cross-Section View Super-Six Carburetor

Setting it to give too rich a mixture results in carbonization, mis-firing, and increases the wear and tear on the moving parts of the motor.

If you find it necessary to enrich the mixture for starting purposes, do not forget to re-adjust it to the lean position as soon as the motor warms up.

Do not have the air control lever in the "choke" or "hot" position after motor is warm. The increased resistance to the air intake causes proportionately greater throttle opening than is necessary for the power developed and the results in excessive gasoline consumption.

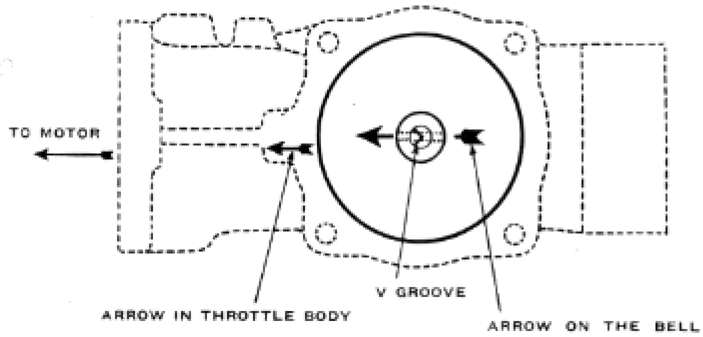
The only attention necessary on this type of carburetor will be to see that the filter under the float chamber is not clogged up, thereby restricting the flow of gasoline, and that the needle valve is seating properly and does not allow the gasoline level to increase and flow at the regulating sleeve. It is also advisable to note the action of the carburetor in order to make sure that the piston valve is acting smoothly and responds to the speed of the motor. It is possible that this piston valve may be stuck in the cylinder through an excessive accumulation of dust, which may be caused by driving on a much frequented road. Provided the owner uses the strangler for starting, it is very unlikely he will notice the valve having stuck, it being possible to operate this carburetor without any valve action at all. However, if the car is used by an experienced driver who counts upon quick acceleration and good hill climbing abilities, he will notice the difference. Especially will the difference be noticed if he is driving without the strangler; this particularly applies to cold weather.

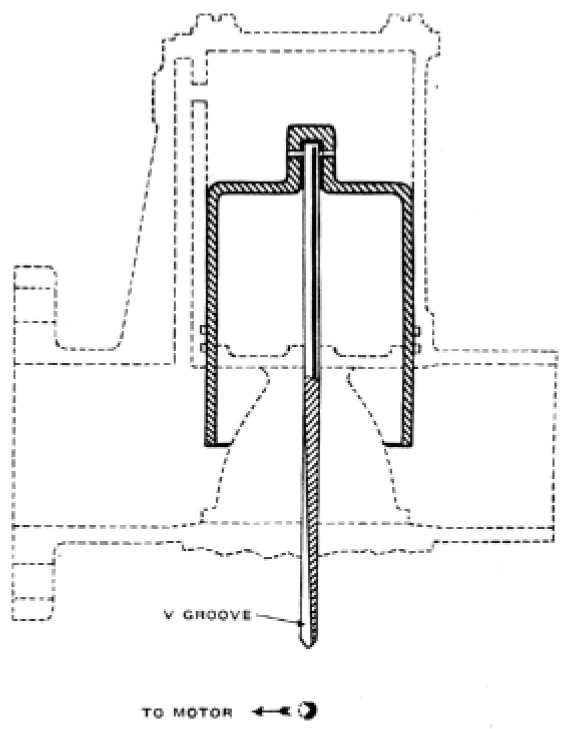
To free the valve, it is only necessary to remove the cover at the top of the cylinder, withdraw the valve from its place and clean it with a little gasoline. In putting it back, a few drops of kerosene on the top of the piston will help in flushing down any sediment or grit which the gasoline may have left.

Important

WHEN ASSEMBLING METERING PIN AND ALSO THE 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, VIZ., AND THAT ARROW ON BELL ALSO POINTS IN SAME DIRECTION AS ARROW IN THROTTLE BODY.

THESE ARE IMPORTANT FOR CARBURETOR TO FUNCTION PROPERLY.





Valve-Timing

If, for any reason, the cam or crank shaft gears have been removed, and it has been found necessary to re-set the timing, the following is the method of procedure.

Open the hand plate inspection hole in the left rear engine foot, and with the hand crank, bring No. 1 piston to the upper extremity of the compression stroke. This can be determined by holding the finger over the pet-cock on No. 1 cylinder, which is nearest the radiator, until it starts to blow. Then watch the flywheel through the hand inspection opening for the marks DC-1-6 to come to the pointer. Then turn the flywheel one complete revolution, bringing the mark DC-1-6 again to the pointer, and carefully continue to turn the flywheel until the mark EC-1-6 comes to the pointer, this mark being approximately $\frac{5}{16}$" beyond the mark DC-1-6 measured on the rim of the flywheel.

Leaving the flywheel in this position proceed to turn the cam shaft in an anti-clockwise direction, until No. 1 exhaust valve is closed. In order to make certain that the exhaust valve is closed, turn the cam shaft one-quarter turn further in an anti-clockwise direction, and adjust the tappet so there is a clearance of .003" between the tappet and the end of the valve stem. Then turn the cam shaft back, or in a clockwise direction, until the exhaust valve begins to lift, then turn again in an anti-clockwise direction, so that the exhaust valve on No. 1 cylinder has just closed and one can get a .003" feeler between the tappet and the end of the valve stem. You will know then that you have the correct position of the cam shaft in relation to the above described position of the crank shaft. Check this on No. 3 and No. 5 cylinders also.

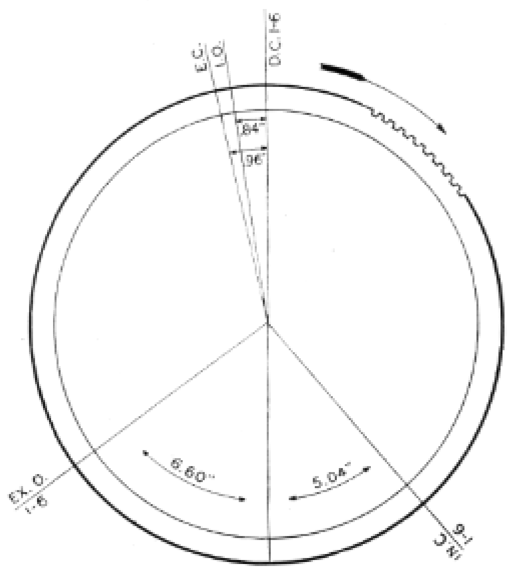
Install the cam gear on the cam shaft flange, taking care to see that the button and washer are in place between the cam shaft flange and cam gear, also using great care not to move the cam shaft. The cam gear should be mounted on the cam shaft flange so that the round hole in the cam gear coincides as nearly as possible with one of the holes in the cam shaft flange. Draw up cap screws and make sure that lock washers are bent into position.

Late timing will be indicated by a lack of power and popping back at fairly high speeds if the motor is hot and pulling hard, as on a moderate hill. Early timing will be indicated by inability to make motor run smoothly and lack of power at moderate speeds, 10 to 15 miles per hour especially, or accelerating. Motor will overheat very easily and exhaust valves will burn up.

Cycle of Timing

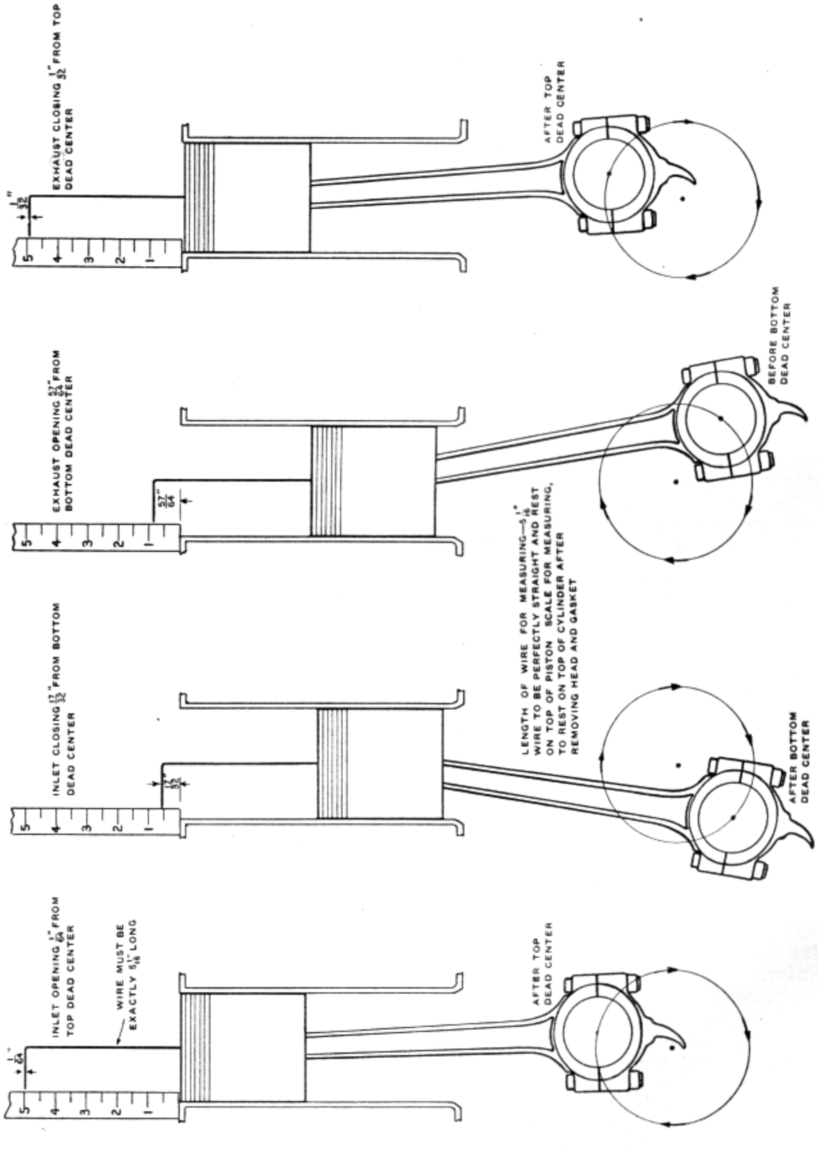
Intake 1 and 6 opens .84 inch after "DC" 1 and 6 has passed pointer. Shaft makes ½ revolution, bring it to lower "DC" position. Intake closes 5.04 inch after this point. Compression and expansion stroke take approximately 5/6 of revolution. Exhaust opens 6.60 inch before bottom "DC" is reached and remains open until top "DC" 1 and 6 is passed by .96 inch.

Bottom "DC" is not marked but can be gauged by making half revolution from upper "DC."



MEASUREMENTS TAKEN ON CIRCUMFERENCE OF 13¾" DIAMETER

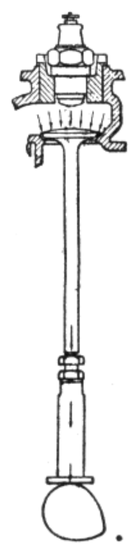
Super-Six Valve Timing Measured by Piston Travel



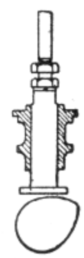
Tappet Adjustments

As the demand for motor silence is becoming more and more pronounced and there is a tendency for mechanics to heed owners in their demands for this extreme silence, the question of proper adjustment of tappets becomes important. This does not refer to instances where any one particular tappet is noisy to an unusual extent, but to instances where the general tappet noise of a motor is greater, in the opinion of the new owner, than that in some other motors he may have noticed.

The lashing up of tappets with a minimum clearance on new cars results in cut push rods and cams. If it were possible to get all Hudson owners to drive their cars with a .005" to .006" tappet clearance for the first 500 miles, the wearing of tappets and cams would be practically unknown. If owners could be made to appreciate what this means to them in the ultimate life and economy in operating the car, they would certainly be glad to drive their cars with a little more noise until the parts were worn in and could be tightened with safety.



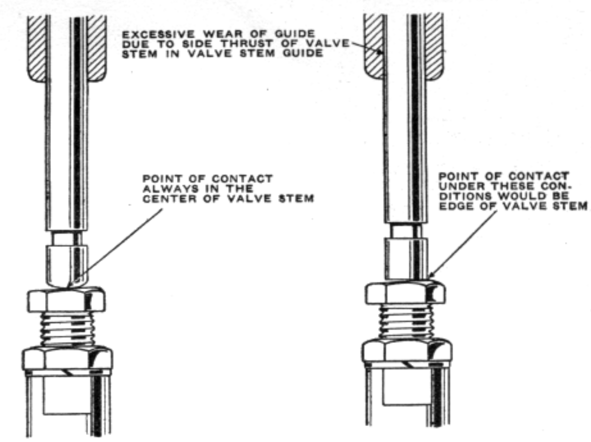
Showing condition which prevails when tappets are adjusted too closely and motor running under load. Note valve slightly open due to expansion of valve stem, allowing full force of explosion to be transmitted through valve assembly to bottom of tappet. Cut push rods and burned valve seats are some of the results.

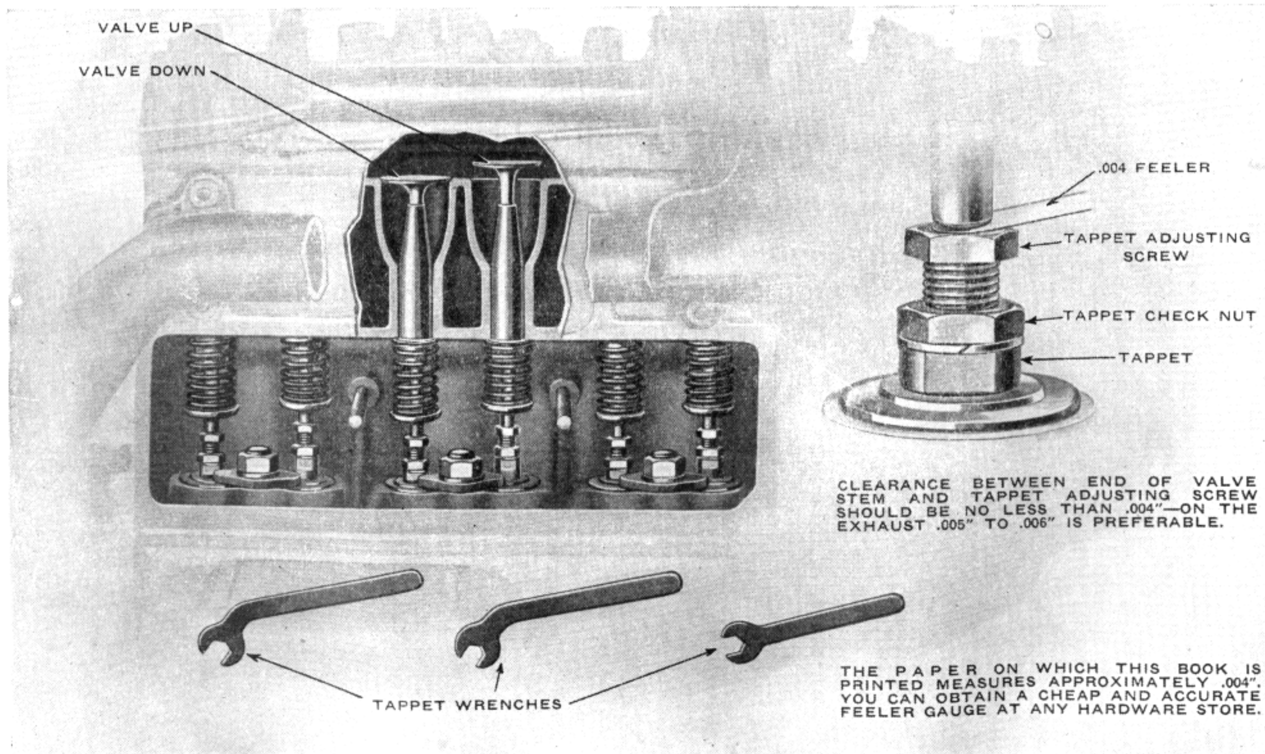


If proper clearance is allowed at these points, a film of oil will accumulate between cam and bottom of push rod at every revolution of cam shaft, preventing any chance of a cut tappet.

It is not right to take the quietest tappet of the twelve and lash up the others to equal it. Endeavor to average the noise as much as possible. The motor may be a little more noisy, but so long as there is a distinct evenness to the sound, it is far less objectionable than eleven quiet tappets and one noisy one. This method of adjustment offers a clearance of from .004" to .006" which will never result in cut push rods.

In the sketch we have endeavored to show what takes place when the tappets are lashed up too tightly. The tappet is riding the cam all the time. The ground surfaces of the cam and tappet, although perfectly smooth to the eye are actually not so. Any ground surface, fresh from the grinding





Valve Adjustment

wheel, is quite rough when viewed under the microscope, and if two such surfaces run together at high speed and with little or no oil, cutting is sure to result. The reason for this is that small particles of steel, which are removed by the cutting action, stay in the path of the cam and push rod and are not flushed out by the oil film, as would be the case if the tappet had sufficient clearance to leave the cam every revolution and allow a little oil to accumulate. We have made some tests on this phenomenon and find that a tappet which is run 500 miles with a .006" clearance polishes up to such an ideal surface that it is practically impossible to wear it thereafter even by abuse.

It is a physical impossibility to machine two surfaces so that they will always come together with a perfectly flat contact. Our sketch shows, in an exaggerated way, the condition of the adjusting cap screw which is not absolutely square with the bottom of the valve stem. In the case where the flat valve stem is used, the contact is made to one side and there is a direct thrust or tendency to push the valve stem away, which causes rapid wear of the valve stem guides. By pointing the end of the valve stem, it forms a small cup seat for itself, which is also in the center of the adjusting screw and the lift is therefore always direct and perfectly vertical.

As the quality and amount of oil contained in the motor has also a great deal to do with valve tappet noises, it is important that you do not unnecessarily adjust tappets without making due allowance for the condition of the oil and its effect on such tappet noises.

The Electric System

In this book and other literature dealing with the Delco System, the words "motor" and "generator" are frequently used. A motor and a generator are essentially one and the same machine so far as the construction is concerned. If we take such a machine and connect it to a storage battery so that the current will flow from the battery through the windings, the armature revolves and the machine functions as a motor; i. e., the energy taken from the storage battery is transformed into mechanical power.

If the armature is mechanically driven (by means of a gas engine or otherwise), the field and armature circuits being closed, the machine will function as a generator. If a storage battery is connected in series with the armature, the current generated will be used in recharging the battery.

The Delco "motor-generator" as it is called, consists of a motor and a generator. They are contained in the same housing, thus forming a single unit.

Electrically, however, they are just as much separate as if they were built in separate housings. On the armature shaft there are two sets of armature windings and two commutators entirely independent of each other. The commutator and brushes at the rear end belong to the motor part of the machine; those at the front belong to the generator part.

In the field coils there are two sets of windings, one being used when the machine acts as a motor to crank the engine and the other when it acts as a generator to keep the battery charged.

A Single Wire System

The wiring of the Super-Six is known as the single wire or grounded return system. This is much more simple than the two wire system, since the frame of the car is used in all circuits as the return. Circuit diagram, Fig. 1, shows all the circuits of the Hudson-Delco system and the following explanation of it shows how they may be traced.

Fig. 2 shows how simple the actual wiring is.

Some of the conventional ways of indicating electrical connections in wiring diagrams are given on page 52.

The Cranking Circuit (Figs. 1 and 3)

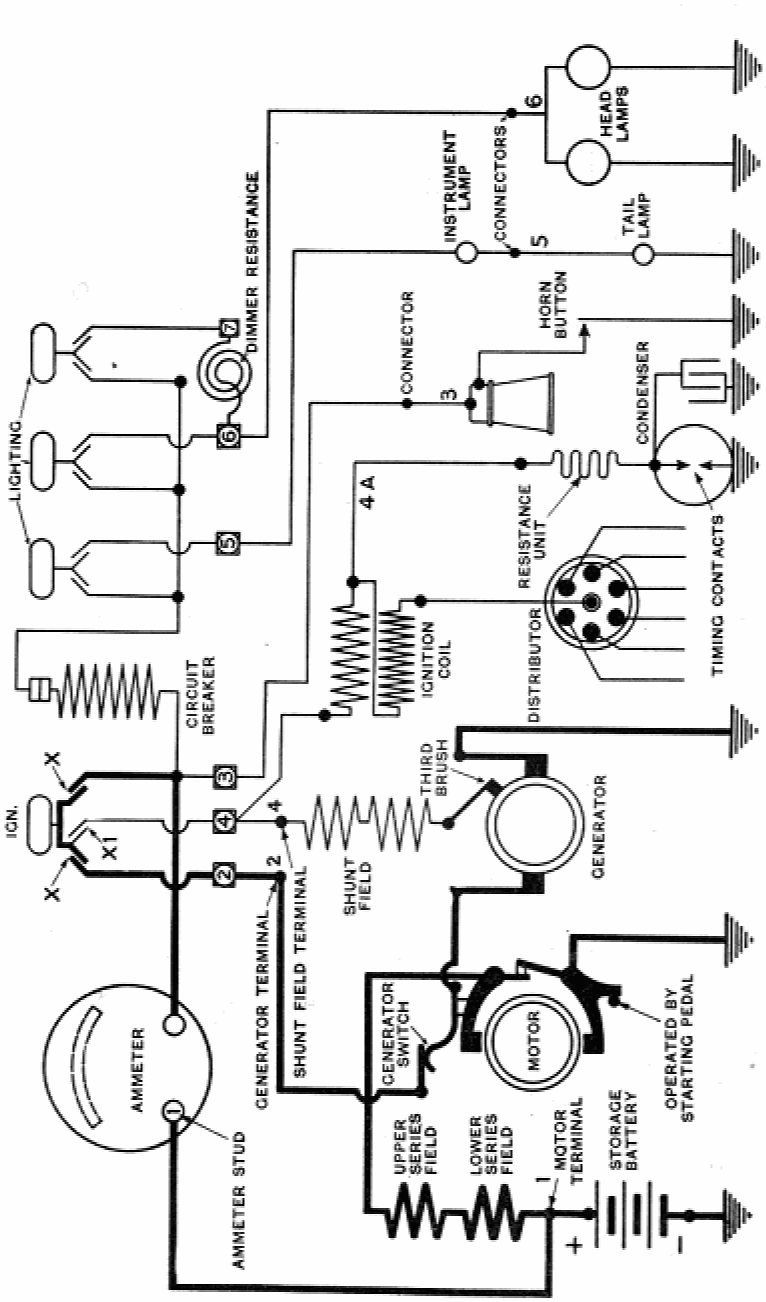
At the lower left hand corner of the diagram, Fig. 1, the storage battery is shown with the negative side connected to ground. From the positive terminal of the storage battery a line goes to the motor terminals. This is the lower of the three terminals on the side of the motor generator as shown in the accompanying illustration (Motor terminal No. 1).

A second wire is attached to the motor terminal the other end going to No. 1 terminal on the ammeter. This, however, will be taken up later, under "Generator Circuit."

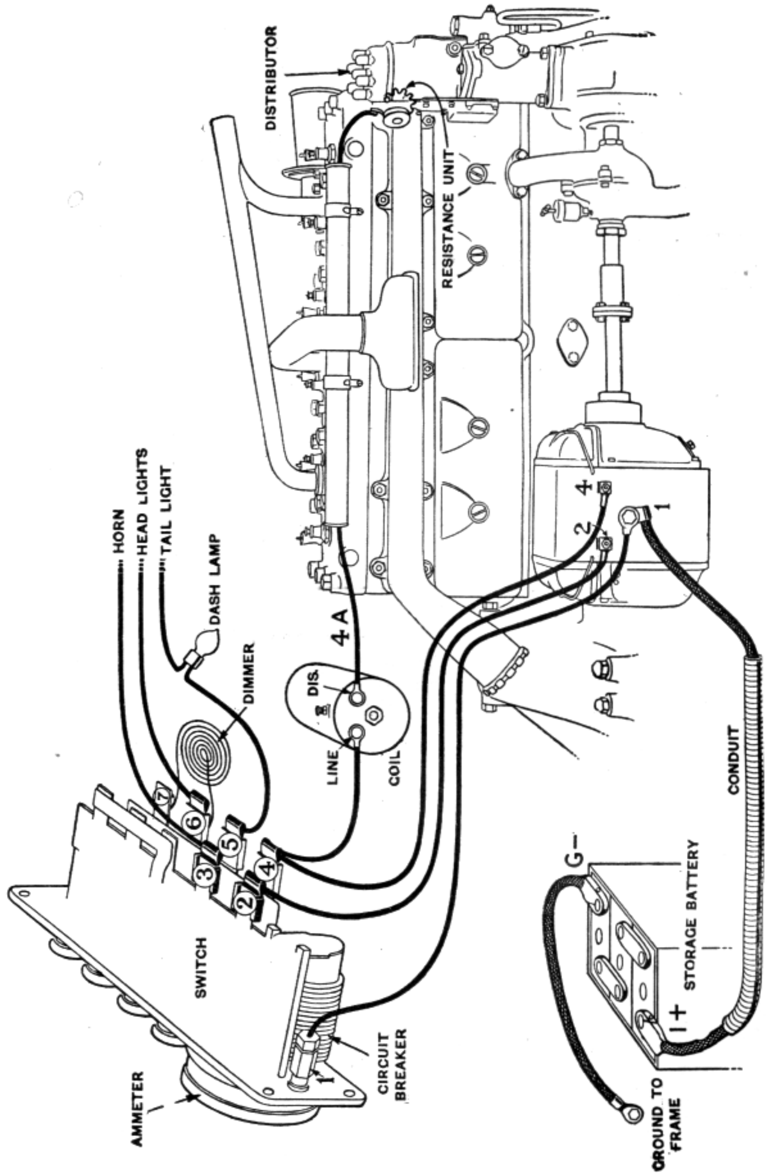
The motor terminal is connected inside the motor generator to one end of the lower series field coil, then after passing through the upper series field coil the line goes to the upper motor brush which is insulated. The lower motor brush is grounded to the frame. Between the brushes is shown a circle representing the motor commutator. The motor brushes and commutator are shown in the following illustration.

In Fig. 1 both motor brushes are shown raised away from the commutator. They remain in this position at all times unless when cranking, thus saving unnecessary wear on the brushes and commutator. When the starting pedal is depressed, the rod operating in contact with the lower brush arm moves, allowing both brushes to come in contact with the commutator.

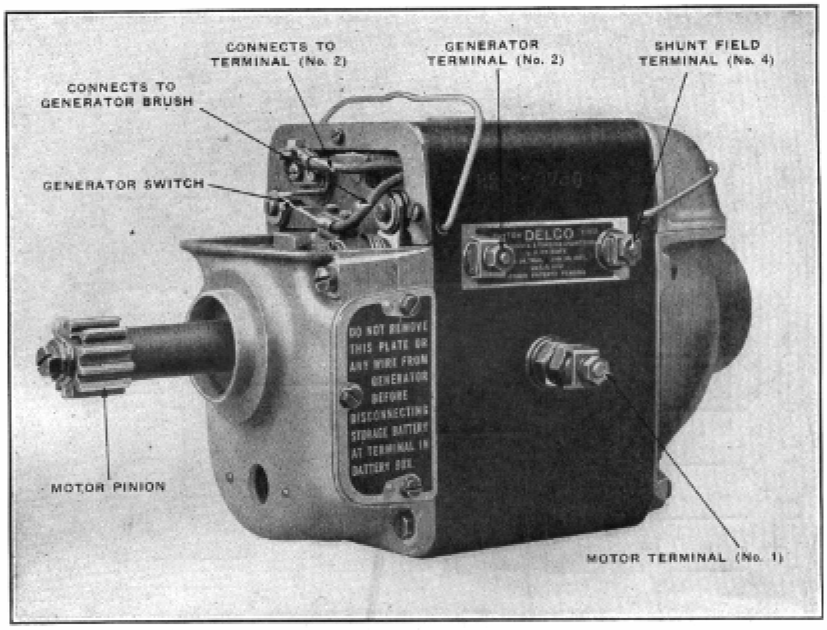
The brushes are held against the commutator with sufficient pressure by means of springs. The commutator consists of copper segments insulated from each other by means of mica. The armature windings are soldered to the commutator segments, therefore, when both brushes touch the commu-



Circuit Diagram
Fig. 1



Wiring Diagram
Fig. 2



Side View of Generator

tator, current may pass from one brush to the other through the armature windings.

The raising and lowering of the motor brushes, therefore, functions like a switch, i. e., when the brushes are in contact with the commutator, the circuit is closed; when raised away from the commutator the circuit is opened.

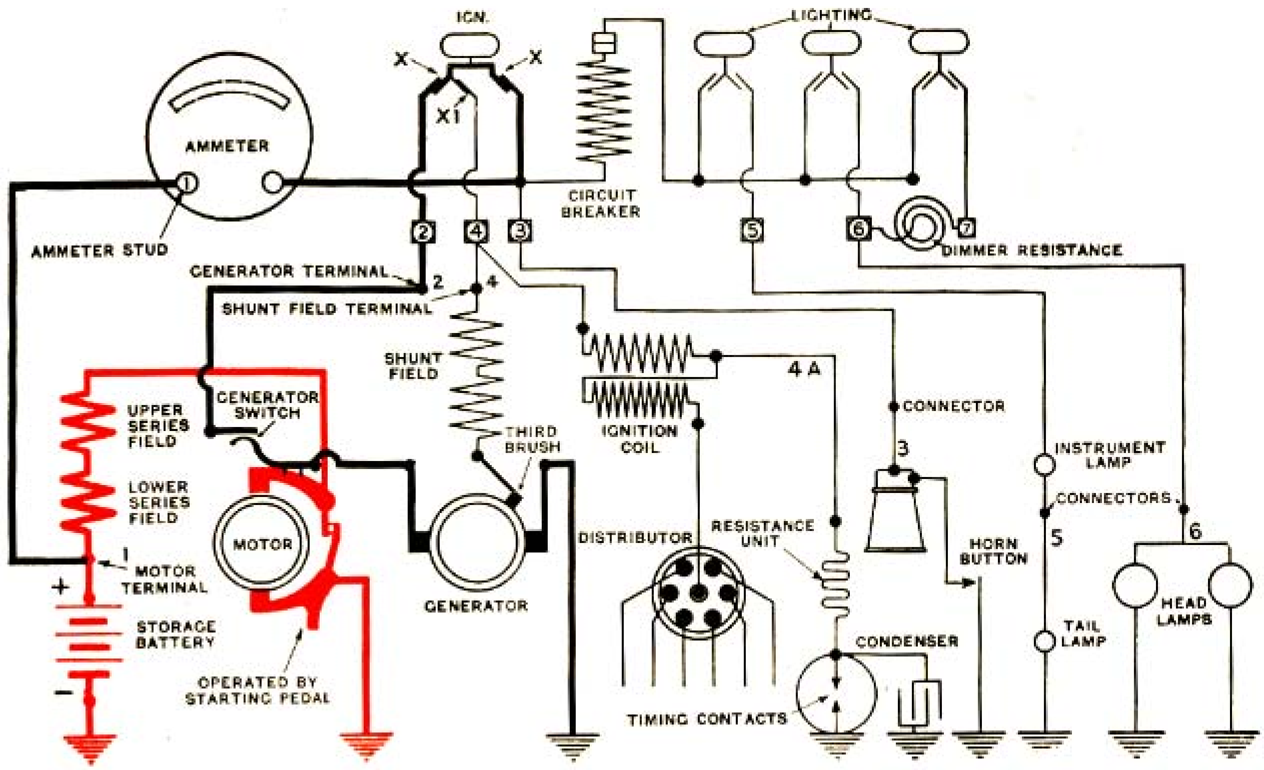
The cranking circuit then simply is this, when the starting pedal is depressed both motor brushes are brought into contact with the commutator. This completes the circuit and current flows from the positive terminal of the storage battery through the series windings of the motor to the upper motor brush, then through the armature winding to the lower motor brush. This brush being grounded, current flows through the frame of the car to the negative terminal of the storage battery which is also grounded. This current going through the field coil and armature windings results in the armature revolving.

When the starting pedal is depressed, in addition to moving the motor brushes, it causes the motor clutch to engage with the teeth on the fly wheel and with the armature pinion. When the armature revolves, therefore, it drives the fly wheel by means of the motor clutch, and the engine is turned over or cranked electrically. This circuit is shown in red in Fig. 3.

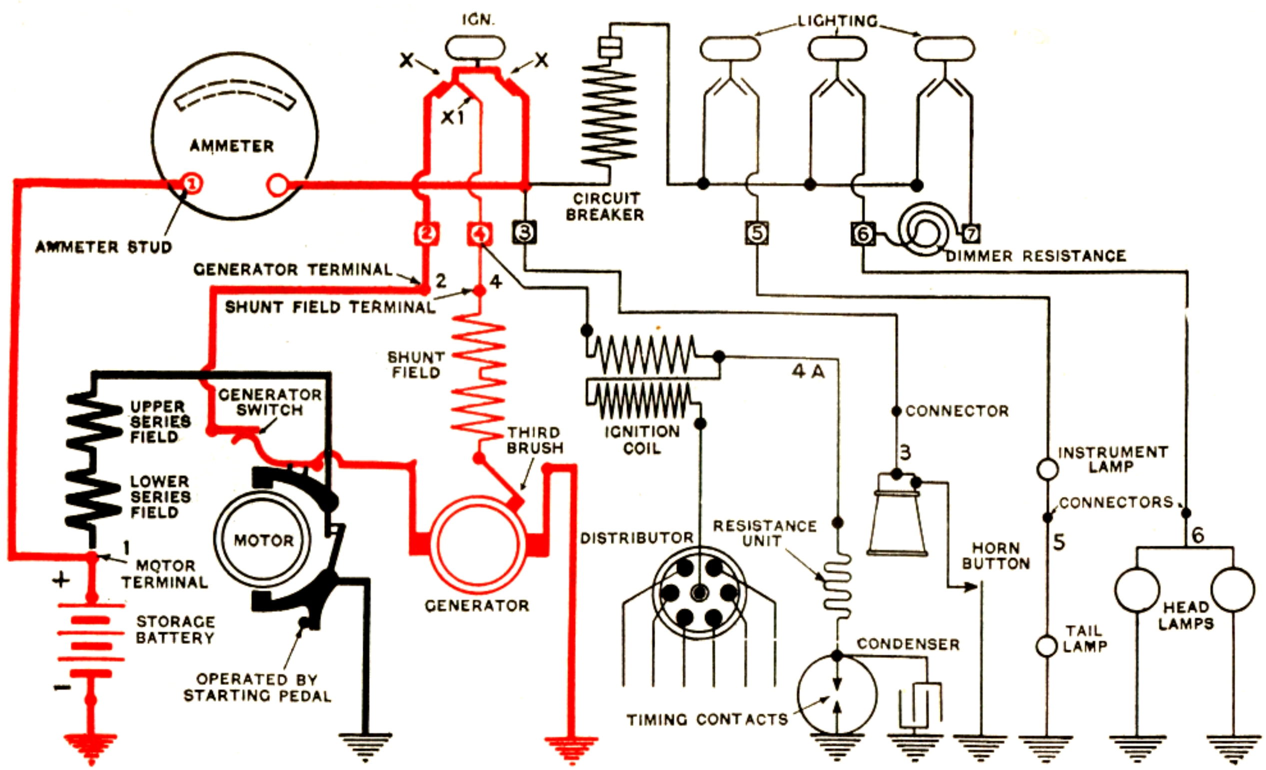
The Generator Circuit (Fig. 4)

Returning now to the motor terminal between the positive terminal of the storage battery and the series field coil, take the line leading to No. 1 terminal on the ammeter. After passing through the ammeter, the line goes to a point above terminal No. 3, where it branches off in three directions. The first of these goes upwards to the ignition button contacts, "X," the second goes to the right to the circuit breaker and the third goes down to the terminal No. 3 on the switch.

Taking the first of these going to the ignition contacts "X": When the ignition button is pulled out, these contacts are closed. This connects to



Cranking Circuit
Fig. 3



Generator Circuit.
Fig. 4

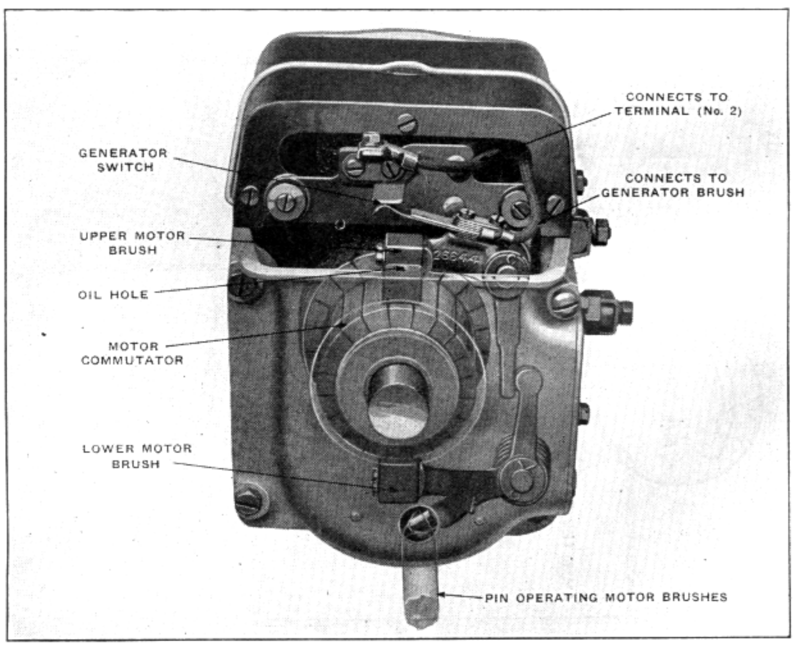
terminal No. 2 and from there a line goes to the generator terminal. A wire leads from this terminal inside the generator to the **GENERATOR SWITCH.**

This is simply a place where the generator circuit is disconnected during the time that the motor circuit is completed, i. e., while cranking. The generator switch is closed at all times except when cranking. It thus opens and closes the generator circuit at the proper time due to the up and down motion of the upper motor brush, which in turn is actuated by the starting pedal. A wire connects from the generator switch to the left hand generator brush, the circuit being completed through the armature windings and commutator to the right hand brush which is grounded. Current therefore returns through the frame of car to the negative side of the storage battery in the usual way, thus completing the generator armature circuit.

Shunt Field Circuit (Fig. 4)

Returning to the contacts "X" (closed when the ignition button is pulled out), a second pair of contacts, "X-1," is shown, through which current may pass by means of the light line in the center down to terminal No. 4. Two branches lead from this point, one to the shunt field terminal No. 4 and the other to the ignition coil. Take the first of these leading to the shunt field terminal to which is attached one end of the shunt field winding. The other end of the shunt field winding terminates in a small brush resting on the generator commutator. This is known as the third brush and is for the purpose of regulating the output of the generator.

When the generator circuits are completed as explained above, one or other of two conditions may exist, depending on whether the engine is at rest or running. When the engine is at rest and the generator circuits completed, current flows from the storage battery through the **GENERATOR** windings and causes the generator to act as a motor as explained on pages 33-36. (Note—This must not be confused with the actual cranking operation in which the current from the storage battery flows through the **MOTOR** windings.)



Motor Brushes and Commutator

The functioning of the generator (as a motor) is as follows: The portion of current which flows through the shunt field winding and third brush excites or magnetizes the field (or pole) pieces of the machine. The armature receives its excitation (or magnetism) from the current passing through No. 2 terminal, therefore, it will revolve between the pole pieces—and the electrical energy taken from the storage battery is thus converted into rotary energy—i. e., the generator acts as a motor.

The only purpose of using the generator as a motor is to cause the armature to turn over slowly to facilitate meshing the flywheel gears before the cranking circuit is closed. These gears would seldom stop in the correct position for meshing and the starting would be very uncertain. The gears being brought completely into mesh results in the brush plunger being withdrawn sufficiently to allow the motor brushes to drop. This opens the generator switch and the generator circuit is disconnected. The current then ceases to travel through that path but takes the newly completed circuit through the motor windings, as explained under "Cranking Circuit."

Actual Generating Conditions

Now, we assume that the engine starts: The pedal is released and the gears run out of mesh again. The plunger travels into place and lifts the motor brushes off the commutator, at the same time closing the contact at the generator switch. The generator circuits are complete again, and if the engine is driving the generator fast enough, current is being generated.

In describing the generator circuit in the foregoing paragraphs, we assumed that the engine was not running, and that the current from the storage battery passing through the windings caused the generator to turn over as a motor. Now we have assumed that the engine is running, the generator **IS BEING DRIVEN** and the same circuits are completed or closed. As long as the generator is being driven faster than it would ordinarily turn over as a simple motor, it will generate current instead of using it up. Therefore the current will flow along the same path as before, but in the **OPPOSITE DIRECTION.** The shunt field current, however, will flow through the field windings in the same direction.

The generator will be putting current **into the battery** instead of **taking it out.**

If the strength of the magnetic field remains constant the amount of current generated is proportionate to the speed of the generator. A gasoline engine runs at speeds varying from 200 to 2000 revolutions per minute and upwards, and it is therefore obvious that altogether too much current would be generated, and the storage battery would soon be ruined if some means of regulating the supply were not included in the system.

Regulation of the Charging Rate (Fig. 4)

The regulation of the current (generator output) is obtained simply by varying the strength of the magnetic field, but this is brought about in a different manner to, and is an improvement over, the methods formerly used. Referring to Fig. 4, it will be seen that the lower end of the shunt field is connected to a third brush which is in contact with the generator commutator.

The strength of the magnetic field depends upon the amount of current flowing through the field windings, and this in turn depends upon the voltage (pressure) applied to the third brush. This voltage depends upon two things: First, the position of the brush on the commutator with relation to the other brushes, and second, upon the speed of the armature. In regard to the position of the brush on the commutator, this is set before leaving the factory to give the best average charging rate, and must not be moved or interfered with as long as the charging rate is satisfactory.

If it becomes necessary to **INCREASE** the charging rate, loosen the two screws by which the arm supporting the third brush is attached and move to the right (looking at front end of generator). A small movement makes a considerable difference in the charging rate. Then tighten the screws.

IT IS HIGHLY IMPORTANT after moving the third brush to sand it carefully down so as to fit the commutator accurately, otherwise the generator will not deliver the full amount of current.

If it becomes necessary at any time to **DECREASE** the charging rate, proceed exactly as outlined above, but move the brush to the left.

The third brush affects the generator output at varying speeds in the following way: At low speeds the voltage or pressure applied to the third brush is comparatively high, therefore, a considerable amount of current will flow through the shunt field windings. This gives a strong magnetic field at low speeds, and the generator output will be good considering the low speed. Increasing the speed under these conditions would increase the generator output too rapidly and at high speeds there would be too much current produced. With the increase in speed, however, the voltage applied at the third brush decreases, consequently the magnetic field becomes weaker and the generator output is kept from becoming too great. In this way the generator output increases until a speed of about 20 to 24 miles per hour is reached. The current is then at a maximum which is arranged to take place at this speed because experience has proved that this gives the best all around results. At still higher speeds the magnetic field becomes so weak that the output begins to diminish, thus preventing the storage battery from being charged at too high a rate. The following table represents on an average the manner in which the charging rate should vary at different speeds.

Miles Per Hour	Amperes
9	5
12	10
18	16
24	17
30	15
36	13
42	11

When the engine is running less than 300 revolutions per minute, the generator will run faster than it is being driven by the engine. This is because the generator does not generate sufficient pressure (or voltage) to overcome the voltage of the battery and current therefore flows back through the generator windings. Thus the armature revolves as a motor.

An automatic cut-out could be used to prevent the battery from discharging in this manner through the generator windings at speeds lower than 300 revolutions per minute. The amount of current wasted, however, is negligible and an automatic cut-out is therefore an unnecessary complication.

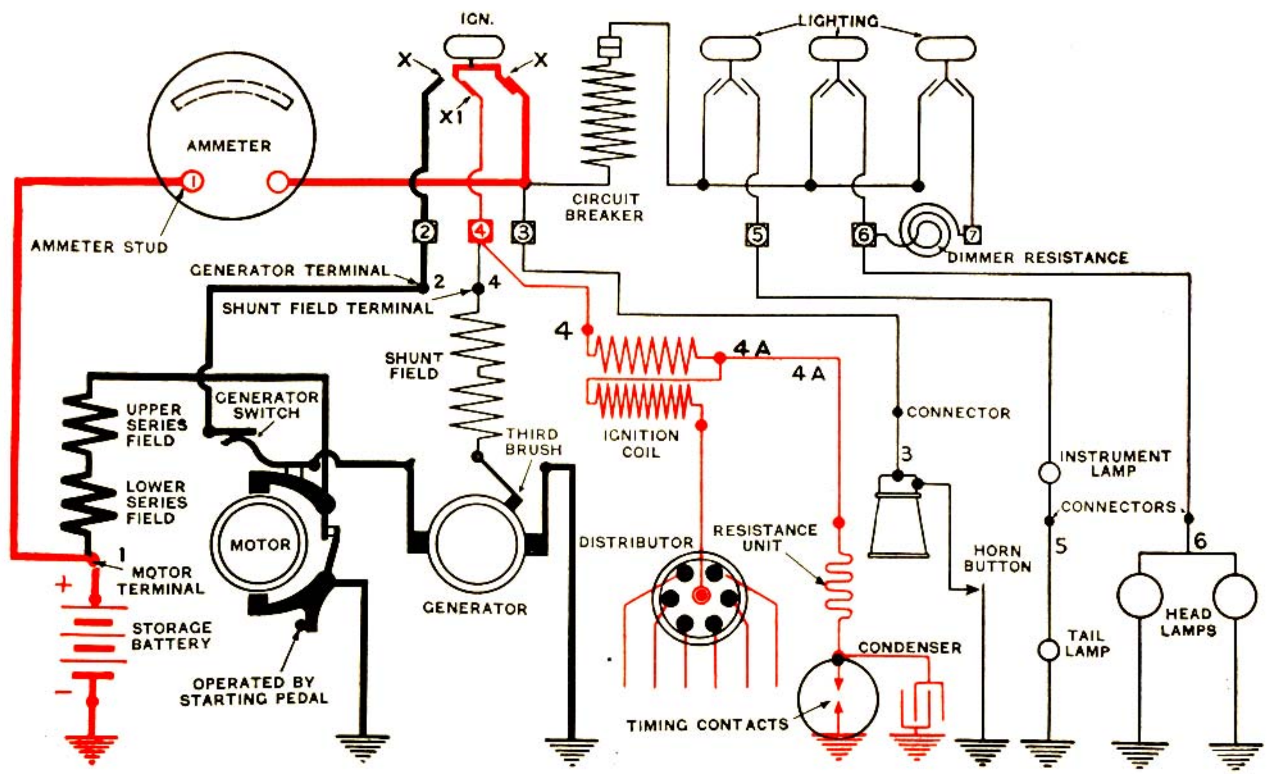
A roller clutch, similar to the free wheel on a bicycle, is used to allow the generator to over-run at speeds lower than 300 revolutions per minute as explained above. This clutch also allows the armature to revolve when the ignition button is pulled out as explained under **"GENERATOR CIRCUIT."** If the engine should be stopped or stalled without switching off the ignition button, a steady discharge from the storage battery of 3 or 4 amperes would take place causing the armature to revolve. It is essential, therefore, that the ignition button should be pushed in whenever the engine is not running.

The foregoing explains the circuits brought into operation by closing the switches at "X" and "X-1," as shown in red, Fig. 4.

Ignition Circuit (Fig. 5)

Returning to terminal No. 4 on the combination switch, a wire is shown connecting to the ignition coil. This is represented in the diagram, Fig. 5, by two zig-zag windings, the upper one representing the primary winding of the ignition coil and the lower one representing the secondary or high tension winding. (These are further described under "Ignition Coil.")

When the ignition button is pulled out, contacts "X" and "X-1" are closed. Current may, therefore, flow from the storage battery through the contacts "X" and "X-1" to terminal No. 4. Passing out of the switch at this point it goes to one end of the primary winding of the ignition coil and, after passing through this, it goes along the wire marked "4A" to the resistance unit which



Ignition Circuit
Fig. 5

is mounted on the side of the distributor, then through the timing contacts (breaker points) when closed, to ground. The return part of the circuit is completed to the negative side of the storage battery in the usual way by means of the frame of the car. This completes the primary ignition circuit, also known as the low tension circuit.

The Ignition Resistance Unit (Fig. 5)

This consists of a coil of wire mounted on a porcelain spool. The coil of wire (represented in Fig. 5) is connected in the low tension ignition circuit in such a way that all the current passing through the ignition coil and distributor contacts must pass through this wire. The resistance wire is made of a special alloy. Under ordinary circumstances it remains cool and offers little resistance to the passage of current. If the primary circuit should remain closed for any considerable length of time when the motor is not running, the current passing continuously through the coil will heat the resistance wire thereby increasing its resistance to a point where only a normal amount of current will pass. This insures against waste of current and damage to the ignition coil and timer contacts.

The Condenser (Fig. 5)

The condenser is represented in Fig. 5 at the right side of the distributor contact points. One side of the condenser is connected to the ignition circuit between the resistance unit and the distributor contact points, and the other side is grounded.

The condenser is a simple device and serves two very important purposes.

First. It prevents the arcing or burning at the timer contact points that would otherwise take place every time the contacts "break."

Second. It gives a greatly increased pressure (or voltage) to the high tension current.

Without this effect the voltage would not be sufficiently great to cause a spark at the spark plug points. The other side of the condenser is grounded and since the two wires are not connected together inside the condenser, it is obvious that any internal connection would cause a short circuit and trouble would result.

The condenser may also fail due to open circuits caused by loose connections. These may be intermittent or constant, but in either case will cause failure of the ignition.

Before leaving the subject of the primary or low tension ignition circuit, it should be noticed that when the generator is being driven fast enough to charge the storage battery, the current used for ignition, lights, etc., will come direct from the generator and not from the storage battery.

High Tension Circuit (Fig. 5)

The lower zig-zag winding of the ignition coil represents the secondary or high tension winding. One end of this winding is connected to the primary winding and the other end is connected to the high tension terminal on the side of the coil. From this terminal a wire leads to the center of the distributor head, from which point the current is distributed by means of the rotor to each cylinder in the proper order.

Distributor and Timer

The distributor and timer is separate from the motor generator and is carried on the front of the engine above the timing gears. It is driven by spiral gears from the pump shaft.

The distributor consists of a cap or head of insulating material carrying one high tension contact in the center with similar contacts spaced equidistant about the center, and a rotor, which maintains constant contact with the center.

The rotor carries a constant button (Page 42) which serves to close the high tension circuit to the spark plug in the proper cylinder.

Beneath the distributor head and rotor is the timer. This is provided with a screw in the center of the shaft, the loosening of which allows the cam to be turned in either direction to secure the proper timing; turning in a clockwise direction to advance and counter-clockwise to retard.

The cam action opens the contact points while the closing is brought about by means of a flat spring.

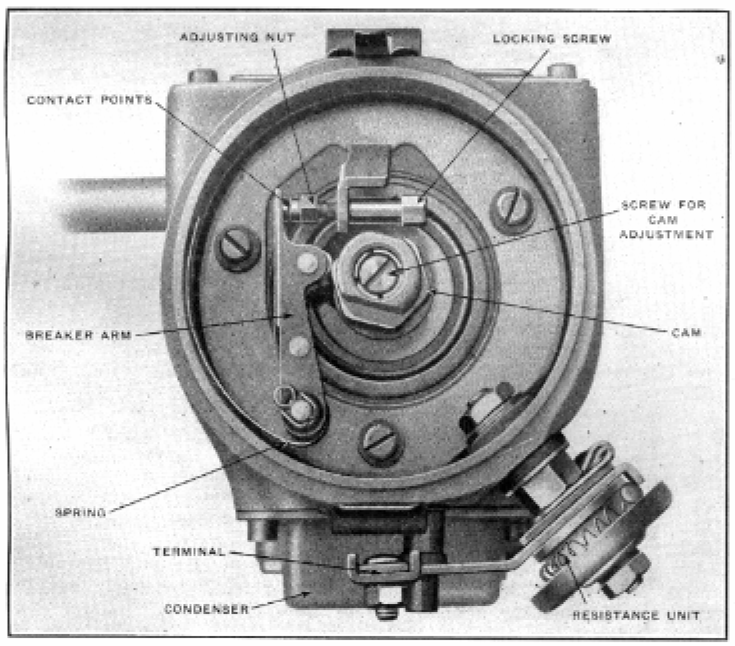
See that the contact points, breaker arm and spring are in perfect condition and work freely. The contact spring should press the contact points firmly together when the cam is on contact. If the contact points show signs of pitting or burning they should be cleaned up so they have sufficient contact.

Sometimes a file is used to clean these points, with the result that the contact surfaces are not parallel. Do not file the contact points unless they are badly pitted. Contact points can be cleaned with a piece of very fine sand paper.

Before setting the ignition timing, it is essential that the contact points on the timer have a proper gap (See page 41). If the gap is changed after timing the cam, the ignition timing will also be changed. The gap should be .018".

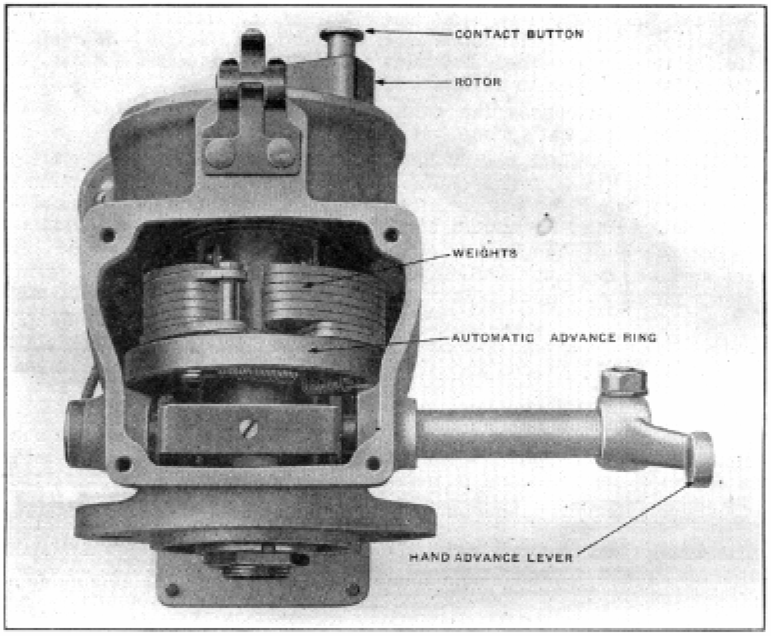
The mechanism for operating the automatic spark advance is shown in the next illustration. The weights which are mounted on the disc move outwards as the speed increases, overcoming the resistance of the springs. This has the effect of automatically advancing the spark to the correct position in proportion to the engine speed.

The hand spark control is for the purpose of securing proper timing for various conditions, such as starting, difference in gasoline, variable weather conditions and for higher speed.



Distributor

A wrench is furnished with the car to fit adjusting nut (Page 41) also a thickness gauge on this wrench for the contact points, and a thicker gauge for the spark plug points.



Automatic Advance Governor

To Time the Ignition

Set the spark lever on the steering wheel at the top and see that the advance rod which connects the distributor advance lever and sector gear at the base of the steering box is not too long so as to bind the distributor advance ring in the housing.

This rod should be adjusted so that the yoke end fits into the generator advance lever without any binding when the hand lever on the steering gear is fully advanced. The distributor advance ring will wear rapidly if this adjustment is not properly taken care of.

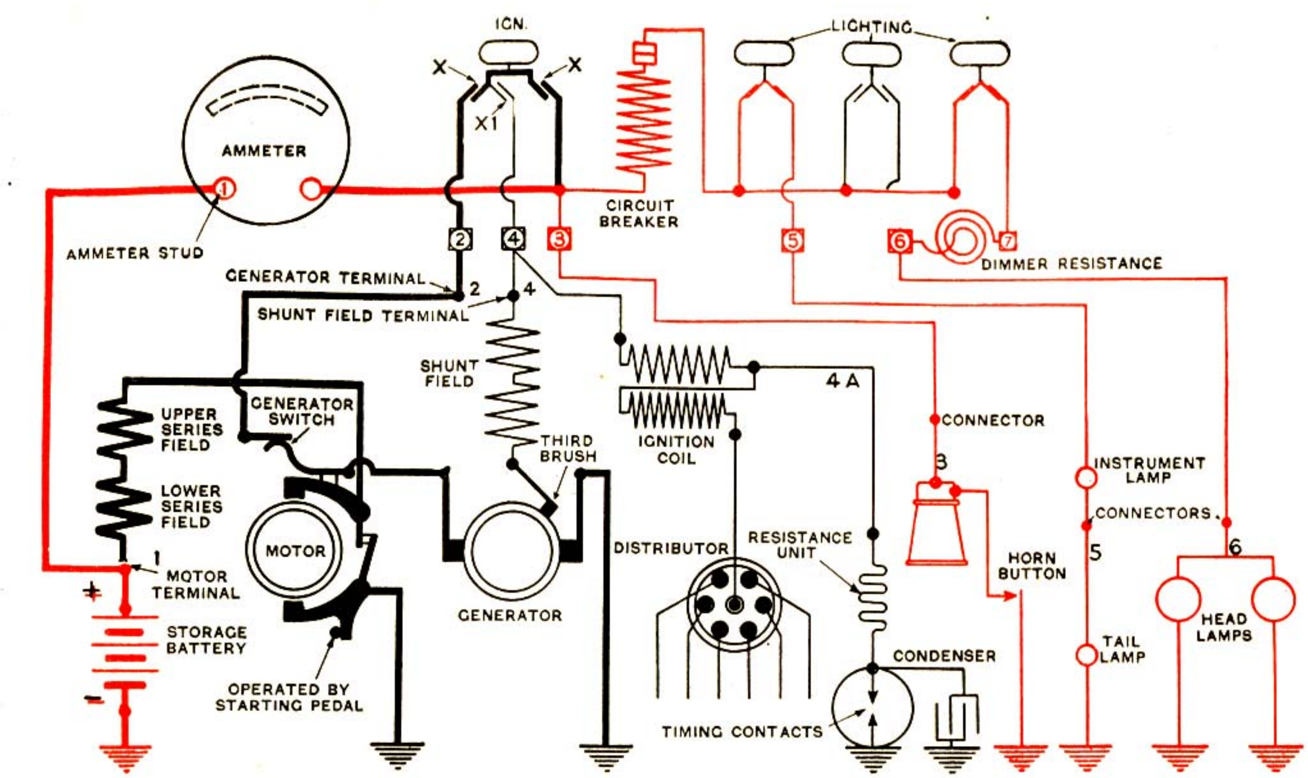
Open the priming cocks on the motor, turn slowly by hand, using starting crank until No. 1 cylinder starts to blow. This indicates that this cylinder is on its compression stroke. To determine this, hold your finger over the priming cock.

No. 1 cylinder is due to fire in advance position when the mark "A" on the flywheel reaches the pointer attached to the crank case. This may be observed through the inspection hole on the flywheel housing left side motor. Mark "A" is ½" before top center. (Top center is marked D-C-1 & 6.)

Loosen cam and set to break at this point. The adjusting screw on the cam must always be set down tight after changing this adjustment.

The spark occurs the instant the timer contacts are open. In checking the timing, the cam should be held on tension in the opposite direction of rotation so that all back lash is taken up when rotor button comes under No. 1 contact on the distributor head.

After checking the timing, replace the rotor. Rub a little vaseline on the rotor track of the distributor head before seeing that this is down tight in position.



Horn and Lighting Circuits
Fig. 6

The Ignition Coil

The ignition coil is mounted on the dash, and serves to transform the low voltage in the primary circuit to a high voltage in the secondary circuit.

The center of the coil consists of an iron core composed of a bundle of soft iron wires. Around this is placed some insulation on top of which the primary winding is wound. This consists of comparatively few turns of heavy insulated wire and terminates in terminals 4 and 4-A (on the end of the coil). Insulation is placed around the primary, and outside of this the secondary winding consisting of many turns of fine insulated wire is wound with additional insulation between each layer. One end of the secondary is connected to the primary near terminal 4-A, and the other end terminates in the high tension terminal on the side of the coil (See Fig. 5).

Horn Circuit (Fig. 6)

Current for the horn is taken from the storage battery if the ammeter shows discharge, or from the generator if the ammeter shows charge.

If taken from the storage battery it goes through the ammeter direct to terminal No. 3 on the combination switch. If taken from the generator it goes first of all to terminal No. 2 on the combination switch, then through contacts "X" (the ignition button being pulled out) to terminal No. 3. A wire connects No. 3 to one of the terminals on the horn, the other terminal being connected by means of a wire to the switch operated by the horn button. When the horn button is depressed the switch contacts are closed and the current is grounded at this point. The remaining part of the circuit is completed through the frame in the usual way. The horn contains a small motor consisting of an armature and field windings, and when the horn button on the steering wheel is depressed it allows the current to flow through these windings causing the armature to revolve and sound the horn.

The Circuit Breaker (Fig. 6)

The Circuit Breaker is mounted on the Combination Switch as shown in Figure 2; it is a protective device to prevent excessive current from flowing through the lighting circuit in the event of a ground developing in the line.

It consists of a coil of insulated wire wound on an iron core. The winding is connected to a pair of contact points in such a way that when the contacts open, the circuit is interrupted or broken. Normally the contacts remain closed allowing sufficient current to pass through the circuit breaker to supply the lights. If any part of the lighting circuit becomes grounded without first of all passing through the lamps, a heavy flow of current far in excess of the normal amount will take place. This heavy current magnetizes the iron core of the circuit breaker so strongly that it attracts the small piece of iron called the armature thus separating the contact points. This momentarily cuts off the flow of current, which in turn allows the contacts to close again and the operation is repeated, causing the circuit breaker to give out a clicking sound.

The circuit breaker thus not only gives warning of a ground in the lighting circuit but also prevents injury to the wiring by permitting only about from 5 to 7 amperes to flow through it when vibrating.

If the circuit breaker vibrates repeatedly do not attempt to increase the tension of the springs. The vibration is caused by a short circuit or ground in the system and this must be located and eliminated before the circuit breaker will again operate properly.

If the Circuit Breaker Vibrates

Push in the three ignition buttons. If the breaker continues to vibrate, the trouble should be looked for in the switch. If the breaker stops vibrating when the three ignition buttons are pushed in, pull them out one at a time and observe which one causes it to commence vibrating. The ground or short circuit must be in this line. The trouble may be located more accurately by disconnecting the wires at the junction block, lower left hand side of dash. If the circuit breaker continues to vibrate when these wires are removed, the ground must be in the wiring between the switch and the junction block; but if it stops vibrating, the trouble must be in the wiring between the junction block and the lights.

By testing each wire individually, the exact circuit wherein the trouble exists may be located.

Lights (Fig. 6)

Returning to the point above switch terminal No. 3, Fig. 6, where the line divides. The line going to the right leads to the circuit breaker. After passing through the circuit breaker winding, represented by the zig-zag lines and contact points, connection is made from this point to each of the three lighting contacts. The operation of each of the three lighting buttons will now be described.

Dash and Tail Light Circuit (Fig. 6)

When the lighting button nearest to the ignition button is pulled out, the dash and tail light circuit is completed and the current passes out through terminal No. 5, then to the dash lamp socket and through the lamp filament.

A wire leads from this lamp to terminal No. 5 of the junction block on the dash and from there a wire leads to the tail lamp. After the current passes through the tail lamp, it goes to ground, i. e., the frame of car. Thus the lamps are "in series," and current has to pass through both bulbs before it reaches ground. It, therefore, follows that if the filament of either lamp burns out or the line becomes broken or the ground disconnected, both lamps will go out. The wiring is arranged in this manner for the purpose of warning the driver when the tail light is out.

Head Lights (Bright) Circuit (Fig. 6)

When the center one of the three lighting buttons is pulled out, the headlight circuit is completed and current passes out through terminal No. 6 to terminal No. 6 of the junction block on the dash, and from there a wire leads to the front cross member of the frame where it branches out immediately back of the radiator. One branch wire feeds the right hand headlight, the other the left. After the current passes through the lamp bulb it goes to ground. Both lamps being fed from branches of the same wire they are "in parallel." Therefore if one bulb burns out, the other circuit is still intact and the lamp on that side will continue to burn. If the feed wire be grounded before the point where it divides, both lamps will go out, owing to the completion of the circuit without passing through the lamp bulbs.

Head Lights (Dim) Circuit (Fig. 6)

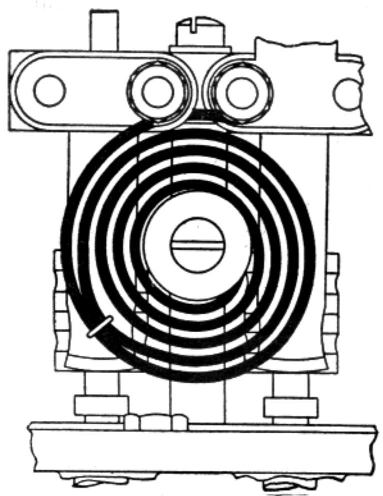
When the end lighting button is pulled out, the headlight circuit is completed, but instead of the current passing directly out through terminal No. 6, it first of all passes through the dimmer resistance. This is a coil of wire that has the effect of choking the current supplied to the headlights and they do not burn so brightly, nor do they consume so much current.

If the headlights are operating "dim," it is unnecessary to depress the "dim" button in order to get them to operate at full candle power. Simply pull out the second button. This operation cuts out the resistance, and if the second button is again depressed, the lights will operate dim.

Varying the Dimming of Headlights

We frequently receive inquiries on the possibility of varying the intensity of the headlights when the dimmer is in circuit. As this is more or less a matter of personal taste, and so easily accomplished, we believe the following information will be of value:

It is necessary to remove the switch in order to bind up one or more coils as shown. The switch is held in place by four bolts which pass through the housing at the back of the switch. When these bolts are loosened, the housing will fall down. Therefore, the No. 1 wire which connects with the generator should be removed before dismantling the switch, otherwise short circuit will result and the wires may be burnt out (See Page 32). Tying one coil together will not make very much difference. Removing half of the resistance will make a considerable increase in the light given, almost too much for town driving. We recommend experimenting by short circuiting the outer coil first then making further adjustments to suit personal taste.



The Dimmer

The Junction Block

The Junction Block provides a handy means of disconnecting the lighting connections in case of trouble on any particular line or when removing the body. For instance, if the circuit breaker commences to click when any of the lighting switches are pulled out (indicating a ground); it is obvious that any of the junction block connections can be reached quickly and the wires disconnected one at a time till the faulty line is discovered.

The Junction Block is located on the engine side of the dash near the left hand side frame.

Attention to Be Given to Electric System

The Motor Generator

Examine from time to time all wires attached. See that terminal clips are well soldered to wires. Sometimes they become partly or completely disconnected. Wires that are exposed, due to cut or worn insulation, should be replaced with new wire or the injury should be taped over and shellacked. Clean off all oil, dirt and moisture from terminals especially.

Don't use aluminum paint near terminals. It may cause a short circuit.

See that bolts securing the generator to the supporting bracket have not worked loose.

Oil according to instructions on the generator or in the Reference Book.

Commutator and Brushes

A clean, dry commutator and well-fitting brushes are necessary and a very brief inspection shows whether they fulfill these conditions or not.

The motor commutator gives very little trouble, but the generator commutator, being fitted with carbon brushes, has a tendency to become dirty. This is particularly the case when oil is allowed to accumulate on the commutator.

Don't put any oil on the commutator. A dirty commutator may be cleaned by using a little kerosene on a cloth and then wiping off thoroughly dry with a clean cloth.

When a commutator is in perfect condition it has a smooth, glossy surface, usually of a purplish color. The surface of the brushes where they rub on the commutator also presents a smooth, highly polished appearance and the entire area or cross-section makes contact. When this most desirable condition is attained, very little trouble is experienced, since the commutator remains clean and bright and the brushes show hardly any signs of wear. This is not beyond the reach of anyone if only a little time and care are given toward the end in view.

Use only a medium sand cloth, say No. 0 or No. 00.

Never use emery or emery cloth near a generator.

To Smooth Commutator

Take a strip of sand cloth the width of the commutator and pass it under the brushes. Pull the ends of the strip back and forth until the commutator is smooth all the way round.

Don't attempt to hold a piece of sand cloth on the commutator with the finger or a piece of wood. This will cause an uneven surface and the brushes will fit poorly.

After sanding the commutator, carefully remove all grit and dust, taking special care to clean thoroughly between the copper segments, then polish with cheese cloth and a small quantity of oil.

High Mica (Fig. 7)

This condition exists when the copper segments of the commutator have worn down, leaving the mica slightly higher. The brush then rides on the top of the mica and makes very imperfect contact with the copper or none at all. As a result, very little or no current will be generated.

To remedy this trouble, remove the armature and true up the commutator in a lathe. This should be very carefully done, taking only a light cut. This prevents waste of copper and keeps the tool from digging in. Notch all the micas between segments with a saw-file, then with a piece of hack-saw blade, undercut the mica to a depth of about 1/32 of an inch below the copper. (See Fig. 7). The hack-saw blade used should be .002" or .003" thicker than the mica and should be ground to this size if necessary. This operation should be performed very carefully and by a skilled workman, if possible. Finally use a strip of smooth sand cloth to remove any burrs, and polish with cheese cloth and oil. Revolve the armature at a high rate of speed for this purpose.

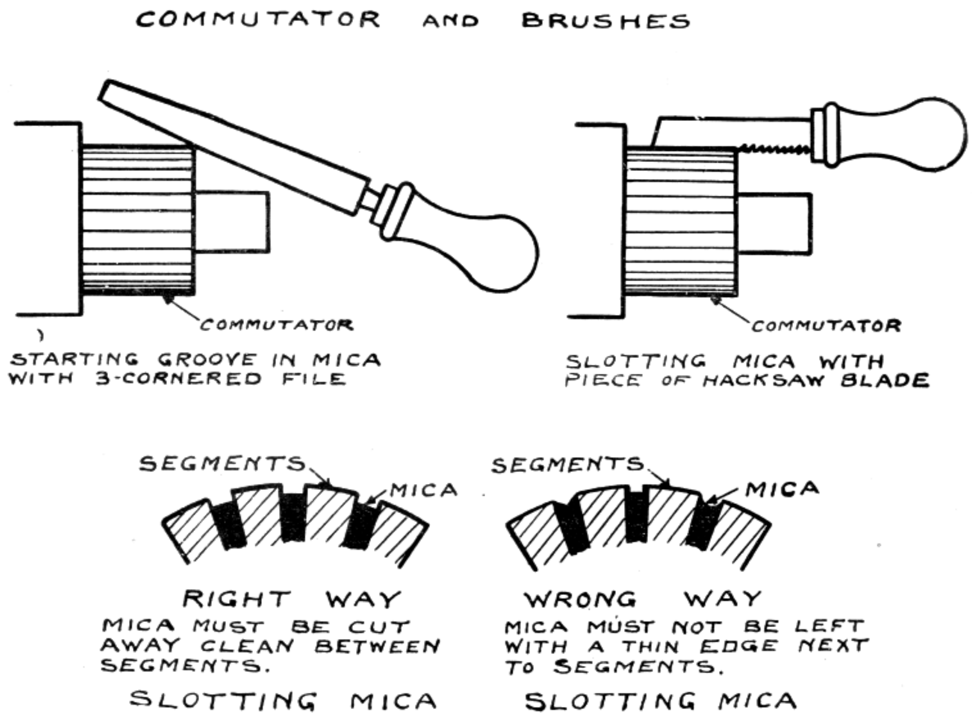


Fig. 7

Fitting Brushes (Fig. 8)

To fit brushes properly, insert a strip of sand cloth as before, but turn the rough side next to the brushes. Allow the brush to rest on the sand cloth with normal spring tension. Then pull the strip back and forth with the ends held close together. (See Fig. 8.)

Examine brushes after sanding to make sure they have been sanded all over the end. Pay special attention and keep the commutator very clean for a few days afterwards until the commutator and brushes take on a high polish.

Caution

Never clean a commutator with gasoline. It may get into the winding and continue to evaporate for quite a long time. This might become ignited when the machine is operated.

Noisy or Squeaky Brushes

This is usually due to badly fitting brushes. It can, therefore, be remedied by paying special attention to insure perfect contact between the brushes and commutator.

DO NOT PUT ANY OIL, GREASE OR OTHER LUBRICANT ON THE COMMUTATOR.

Sometimes the noise ceases if the brush is slightly set to one side by means of a piece of wood. Do not use a screw driver or other piece of metal for this purpose. See that the brush arm moves freely and that there is sufficient spring tension to press the brush firmly against the commutator. If all methods given above fail, try fitting a new brush.

If the motor brushes are at fault, the same remarks apply as given above. If it is necessary to sand down or fit new motor brush, a hard medium must be used in place of sand cloth. A carborundum cloth known as "Aloxyte" is a very suitable medium for this purpose. Use smooth sand cloth, however, on the motor commutator. (Note: It will not be necessary to undercut the mica on the motor commutator since, with the harder brushes, the copper and mica wear at the same rate.)

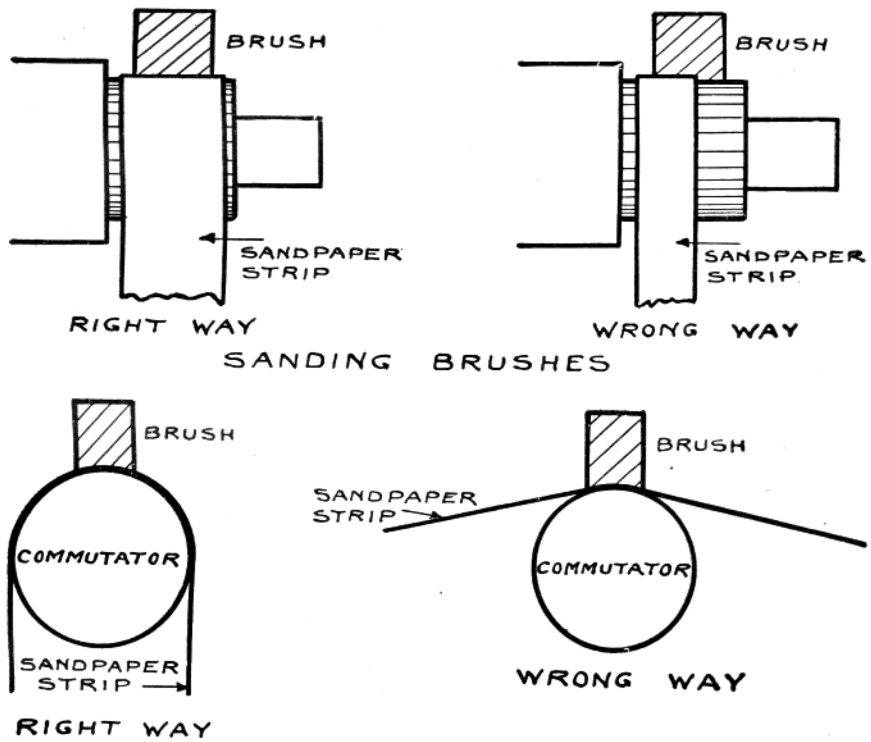


Fig. 8

The Distributor

Examine the wires leading to the distributor, both the low tension and the high tension. Keep the outside of the distributor head dry and free from oil, dirt and moisture. Remove the head occasionally and clean out the inside with gasoline. Examine the brush (contact) in the center of the distributor head.

See that it is clean and has sufficient spring tension to cause it to make contact with the center of the rotor; otherwise the ignition will be faulty. The same remarks apply also to the rotor brush that revolves and makes contact with the high tension terminals in the distributor head.

Remove the rotor by lifting straight up. Inspect the mechanism below the rotor. Remove any particles of dirt and dry up any oil or moisture that may be there. Examine the contact points and occasionally clean by drawing a small piece of smooth emery cloth between them.

Replace the rotor, then replace the head, taking care to turn it around until the tongue engages with the notch in the head.

Special attention should be given to the ignition resistance unit. Use a small brush to remove any dirt that may be collected about it.

To test the ignition resistance unit proceed as follows: Close the distributor contact points, then close the ignition switch. This allows current to flow from the storage battery through the ignition circuit. A drop of oil placed on the wire of the resistance unit should smoke in thirty seconds.

If the wire does not heat up sufficiently, examine the resistance unit for an "open circuit" or "short circuit." (Note: "Open circuit" would mean no current passing through the ignition circuit. "Short circuit" would mean current flowing through the contact points to ground without passing through the resistance unit.) Re-assemble carefully so that the current passes through the resistance wire before going to ground.

There can be no question whatever regarding the good results that will follow if you attend to these few inspections.

When Starting the Engine Note Particularly the Following:

Do not continue to crank the engine for more than thirty seconds if it should fail to start.

Do not hold the starting pedal in after the engine has started as this will burn out the lubricant in the motor clutch. On account of the high rate of speed at which it operates, very serious damage to the armature and clutch will result if the motor clutch should become dry and stick.

Review your actions and make sure that you have followed out the instructions in regard to position of throttle, spark lever, etc., and see that there is gasoline in the tank.

Take Care in Starting Engine

It frequently happens that you are in a very crowded street where the noise of the traffic prevents your hearing whether your engine is running or not. As a result, the starting pedal is pressed down with the intention of starting the engine, only to realize an objectionable screeching sound and a sense of having done some damage to the starting gears.

It is not reasonable to suppose that an absolutely fool-proof piece of apparatus can be devised which will eliminate the possibility of this happening, and we therefore take the opportunity of cautioning all owners against being too hasty in assuming that the engine has stopped. In the winter time when the curtains are all down and much exterior noise is excluded, the danger is increased.

To safeguard against this, get into the habit of either pressing down on the foot accelerator or advancing the hand throttle so as to determine if the engine is running. Do this in every case if you are not certain that the engine is in operation, before the starting pedal is pressed down.

When the engine is stopped or stalled do not leave the ignition button pulled out. This will discharge the battery through the generator winding.

When engaging the starter gears, it sometimes happens that the teeth do not mesh readily. Do not force the starter pedal but allow it to come back a little and try again. By this time the gears will have changed their positions so as to allow the teeth to mesh properly.

The Motor Generator

The motor generator, operating as a motor, receives its energy from the storage battery and transmits it through the motor clutch to the flywheel for cranking the engine.

The motor generator, operating as a generator, receives its energy from the engine through an extension of the pump shaft, and delivers electrical energy for the charging of the storage battery, and for operating the lights, horn and ignition.

The Motor Clutch

The motor clutch and gears, which operate between the flywheel and the armature pinion, are for the purpose of getting a suitable gear reduction between the armature and the flywheel and permit the gear in mesh with the flywheel to overrun the armature when the engine starts, and prevent the armature from being driven at an excessively high speed during the short time the gears are in mesh after the engine is running on its own power.

The Generator Clutch

The generator over-running clutch is for the purpose of allowing the armature to revolve at a higher speed than that of the pump shaft during the cranking operation; at the same time permitting the armature to be driven by the pump shaft when the engine is running on its own power.

Lubrication

There are oil holes in the front and rear end housing. These convey oil to the ball bearings at each end of the armature shaft, and should receive four or five drops of engine oil every 300 miles.

Some Useful Hints

If the armature fails to turn over when the ignition button is pulled out the trouble may be caused by one of the following:

1. Defective switch contacts. To test for this short circuit terminals 2 and 4 on the side of the motor generator (See the Super-Six reference book), to the positive terminal of the storage battery. This completes the generator circuits without passing through the switch, and if the armature now revolves it indicates that the trouble is not in the generator, but probably in the switch.

2. Sticking front end clutch.

3. End thrust in armature shaft, or generator out of alignment.

4. A foreign body lodged between the armature and pole pieces or generator frame.

5. Broken or jammed generator bearings.

Items 2, 3, 4 and 5 are all mechanical troubles and the cause of the sticking armature should be readily discovered.

6. Generator brushes making bad contact with the commutator, or none at all. This applies to the two main brushes and also the third brush.

7. Loose or dirty connections, broken wires, ground or short circuit, weak storage battery.

REMEMBER THAT THE THIRD BRUSH MUST MAKE GOOD CONTACT WITH THE COMMUTATOR AT ALL TIMES.

To realize the importance of this, raise the third brush with the finger while the engine is running, and watch the hand on the ammeter go back to zero.

The same thing applies to the two main generator brushes.

A careful study of the wiring system, as outlined, will be well worth while, and the knowledge and experience thus gained are your best friends when something goes wrong.

The Meaning of Conventional Electrical Characters

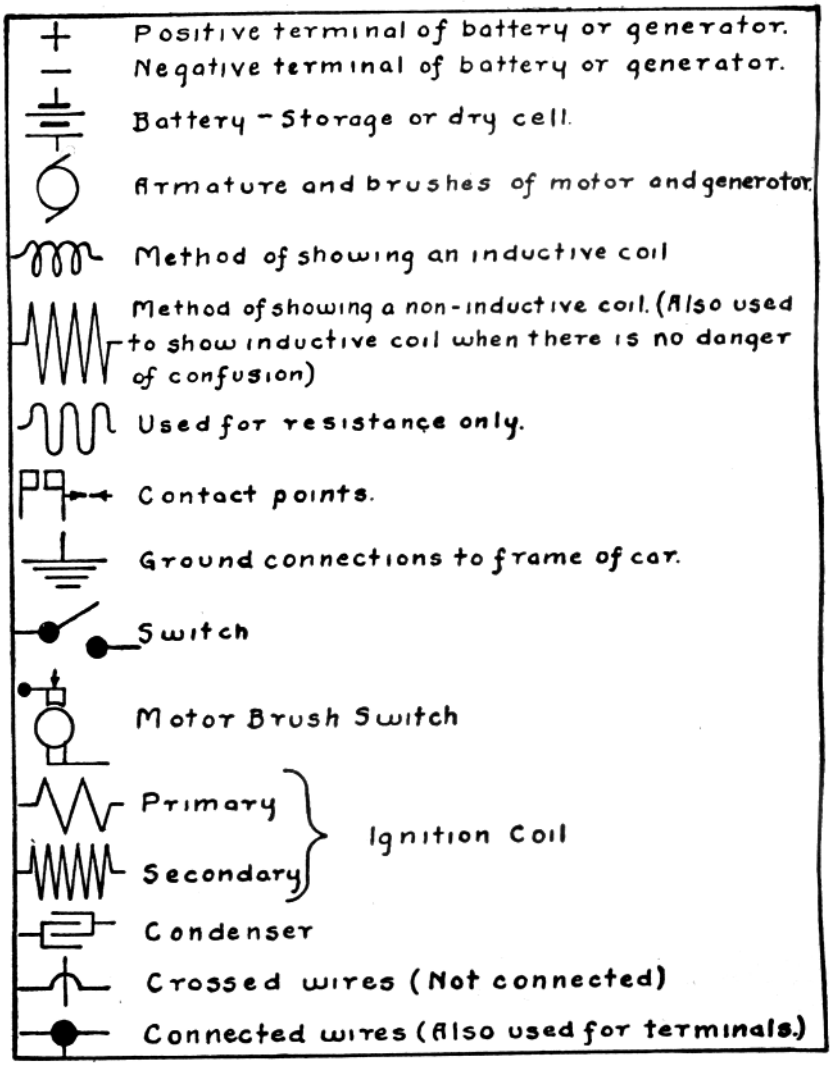
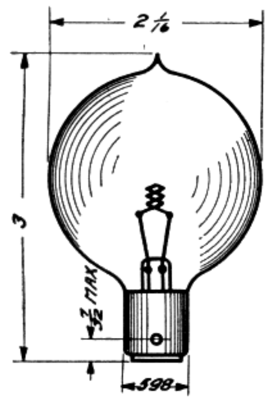
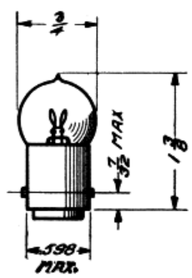


Fig. 9

The Following are the Specifications of the Hudson Super-Six Lamps



Head Lamp Bulb



Tail and Dash Lamp Bulb

Description	Diameter of Bulb in Inches	Maximum Over All Length in Inches	Volts	Amperes	Efficiency Watts per Candle Power	Candle Power	Fila-ment
Head Light G-16½......	2 1-16	3⅛	7	3	1.00	15	Coil
Tail and Cowl Light G-6...	¾	1½	3½	.84	1.25	2	Loop

Single Contact—Ediswan Base (Bayonet Candelabra)

The Storage Battery

The storage battery used with the Electric Cranking, Lighting and Ignition System is designed especially for the Super-Six and is made by The Electric Storage Battery Co. of Philadelphia, Pa., whose products for the automobile trade are known as "Exide" batteries.

The Storage Battery consists of three cells, each cell containing fifteen (15) plates—seven positive and eight negative. The battery when fully charged will burn the head and tail lights approximately 12 hours.

It is an exceedingly important part of the equipment of the modern automobile. It is the "heart" of the electrical system, supplying the power for starting the engine, lighting the lamps and often current for ignition as well.

The average car owner or chauffeur is fairly familiar with the engine and its care, but is apt to regard the battery as mysterious and therefore to ignore it.

A storage battery, like the tires, will eventually wear out with use. The normal life, however, can be very much shortened by neglect, the result of which is the same as abuse.

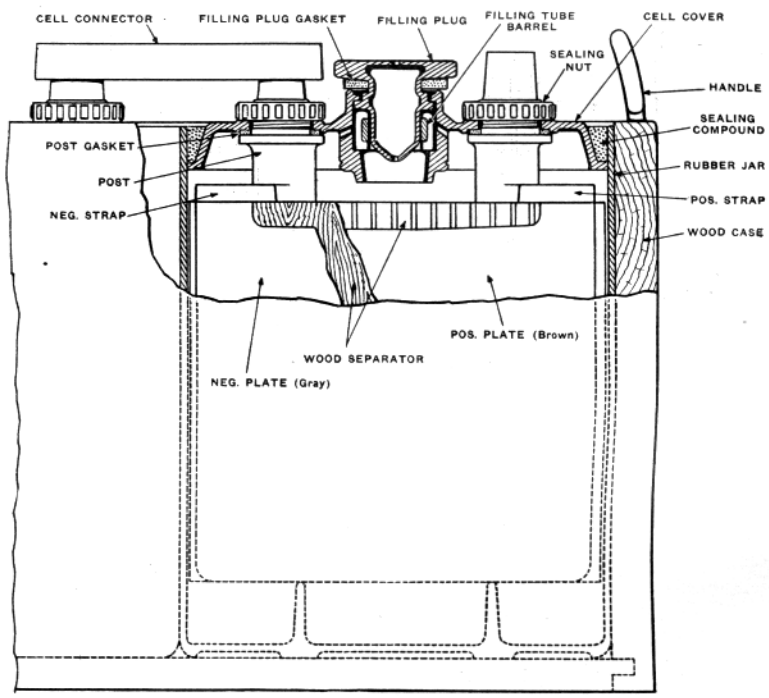


Fig. 1

Storage Battery

Battery in Service

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.

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 above 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.

For a large garage, where water is used in quantity, it is worth while to submit a sample of the city supply for test, since this may be of sufficient purity. Sample should not be less than one quart and should be forwarded in a clean glass bottle, carefully packed and marked for identification, and with express charges prepaid, to The Electric Storage Battery Company, 19th Street and Allegheny Avenue, Philadelphia, Pa. The analysis will be made free of charge.

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.

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 64.

What Readings Indicate

Specific gravity above 1.200 indicates that the battery is more than half charged.

Gravity below 1.200, but above 1.150, indicates battery less than half charged, i. e., is approaching exhaustion.

Such a 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. If gravity will not rise above 1.200 within a reasonable time, look for trouble in the system.

Gravity of 1.150 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, 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 (page 37), causing the cell to discharge itself, or it may be due to a leaking jar, as 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, 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. 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 Super Six battery should be charged at the rate of seven amperes per hour.

Indications of Complete Charge

Continue the charge until the gravity has arisen to a maximum, that is, shows no further rise over a period of 5 hours, six successive hourly hydrometer readings taken on the same cell being alike.

The battery voltage should likewise rise to a maximum.

Near the end of 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), either stop the charge or reduce the rate until temperature lowers.

Quick Charge

To charge a completely discharged battery (gravity 1.150 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. 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 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, wipe off top and sides of battery. When connecting to car circuit, 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 this 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

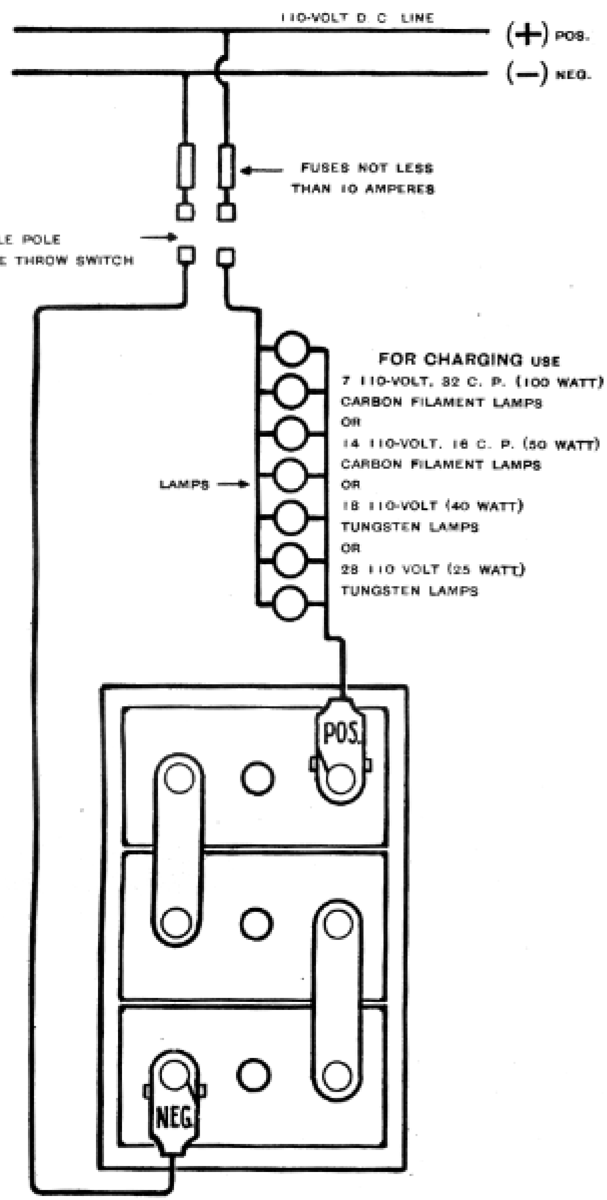


Fig. 2
Charging Circuit Diagram

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 (Fig. 2). 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 Super-Six 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. volts.

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 throughout 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 sand paper. The connections to the generator and the grounding connections to the frame of the car (if car is equipped with a grounded system) 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 or thereabout), 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 considerable 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 or 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. 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 the proper current rate as described.

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 5 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 something lower than 80 degrees below zero, while in a normally discharged battery it freezes at about 5 degrees above zero. 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 charge causes the water to become thoroughly mixed with the electrolyte.

Adding Water

Once in every two months during the out of service period, remove the filling plugs and add water, replace the 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.

Periodic Charge

Specific gravity readings, to check against those taken on the preliminary full charge, furnish an additional safeguard, but need not necessarily be taken every time a "freshening" charge is given.

The taking of specific gravity readings occasionally while the battery is standing idle gives a good line on the uniformity of the cells. If the specific gravity in one cell falls materially faster than in the others, there is probably something wrong with this cell, and it should be taken out and inspected by a competent battery man.

If it is not practicable to have the battery charged at periodic intervals as above described, or sent to a reliable garage where it will receive attention, it can be allowed to stand (provided it has first been fully charged) for a period not exceeding six months, but better results will be obtained if the freshening charge every two months is given.

Always add water and charge the battery before putting back in service.

If the periodic charges have not been given during the out of service period, charge for at least fifty hours at half normal rate before putting battery into service again.

Battery in Need of Repairs

Any repairs necessitating taking cells apart should not usually be attempted by the individual owner, but should be done by a competent repair man (preferably one of the **"Exide"** Battery Depots or an **"Exide"** Distributor). Shipping instructions for batteries to be repaired will be forwarded upon application to the nearest office of the Company.

Packing for Shipment

It is not safe to ship a battery without proper packing, as the rough handling received is almost sure to do damage. The following procedure is recommended:

1. Procure a strong box made with "A" shaped top (Fig. 3) to prevent the package from being placed upside down. The inside dimensions should be at least 2 inches greater than the overall size of the battery.

2. Cover the bottom of the box with a layer of excelsior, shavings or coarse saw dust about 2 inches thick, and on this place the battery. Over the tops of the cells place paper, preferably paraffined, and then cover the whole battery with stout wrapping paper, folding it down over the sides to keep off packing material and dust.

3. Fill the space around the sides and ends of battery with excelsior, shavings, coarse saw dust or even twisted and crumpled balls of paper, ramming down tight.

4. Leave the top of the battery free of packing material and covered only with the paper.

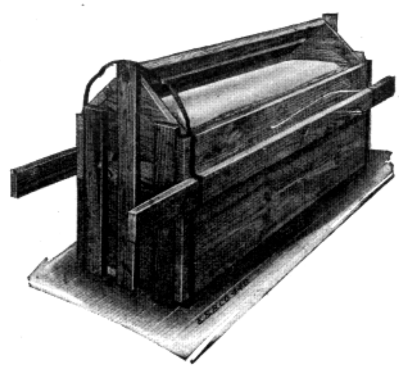


Fig. 3

5. Nail slats on the box for a cover; never make a solid cover. The slatted cover enables the freight handlers to see the contents of the package and helps toward careful handling. A stout strip of wood nailed on each side and projecting beyond the ends for handles will prevent the package from being stood on end.

6. Label the box "Handle with Care" and "Do Not Drop."

7. In addition to the address of destination, as given in shipping instructions, be sure to mark with name of shipper for identification upon arrival.

8. The proper freight classification is "Electric Storage Batteries, Assembled." No railroad caution labels are required.

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 Page 65), 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).

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.

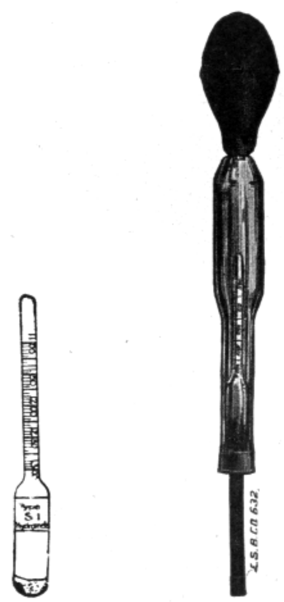


Fig. 4

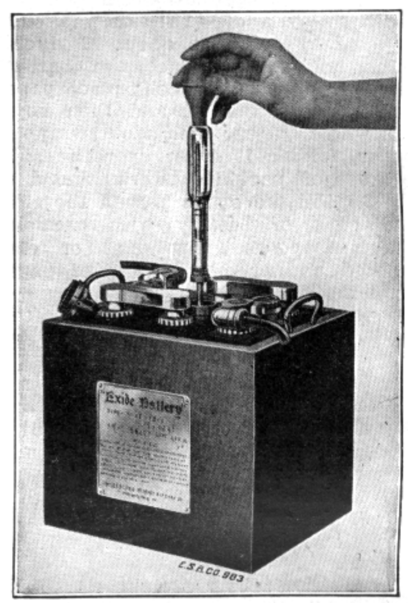
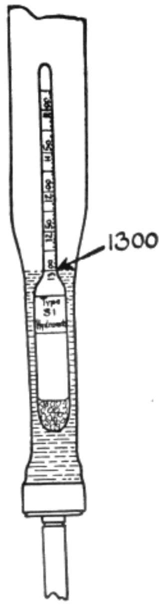


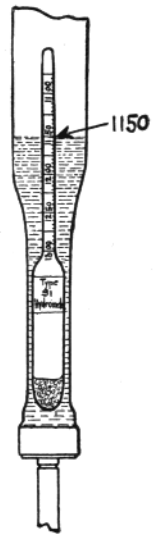
Fig. 5
Taking Hydrometer Readings

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 taken out of the first 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.



Hydrometer
Reading, 1.300



Hydrometer
Reading, 1.150

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 "series") 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 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, it will, at the end of discharge, be about 1.150. 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.

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.

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 **overdischarge,** 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.

High Temperature

High temperature is to be avoided from the standpoint of life. 110 degrees Fahrenheit 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.

Instructions for Putting Into Service "Exide" Batteries Type 3-X-15

The battery on an exported car is shipped dry (without electrolyte), and before being put into service it 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 its 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 instructions are not followed out explicitly.

FILLING CELLS WITH ELECTROLYTE: The electrolyte used for filling should be 1.300 specific gravity (33° Baume) and if this cannot be procured mixed and ready for use, it can be made by mixing especially pure sulphuric acid of 1.835 specific gravity (66° Baume), i. e. "Oil of Vitriol," which can be obtained from a reliable druggist, and distilled water in the proportion of two (2) parts of acid to five (5) of water by volume. The acid must always be poured into the water, and not the water into the acid. Glass, earthenware, or other acid proof vessels thoroughly cleansed, should be used, and the electrolyte allowed to cool before using.

Remove and discard soft rubber caps from filling plugs. Remove the filling plugs and with a rubber syringe or small china or glass pitcher, fill the cells with electrolyte of 1.300 specific gravity (33° Baume), until the level is even with the bottom of the filling tubes (see Instruction Book). Then 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.

Allow the battery to stand for from 6 to 12 hours filled with electrolyte before starting the initial charge.

CHARGING CIRCUIT: If a 110-volt direct current circuit is available make connections and use the four 110-volt, 32 c. p. carbon filament lamps in parallel for resistance, as shown in the figure. In making the connections between battery and charging source follow polarity marks as indicated in the figure, i. e., "+" for positive and "—" for negative. The positive battery terminal is marked "POS," and the negative terminal is marked "NEG." Provide fuses of about six amperes rating. Keep the switch open.

To determine the polarity of the charging circuit, if a suitable voltmeter is not at hand, dip the end of two wires "A" and "B," from the charging circuit into a glass of water, into which a teaspoonful of salt has been dissolved. Then close the switch. Fine bubbles of gas will be given off from the negative wire. Open the switch, and connect the negative wire to the negative battery terminal, and the positive wire to the positive battery terminal. The connections are now completed. If a battery is connected with wrong polarity serious injury will result.

If more than one battery is to be charged at a time, connect the battery in series, the positive terminal of one battery to the negative of the next, and so on. The resistance to be used will be less than if only one battery is being charged. This means that additional lamps will have to be inserted in parallel.

If charging is to be done from a 550-volt railway circuit, connect five lamps in series in the place of each of the four lamps shown in the figure.

If a direct current system is not available, charging can be done from an alternating current system, provided suitable apparatus is used for converting the alternating current into direct current. This can be accomplished by a motor generator set, or a current rectifier, of either the vibrating or mercury arc types.

INITIAL CHARGE: Start the charge by closing the switch 6 to 12 hours after filling. The lamps should then burn at reduced candlepower and allow a charging rate of about four amperes to pass. Charge until the specific gravity (as read by the hydrometer syringe, see Page 65), and

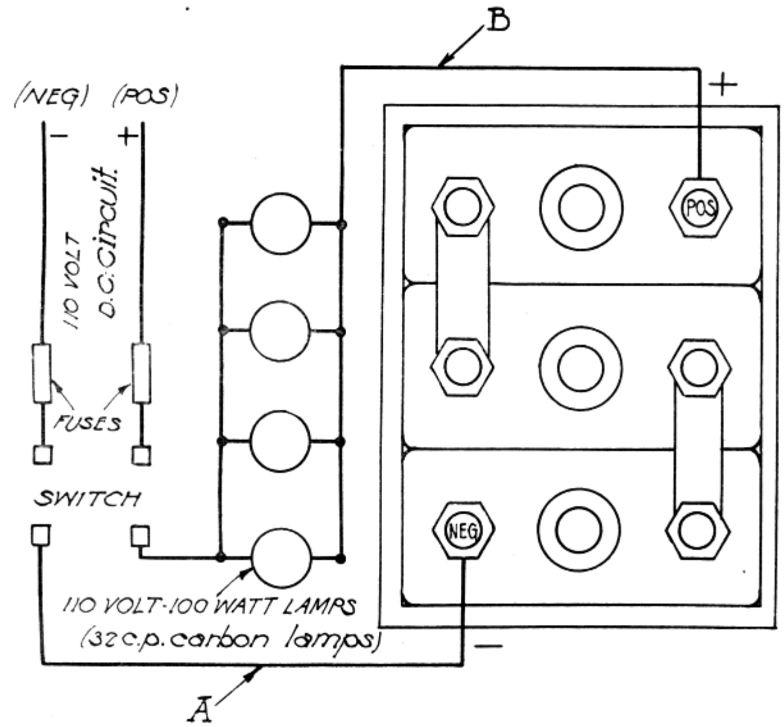


Fig. 1

the battery voltage have risen to a maximum and show no further rise for five hours. The cells should also be gassing or bubbling freely for the same length of time. In any case, give a charge of **at least 24 hours,** and longer if there is any doubt, as it is better to give too long an initial charge than for it to be insufficient.

If the temperature of the electrolyte in any of the cells should approach **110° Fahrenheit** (43° Centigrade), during the charge, stop the charge or reduce the charging rate by cutting out one or two lamps until the temperature lowers.

At the end of charge, read the specific gravity of electrolyte in each cell with the Hydrometer Syringe, and where necessary, adjust so that it will read between 1.275 specific gravity (31° Baume) and 1.300 specific gravity (33° Baume) electrolyte; if the gravity is too high, remove a little electrolyte and replace with water. After the electrolyte is adjusted within the above limits, the battery is ready for service.

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.

Generator System. An equipment including a generator for automatically recharging the battery, in contradistinction to a straight storage system where the battery has to be removed to be recharged.

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.

How to Use the Super-Six Removable Cylinder Head

The removable cylinder head is adopted on the Super-Six because of its greater thermal efficiency; in other words, it gives us a more perfectly formed and easier cooled combustion chamber, the advantages of which are noticeable by the performance of the Super-Six motor.

Were we to use the conventional type of bloc with its large volume of indifferently cooled metal, the portion of the cylinder head over the valves would be of a different temperature to that over the cylinders. The shape would not be as uniform, and there would be a greater tendency to collect carbon. It would also be necessary to allow a greater spacing between valve centers in order to make the valve removable, if they were to be of the same size as those in the Super-Six.

There are no disadvantages whatever with the removable head, except perhaps that it sometimes becomes necessary to grind in only one valve and when this happens there is an extra amount of work entailed in the removal of the complete head. However, by using Rich tungsten valves and by cooling them very much more efficiently, we believe we have eliminated the only disadvantage.

Just the same as it was necessary to replace the gaskets on the port plugs and graphite their threads, so that they would not stick, so is it necessary to watch carefully the points enumerated below which refer to the removable head and its gasket.

Compression Leaks

These may be due to the following causes, aside from poorly seated valves or wide gaps in the rings and scored cylinders, for which, of course, the treatment is the same.

The gasket has been damaged by being dented from prying off the head with a screw driver. This frequently disturbs the equality of the asbestos filling and makes it impossible to pinch the gasket tight at all points. The only remedy is to replace the gasket.

The trouble may be eliminated by a few precautions in removing the head. In using a screw driver to pry off the head, always insert it at a point where it can do no damage and never push it very far into the split. Let all the damage take place at the extreme outer edge.

One cannot exercise too much care in removing the head.

A special puller for removing the head may be constructed from a bar bearing on the exhaust pipe flange on one side and the intake manifold flange on the other. The center of the bar is branched, with two puller screws which fit into the spark plug holes. This, however, is an elaborate construction and would only be necessary in shops where cylinder head removals are frequent, in which event it would save time and the expense of new gaskets.

For ordinary purposes, the head may be loosened by turning the motor over with the hand starting crank. Before doing this, a stud nut at the front and rear ends should be left on to prevent the possibility of lifting the head completely off. The compression will loosen the head when the motor is cranked and it can then be pried off further with the aid of a screw driver or a blunt chisel.

If it is necessary to strike the head with a hammer in order to ease it off the studs, use only a lead or a raw-hide hammer. A steel hammer is apt to start a crack in the cast iron cylinder head.

In the illustration below, it will be noted that the stud has thrown up a burr around the top of the threaded portion. When this happens, it is plain to see that the gasket cannot be pinched tightly except at this one point where the clearance is reduced. There will be little pressure on the gasket over its wider area.

The remedy for this is to remove the stud and counter-bore the hole in order to get the condition as shown in Fig. B.

How to Apply the Gasket (Right and Wrong Side)

Make sure that the gasket is in place with the lapped edge downward, as shown in Fig. C.

Unless it is placed in this manner, the recessed combustion chamber may not line up with the upper edge of the cylinder bore and this will leave the lap unprotected. The heat from the combustion chamber will enter the lap and destroy the asbestos packing. It may cause pre-ignition when the asbestos becomes badly eaten away.

On the other hand, if the gasket is replaced with the lap downward, the lap always bears on an evenly machined surface and it cannot overlap the edge of the cylinder bore. In this way the lap is squeezed up tight and the heat cannot enter the crack and destroy the gasket.

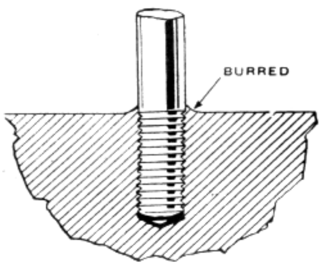


Fig. A.

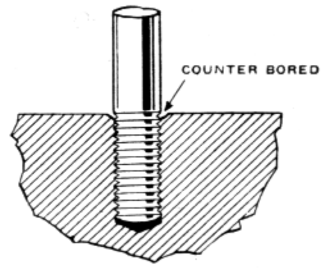


Fig. B.

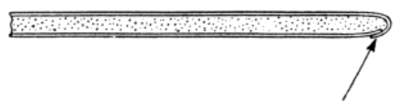


Fig. C.

Warped Cylinder Face

The upper face of the cylinder head, while of very sturdy construction, may be damaged if the studs are not pulled up with an even tension when the head is being set in place.

By applying all the tension to one particular stud, there is a tendency to buckle the upper surface of the cylinder bloc. This would permanently destroy the evenness of the surface, pinching the gasket around the one particular point tightened, and leaving free the portions surrounding it.

If the studs near the valves are strained in this manner, it is also possible to distort the surface to such an extent as to prevent the perfect seating of the valves.

All cylinder studs must therefore be tightened up very carefully. Never use a wrench with more than a 9-inch handle on it, and pull the nuts down a little bit at a time, working over the twenty-five one after another, so that one particular nut never gets excessive tension.

After the motor has been running for a little while and the head is heated up, give them a further tightening in the same manner, but never devote your entire energy to some one stud. If there is a leak at a point which would indicate that the nearest stud needs tightening, do not go after this one particular stud with full force. You are apt to throw up a burr and distort the cylinder head and thus make conditions worse rather than better. The best way is to remove the cylinder head and ascertain the cause of the leak. You will invariably find it due to one of the causes already given.

Leaks Between Cylinders

It will sometimes happen that there is a compression leak between the cylinders at the point indicated by the arrow in the illustration. To test for trouble of this nature, cover the surfaces of the cylinder head and the cylinder bloc with a thin layer of white lead. Fit the gasket, tighten it down and run the motor. If possible, run the motor under load so that you will get the maximum compression and combustion pressure.

Upon removal, the head will show leakage by black streaks at the points where the charge has been getting between the gasket and the machined surfaces.

Trouble of this nature calls for a thorough examination of the cylinder head and the top of the cylinder bloc. Burred surfaces will usually be found; or the gasket may have been damaged.

If you do not have a gasket handy with which to make a replacement, remove the white lead and cover both gasket surfaces with a coat of thin, good shellac. Place the gasket on the cylinder bloc (to eliminate need of handling it again) and let it remain there until it has become tacky, then bolt on the cylinder head and run the motor until the head is thoroughly warm. Allow it to stand in this condition for fifteen or twenty minutes and then tighten it up again.

A shellacked gasket applied in the proper manner will often make a perfectly tight head and eliminates the need of replacement.

It is highly important that the faces of the cylinder head and cylinder bloc be carefully examined before attributing any trouble to the gasket itself.

The only trouble you will ever experience with the gasket is the damage you may do to it in removing the head, provided the workman is careful in making a replacement, there is no reason why a good gasket cannot be retained for at least six head removals.

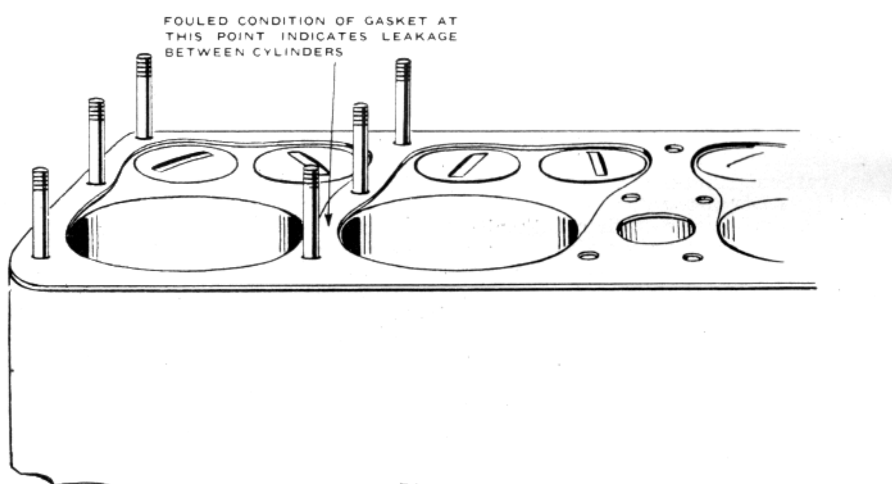
Symptoms of Compression Leaks

The results of gasket leaks are numerous. The usual symptom is a failure to throttle down to low speed and a tendency to buck badly on a pick-up from low speed.

Sometimes the motor will not idle properly; but this would only be true in the case of a very bad compression leak—one which could be ascertained by the noise it would make when the motor is cranked by hand.

It is a good plan to have a compression gauge that can be screwed into the spark plug hole. This gauge should register about 80 to 85 pounds when the throttle piston is held wide open so as to give a full aperture and the motor cranked by hand as fast as you can spin it.

Such tests should always be made with a hot motor, never with a cold one, as there is a tendency for the oil to aid in getting compression when the motor is cold. When hot, the oil is thinned out to the point where it blows by the piston more easily. A test which is of real value can then be made. It then approximates the conditions under which the motor works.



Cooling System

The radiator is of two piece construction which permits of the shell being pressed up and enameled separately. It is then attached to the radiator proper by means of bolts around its outer edge. For purposes of repair, it is possible to remove the shell completely before working on the radiator, thus minimizing the expense of refinishing and the chance of damage to the shell itself.

The fan has been increased in diameter to insure a more efficient circulation of air, thereby making all cars equally efficient in high altitudes or for trans-continental work, which involves long trips across the desert.

The water pump is of an improved design. The pump body and impeller are of a special aluminum alloy which will resist the action of chemicals in the water to the maximum degree. There are no pipes or hose connections between the pump and the cylinder bloc. These are eliminated by bolting the pump directly to the face of the cylinders and by casting the water delivery pipe integral with the cylinder bloc.

The cylinder outlet is made of brass pipe to insure a certain amount of flexibility and an unrestricted passage. As it is intended that this pipe should be removed when the cylinder head is to be taken off, it is obvious that a cast pipe would be more easily damaged and less easily repaired than a pipe constructed of brass tubing.

General Attention

Overheating troubles are much less frequent than they were a few years ago. This has made the average automobile owner somewhat forgetful of the needs of his radiator. As long as the car shows no signs of overheating, people assume that it has sufficient water.

The cooling system should be drained off and refilled with clean water at least once a month. Neglect to do this results in the cooling water becoming very dirty and full of rusty sediment. Unless the system is washed out, it will tend to clog the minute passages in the radiating tubes. Dirty water is not so effective for cooling purposes as clean water.

When the radiator is refilled, make sure that the pump is circulating properly. This may be observed through the radiator filler as long as the water is sufficiently high.

The water connections between the radiator and pump, and radiator and cylinder head, should be examined to see that the rubber has not perished or been damaged, and that the clips are tight.

All water leaks should be eliminated.

If, in the cold weather, anti-freeze solution is being used, proportionately more trouble may be expected to develop at the rubber water connections. The rubber has a tendency to rot, especially if strong solutions are used continuously.

If the owner is not using anti-freeze solution but prefers to drain his car every night, be sure that the radiator drain plug is in good condition and has not been replaced cross-threaded.

Water Pump Glands Tight

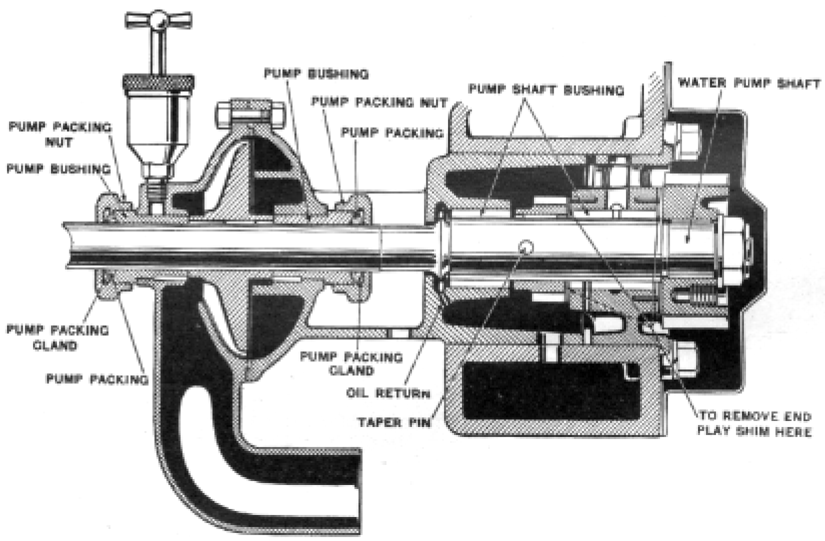
The water pump glands should be tested to see that there is no leakage at this point. If there is a leakage, the gland should be tested to see that it is screwed up tightly, and if such is found to be the case, it should be screwed back and packed in with candle wicking soaked in tallow, or a good grade of twine. Unfortunately, it is a fact that most mechanics use a wrench to tighten the gland far too often. Instead they should put in new packing. The gland is of such construction that with the proper amount and proper quality of packing, it will prevent leakage with only a slight pressure from the packing nut. But, after the packing has once seated or been squeezed up by undue pressure from the nut, no amount of subsequent pressure will prevent it leaking, but will rather tend towards straining the bushing in the pump body, thereby loosening it up and causing a leakage which is very expensive to eliminate.

If mechanics will refrain from tightening these nuts with a 12" wrench, but will pack them more often and handle them more delicately, they will experience no trouble from loose bushings. These bushings are replaceable, of course, but it is an expensive operation and totally unnecessary for at least two seasons, provided the glands are properly packed and a good quality of water is used.

This applies to all models of Hudson cars, especially those having the die cast aluminum alloy pump bodies. In connection with the latter it should be noted that alkali water used in certain sections has a destructive effect on all metal, particularly on these alloys; and they cannot be expected to last so long as they would in sections where the water is of better quality. Incidentally, the same applies to radiator cores, which are made of a high grade, drawn brass. These cannot be expected to last indefinitely in territories where strong alkali water is used. The action of such water is to eat minute holes in the metal, which soon manifests itself upon the exterior surface of the radiator in little beads of water. These soon develop into serious leaks and must be promptly repaired in order to avoid frequent filling up of the radiator. When such water is the only kind obtainable, it is advisable to have a little soda at hand, a small quantity of which, when mixed with the water, will prevent corrosion, as the soda precipitates the matter in the water. This necessitates a thorough cleaning occasionally to remove the sediment. The amount of soda used should vary with the purity of the water. Up to one-half pound may be used and renewed when the water is changed every month or so.

Pump Shaft and Coupling

As the pump shaft is employed for driving the motor generator, it does considerable work. The necessary precautions have been taken to provide adequate bushings at the front end of the pump shaft and in the pump itself. There are also provisions for adjusting any end play which may develop due to the thrust from the spiral timing gears. The pump shaft should therefore be tested for end play by shucking it back and forth and noting the amount of movement. A certain amount of play is necessary but should this be excessive, more than .007", it may be necessary to remove the pump and add shims



Details of Water Pump

behind the washers which take the thrust from the timing gear and distributor drive. After removing the pump shaft, these washers should be lifted and a shim of suitable thickness placed behind them. This will eliminate end play and stop any objectionable rattle or noise emanating from such.

Excessive end play, if allowed to continue, results in a shucking back and forth of the pump impeller, or paddle, eventually wearing it or scoring the interior of the water pump. Provision has been made to allow for sufficient end play without possibility of damage but should the end play exceed 1/64", it is probable that damage will result.

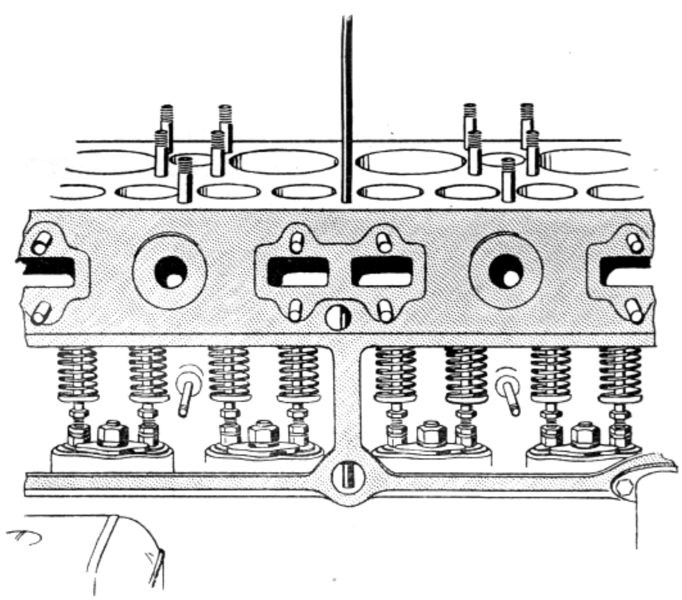
The pump coupling should be examined to make sure that the taper pin which secures the coupling is not loosening and that the key is in place. In instances where it has been necessary to remove this coupling, it may have been improperly re-installed. Proper inspection will insure the coupling and pin being secure so that there will be no possibility of the pin dropping out or of the coupling loosening when the owner is out of range of assistance. Such an accident would tie up the car and probably necessitate being towed in, but if it is looked after periodically this is never likely to happen.

Overheating

Probable Causes and Prevention

Super-Six motors have been particularly free from overheating, and the annoyances which usually accompany this form of trouble. For this reason when trouble does develop, it can usually be attributed to a radical cause of a nature which is sometimes very difficult to locate. This treats with all the conditions which might have a bearing on overheating in connection with a Super-Six motor, and is offered with a view of saving you unnecessary trouble in correcting any complaints of this nature which may arise in your territory.

When diagnosing a case of this kind, always first make sure that the louvre covers and the two discs which were placed in the water outlet holes in the cylinder blocks during the winter months have been removed. (These discs should be retained and inserted again during the winter months.) It is also very important to note that the radiator shutter leaves are in a hori-



zontal position when the operating rod is pulled out to the extreme limit.

The rubber hose connection in the bottom of the radiator should be next examined in order to see that the spring is in the proper place and that the hose is not collapsed. The illustration shows what happens when this occurs, shutting off the water.

We have found in several instances where cars were giving trouble through overheating, that a thin film of iron had been left in the cylinder blocks' water passage ways through a faulty core.

Where the water circulating system is in apparently good order the two Welch plugs in the middle of the right side of the motor and the cylinder head should be removed. It is then possible by holding a light at the lower hole and by looking in the stud hole at the top of the block, from which the stud has been removed, to ascertain whether or not this film of iron mentioned is obstructing the water passage ways. An obstruction in the water circulating system at this point is naturally an unlooked for condition, and for that reason would be very misleading in checking over a motor which has been giving trouble in overheating.

The remedy for this difficulty, of course, is apparent. The film should be broken out by inserting a steel rod 5/16 of an inch in diameter through the stud hole in the top of the cylinder block and knocking it out with a hammer. It is important that the rod be no larger than 5/16 of an inch, otherwise the water jacket may be damaged.

Radiator Shutter

Driving an automobile without some method of keeping cold draughts away from the engine and radiator is just as wasteful of fuel as trying to warm a house in cold weather with all the windows and doors open. In the latter instance, every one knows that it will be necessary to burn a great deal more fuel in order to keep warm.

The gasoline burned in the cylinders of your engine is the only source of heat. Unless we conserve this heat in cold weather, it is going to be consumed wastefully. So we have been in the habit of conserving it as much as possible with a quilted cover. On Super-Six cars this is now out of date!

By the simple expedient of placing shutters of the Venetian blind type in front of the radiator and regulating these shutters by a handle on the dash, the driver is able to control the temperature of his motor at will.

The Boyce Motometer on the radiator filler cap shows the driver when to open the shutters—this is 130° F., the bottom of the circular opening. Or when the liquid reaches the heavy white line extending clear across the face of the motometer. For the motor to work at its highest efficiency, the liquid should be kept at summer average or at the line in the center of the circle just below Hot Motor.

Once this point is reached, a very slight amount of practice in adjusting the position of the shutters will enable him to drive consistently at the best temperature.

There are no adjustments or complicated mechanisms of any kind in connection with the shutter control. The pull rod on the dash is adjustable to a sufficient number of positions to pass the desired amount of air through the radiator from "wide open" to "fully closed."

When in the wide open position the efficiency of the radiator is not affected in the least by the shutters and there is therefore no need of changing or removing the device in the summer time. Furthermore, there is absolutely no danger of the mechanism becoming clogged or inoperative, thereby overheating the motor.

A glance at the illustrations will serve to convince one how simple and effective the shutter control can be made.

A certain amount of caution must be exercised, however, never to allow the temperature to rise above Hot Motor as scored cylinders, wrist pins and burned out motor bearings are liable to result.

Proper Use of Shutter will Prevent Motor Missing and Fouled Spark Plugs

Ninety per cent of missing and fouled spark plugs is caused by lack of heat above the piston head and not from the oil below it. Many articles now appearing in the current automobile journals confirm our views.

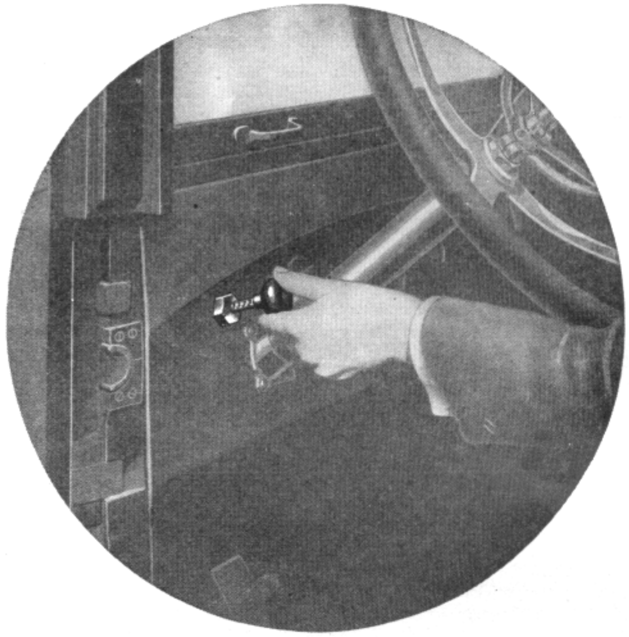
Periodic analyses of gasoline show that the per cent of volatile matter therein contained is gradually decreasing and today, heat between 400 and 500 degrees Fahrenheit is necessary to drive all of the liquid into a gaseous state; or, in other words, to evaporate to dryness.

A portion of this liquid, however, vaporizes at lower temperatures. If this were not true, the starting of a cold motor would be impossible. Kerosene illustrates this point.

While a motor is heating up, or if driven cold, it is evident that the portion which does not volatilize, due to lack of heat, will in time foul the spark plugs and cause missing. After the plugs have become thoroughly covered with this distillate, there is little chance of making them fire. As it is necessary to lubricate the cylinder walls at all times, the oil, instead of being burned, would naturally aggravate the trouble started primarily by the distillate.

It is obvious, therefore, that the motor should be heated up and not driven cold so that missing occurs.

There are Super-Sixes owned in the large cities and also in quite remote districts.



The city man may warm his motor by running it after starting for a block or so in first gear and for two more in second. He should not shift into high gear until his motor is properly hitting on all six. In the meantime his radiator should be covered, either by tightly closed shutters or by other means.

We advise the owner who lives in the smaller town and who does not have drives long enough to sufficiently warm up the motor, to heat it before leaving the garage. Let the engine run with the shutters tightly closed and the spark lever fully retarded until sufficient heat has been generated to completely volatilize the fuel. Under these conditions, missing and fouled spark plugs will be unknown.

We depend upon you as dealers to advise owners and actually show them how to properly warm up their motors. This is the only way they will be able to overcome missing and fouled spark plugs, as the trouble does not lie in the motor itself but in the fuel supplied to it.

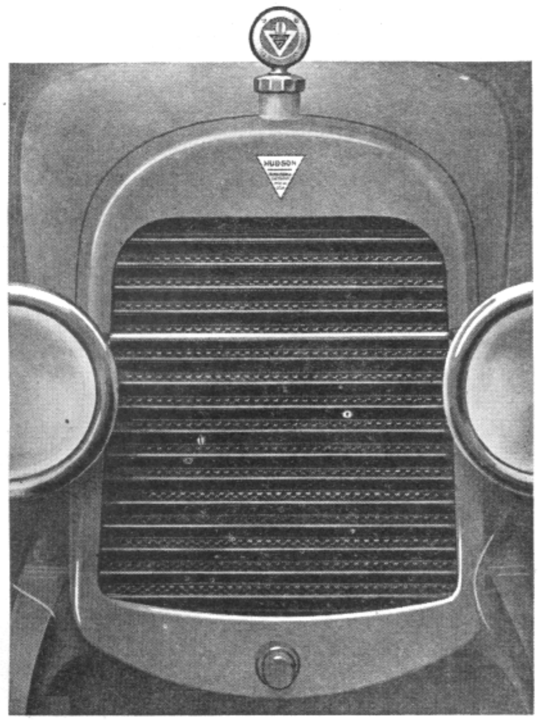
Above all things, impress upon owners the necessity of heat.

Care of the Radiator Shutter Equipment

We are again calling to your attention the correct position of the radiator shutters when wide open. They should be horizontal when the dash adjusting rod is pulled out to the last notch. If they do not come to a horizontal position when the dash adjustment registers with the last notch, either the rod connecting the shutters to this dash lock is not properly adjusted or the hinges of the shutters themselves have become gummed, thereby causing them to stick.

An adjustment is provided in the clevis connection between the rear end of this rod and the dash adjusting rod, located just under the cowl apron, by means of which the relative position of the shutters and the dash adjustment may be changed.

If the bearings of the shutters have become gummed so that they do not respond to the movement of the dash regulator, they should be washed with kerosene. **Never use lubricating oil on these bearings.** It is possible, in cases where owners have used lubricating oil, that the bearings have accumulated a sufficient amount of road-dust to make them partially in-



Shutters in Horizontal Position When Wide Open

operative. Thus, instead of allowing the pull rod to open them to their wide-open position, the shock-absorbing spring placed between the bell crank and the shutters, within the radiator shell, merely compresses and does not open the shutter to its horizontal position.

As opportunity presents itself, examine the various cars out in your territory with the foregoing in mind.

Thermostatic Control

A thermostat is located in the cooling system between the motor water outlet manifold and the top of the radiator. This allows a very much quicker warming up of the motor as it shuts off water circulation between motor and radiator until the cooling medium of the water jacket has reached a temperature of approximately 120 degrees. At this point the thermostat opens a valve which allows a portion of the water to pass through the radiator, thereby preventing overheating. A by-pass pipe connects the thermostat with the radiator outlet, so arranged that pressure will not build up against the thermostatically controlled valve. This allows what might be called a short circuit for the water, sending it to the pump without going through the radiator.

In this way we have arranged practically an automatic cooling system, the only precaution necessary being to leave the shutters closed until the motometer registers approximately 130 degrees and to take care that the shutters are closed in order to conserve the heat when the car is stopped.

CAUTION: Since when the motor is cold practically no water is passing through the radiator core, there is danger of what there is in the radiator freezing if the radiator shutters are not closed until the motometer registers the proper temperature. Your attention to this detail will safeguard you from possible annoyance.

Replacing Super-Six Piston Rings

One of the many advantages of the removable cylinder head is that it permits the replacement of piston rings without taking off the cylinder bloc. Thus, in cases where the rings in only one or two cylinders need attention, it effects a great saving in labor.

In connection with the actual work of removing the head, we shall say nothing.

From the illustrations which follow, it will be noted that by removing the reservoir and connecting rod cap, the piston assembly may be pushed up beyond the top of the cylinder bloc for more than half its length. This enables us to remove the rings.

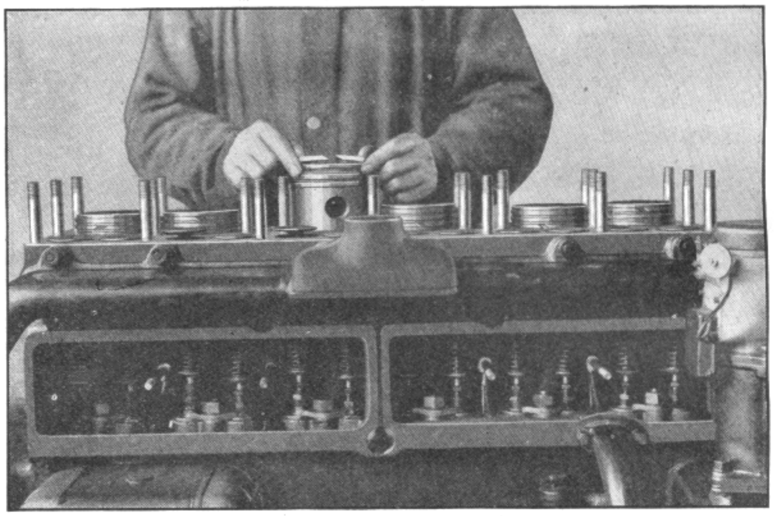


Illustration No. 1

If the piston is then pushed back into the cylinder, the latter is exposed so that we may test for slot clearance the rings which we have removed; and in the same manner fit up new rings if necessary.

In fitting new rings it must be remembered that as the top ring is nearest the combustion chamber it gets the hottest. More slot clearance must be allowed for expansion on this account. The top ring therefore should be fitted with a clearance of not less than .006″ when tested with a feeler gauge, as shown in illustration No. 2. The second and third rings should have a slot clearance of not less than .003″ and not more than .005″, the lesser clearance being desirable.

We cannot afford to guess at the clearance in an adjustment of this kind for it is far too delicate to be gauged by the naked eye. A feeler gauge must be used. Since they can be purchased at any hardware store, there is no excuse for lack of such tools.

Bear in mind that this is the only way in which you can conscientiously insure good workmanship and the desired results. Merely taking any ring that comes to your hand and filing the slot clearance so that it looks approximately right, is no assurance that you are going to improve compression or eliminate smoking trouble. Since these two complaints are usually the reason for replacing the rings, why not do the job properly, taking the necessary pains to work to thousands in so vital a matter?

The new rings may need fitting into the grooves in the pistons. If they are tight they will not be free to expand when heated and will either wear excessively or cause a scored cylinder. A piece of fine emery cloth glued to a piece of flat hardwood, can be used to reduce the thickness of the rings for fitting into the grooves. Rub the ring over the emery cloth with a rotary motion so as to reduce it to equal width all over. In refitting them to the grooves, they should revolve freely with the fingers. There should be no actual clearance that you can measure, but they should be fitted with what is known as a "sliding fit."

Rings should be replaced in the order in which they are removed, that is, the slots of the upper and lower rings should point in one direction, while the slot of the center ring should point in the opposite direction. Mark the upper ring so that in replacing after fitting, you will put the right ring in the right slot; it must have correct slot clearance.

If you are replacing the same rings that came off the piston, clean the groove thoroughly to remove all carbon and clean the back of the ring. Never

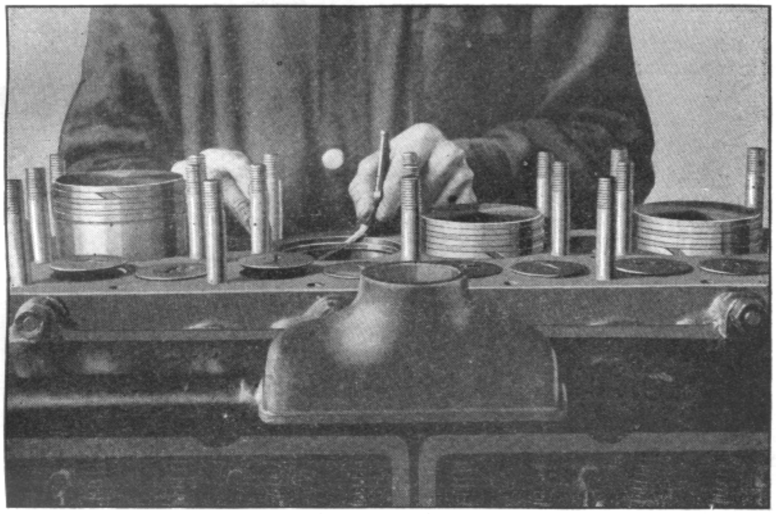


Illustration No. 2

replace an old ring without first testing the slot for clearance. If it is worn to more than .010" or .012", it is cheaper to replace the ring at that time than take a chance of having to tear the motor down for a second repair.

If you have difficulty in lining up the rings in the cylinder bore, to test for the slot clearance, use the piston to keep them straight. In other words, after letting the piston down into the cylinder, enter the ring and then push the piston up again so that it bears against the ring and lines it up. If the ring is slightly cocked in the bore, you cannot measure the slot clearance with any accuracy.

In measuring the clearance of rings which are assumed to be excessively worn, bear in mind that .001" wear on the cylinder bore equals .00314" increase in the circumference. Thus a ring originally fitted with a .006" clearance will have at least .012" when run in, because it will wear at least .002" before it is polished up thoroughly. Then, if the cylinder also wears, say .001", the ring will have a slot clearance of at least .015".

Clearly this is no defect which we can overcome except by careful fitting in the first place and subsequent use of plenty of good quality oil to help the ring and cylinder bore resist wear. Dirty oil occasioned by failure to clean the reservoir, excessive carbon deposit which is not removed in time, and inconsiderate use of a new motor, all tend to cause excessive wear in the rings and cylinder bore.

The direct result of such wear is loss of compression, smoking, excessive oil-carbon deposit and a generally unsatisfactory motor. These things can be overcome if instructions regarding the handling of a new car and attention to lubrication are rigidly adhered to.

In conclusion, we would warn you against experimenting with numerous so-called "leak-proof" types of piston rings which are extensively advertised. Such rings are invariably installed in worn or "run in" cylinders and this alone gives them their reputation.

If installed in new cylinders, they would be subject to the same amount of wear as the conventional type of ring and their efficiency would be impaired to the same degree. The conventional type of ring installed with the necessary care, will be just as effective as the freak rings; perhaps more so. The more the cylinder is polished up the better the chance of getting the simple conventional type of ring to perform its function satisfactorily and with the minimum amount of resultant wear.

As a final warning, we again urge you not to guess at matters involving thousandths of an inch. Have a good feeler-gauge at hand for this kind of work and have plenty of light to work with.

A little care expended in working to a few thousands of an inch will often save many dollars in the repair shop.

Caution

As there is a possible variation of four ounces between the high and low limits in the weight of Super-Six pistons, it is absolutely essential that you specify the weight stamped on the head of each individual piston when ordering any for replacement.

Watch any piston repairs closely and always replace a piston with one of the same weight, as the inevitable result of installing them without regard to weight will be a badly balanced motor.

General Motor Adjustments

Test all motor bolts. In order to preserve the alignment of the power plant with other units, especially the radiator and gear shifting mechanisms which project through or are attached to other portions of the car, it is essential that all motor bolts be in place. On the Super Six, the front motor bolts are cushioned underneath with a heavy spring so as to permit of a certain amount of weaving in the chassis without any tendency to strain the motor alignment in the wrong direction.

On the 1915 model cars, there is a semi-three-point suspension which permits of rigid attachment. On this model, it is particularly necessary that all bolts be tested to see that they are tight, as any looseness tends to destroy the alignment.

On the Super Six it is only necessary to test the tightness of the rear motor bolts. This is but the work of a few moments when suitable wrenches are used.

Bolts which are left in a loosened condition permit of a great deal of hammering and pounding between the motor support and its bracket on the frame. This, in time, tends to crystallize the metal and breakage results.

Fan Belt Tension and Fan Bearings

Most important in the functioning of the cooling fan is the fan belt tension. If this is allowed to become too slack, there is considerable slippage which results in insufficient air being drawn through the radiator and over-heating will occur. On the other hand, if the fan belt is too tight, as may be the case if a new belt has been fitted, the forced stretching of the belt causes a certain amount of destruction and tends to breakage, and the excessive pressure on the bearings in the fan hub will eventually ruin them.

The tension of the belt should be such that the fan can be easily revolved when taken by the rim and pulled around with two fingers. The belt itself should slip over the pulley on the crank shaft when grasped with the hand and pulled. If it is impossible to pull the belt in this manner, it should be loosened by lowering the bracket to which the fan is attached. This is done by merely revolving it around the stud on the cylinder block and bringing it closer to the crank shaft.

The fan bearings are of the cup and cone type and are secured by a lock nut. Any looseness of the bearings which may have been caused by a tight belt should be immediately adjusted, with instructions to the owner to watch the fan carefully and note if the bearings have been damaged. Upon the first signs of further loosening up, the bearings should be removed and examined. They should then be set up so that the fan will spin easily, having only enough play to permit it being felt when the fan is rocked by hand. If the bearings are set up too tightly, they will crush and cause destruction. This will cause a noisy fan which may later result in the owner attributing the noise to the motor itself, thereby incurring experimental expense in trying to diagnose the trouble through incompetent hands.

Generator Clutch Alignment

When running the motor, observe that the generator pump shaft runs true and that there is no tendency to chatter at the point where it enters the front end of the generator. Any looseness at this point, if great enough to allow any chatter, will result in excessive wear on the coupling parts.

If the pump shaft runs true and misalignment is due to the front end of the generator being over to one side, the generator bolts should be loosened and the generator re-aligned.

If the pump shaft runs eccentric, the coupling should be removed and straightened.

It is possible that the pump shaft itself has been bent through removal of the taper pin without properly blocking up the shaft underneath to take the force of the hammer blows. In this case, it will be necessary to remove the pump shaft and straighten it. Straightening either the shaft or coupling requires considerable skill and lathe work.

The generator bolts should be tested to make sure that they are tight.

If there has been any tendency to misalignment it will already have been necessary to loosen the bolts and re-align the generator. However, if the coupling is apparently running true and the generator properly lined up, the bolts should merely be tested to insure against loosening in the future.

In order to re-align the generator it is necessary to remove the cap screws, then, with a large screw driver, set up or back down on the stud upon which the generator rests. The rear end of the generator is piloted in the crank case and cannot possibly get out of alignment. A slight amount of adjustment is necessary to line up the front end and by the simple method above outlined it can be accomplished by a novice in a very short time. Tightening the cap screws which pass through the center of the supporting studs clamps the generator securely into place.

A generator which is allowed to continue loose upon its base will ultimately cause considerable damage to the starter gears and clutch.

In the case of the former, the gears get out of line and wear to a point where they cannot resist the strain imposed upon them when cranking the motor. The teeth shear off, perhaps damaging the fly wheel and making a very expensive repair.

Starter Adjustment

The mechanism which brings the starting gears into mesh and is also used for actuating the motor switch, is provided with an adjustment. Should this loosen up, the correct alignment between the meshing of the gears and switching on of the current cannot be maintained.

The gears which mesh with the small pinion on the armature should come in contact before the rod is withdrawn sufficiently to allow the motor brush to drop on the commutator and before the pinion meshes with the fly wheel teeth. If this adjustment has been disturbed, through removal of the transmission or gear shift mechanism, it should be readjusted.

Barring accidents or repairs of this nature, there is little possibility of the adjustment becoming disarranged.

On the 1914, '15 and '16 models, the construction is slightly different. There are two flanged nuts upon the plunger which actuates the motor brush. The fork which shifts the gears has a projecting arm which fits in between the flanged nuts, thus transmitting the action from the pull rod and brush plunger to the gear shifter fork. If these nuts become loosened, they tend to back away from one another, allowing more action of the plunger rod before the gears are moved. In this way it is possible for the motor brush to drop upon the commutator before the gears mesh. This makes it practically impossible to mesh the small pinion with the gear teeth on the fly wheel.

If the plunger is backed out too far, it will be possible to mesh the gears and engage the pinion with the fly wheel before the motor brush drops. In an extremely bad case it would then be possible to get the gears into mesh without dropping the motor brush at all. The adjustment is apparent as soon as the housing on the rear crank case is removed.

It is therefore essential that this be tested to see that there has been no tendency to loosen. If such adjustments were neglected, it is quite possible that the owner would be totally unable to engage the gears and crank the motor without the assistance of an experienced mechanic.

General Condition of Motor

Such troubles as faulty ignition, failure to start easily, irregularities in running, or a tendency to overheat invariably have their remedies in some accessory or fitting other than the motor proper.

Thorough inspection and the necessary attention to adjustments insure the proper functioning of the apparatus which aids the motor in its work. But the motor itself permits of little adjustment except for grinding valves and setting tappets.

When a motor is damaged, it invariably calls for repair which necessitates the replacement of parts.

But there is another frequent cause for motor repair work. This is "noise."

As sounds cannot be measured except by the human ear and the nervous system, our judgment as to what constitutes a noisy motor, transmission, or rear axle, is of a very variable nature. Few owners are so unreasonable as to expect their automobiles to run "absolutely" silent. Occasionally we meet people who believe a car can be so built. But, if we stop to analyze the problem carefully, we must realize that there is no piece of mechanism, not even the common sewing machine, which does not make a noise when it is laboring!

One owner will consider his car smooth and quiet while another would be dissatisfied with the standard of silence set by the same car.

Considering a motor, therefore, we must be governed by averages rather than individual demands. Owners must co-operate with our dealers to the extent of respecting their knowledge of the average working conditions that govern the noises in a Hudson car.

It is dangerous to aim at extreme silence. In some instances, it would necessitate a total elimination of clearance in the bearings. The oiling system and every other condition would have to be PERFECT both as to lubricant and operation. If speed were exceeded in the slightest degree there would be danger of the bearings burning out.

But, when a bearing is fitted to the correct clearance for practical use and lubricated with a good grade of oil, it has a high safety factor and will stand a great amount of abuse without detrimental results.

For this reason, a car which is run a few thousand miles under careful supervision and the best of attention is in better condition than a new car. Furthermore, it will do better work and stand more abuse than a new car. The dangers of seized up bearings and insufficient lubrication are minimized.

Bearing surfaces have become polished and worn in to perfect alignment. It therefore operates more smoothly and with less friction. Yet such a car may make a little more noise than a new car.

Obviously, the Hudson dealer's organization is the more experienced in such matters and is better able to judge from the standpoint of averages.

Motor knocks do not come from ordinary wear and tear. They represent excessive friction at some point or undue looseness in a bearing. Friction may be caused by lack of oil, poor adjustment of the bearings or overheating. The results of such negligence are lasting and manifest themselves in scored cylinders, loose connecting rods, worn timing gears, and worn main shaft bearings.

In detecting a noise in the motor which has the character of a pound or knock, and which is obviously attributed to the working stroke of some one particular cylinder, should be investigated.

You should attempt to discover the cause of the sound no matter what the result of the investigation may be.

Scored cylinders are caused by lack of water which permits of overheating of the cylinder wall, burning up the oil and destroying all lubricant. The resulting friction causes the cast iron cylinder to score, for it cannot run without oil. Worn (and sometimes scored) cylinders are caused by failure to supply the motor with fresh oil periodically. The dirty oil allowed to remain in the reservoir has practically no lubricating qualities and if the motor be subjected to more than the average amount of work, the extra load will cause it to overheat and seize up, due to nothing more than faulty lubrication. THE QUALITY OF THE OIL IS OF GREAT IMPORTANCE.

In some sections of the country where long stretches of dusty roads are encountered, the air drawn in at the carburetor contains a quantity of dust. This is of an abrasive nature and will tend to wear the cylinders and pistons very much more quickly than in a car used in a section where good, oiled, dustless roads prevail. In a dusty section, the flushing out of the oil reservoir and the filling of new oil is of far more importance than in a section where traveling is clean.

Worn timing gears and bearings are the result of dirty and insufficient oil.

Therefore, if a knock is discovered on inspection day, the conditions which cause that knock must be carefully investigated before deciding the responsibility for the trouble.

Owners are requested to bear in mind our remarks in regard to the measurement of noise. Everything in an automobile which revolves, reciprocates, or does any work whatever has a tendency to emit sound. Irrespective of what your own ideas on the subject may be, we ask you to seek the advice of the local Hudson dealer before attempting to make any changes.

Spark Plugs

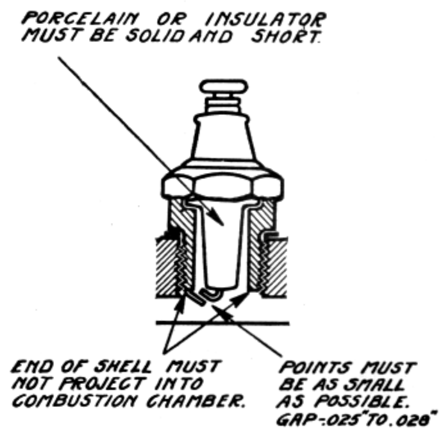
There are so many different types of spark plugs on the market, and the construction of the electrodes, porcelains, etc., is so widely at variance with the type of plug which we have found desirable, that we feel it essential to notify all our dealers and owners on the subject.

The Hudson motors are of the high compression, high speed type and the combustion chamber is comparatively small. On this account, it is absolutely essential that the electrodes be quite short and of the material or size necessary to prevent their becoming red-hot and causing pre-ignition. Plugs with a closed end, or shell, which extends down into the combustion chamber, will be sure to cause pre-ignition. The same is true of plugs which have several electrodes, or one central electrode of very thick section. On this latter type of plug, the porcelain is usually hollow and generally known as the "petticoat" type. On account of the great heat to which these poreclains are subjected, breakage is quite frequent, and the length of the electrode in such a plug is certain to cause pre-ignition.

Another disadvantage of the long electrode is that they distort or warp under high temperatures and vary the spark gap from the correct setting.

The plugs which are fitted at the factory are of a type calculated to give the maximum amount of satisfaction and we are positive that they will not cause pre-ignition under any conditions.

We do not insist that the particular type of plug which we use be carried by our dealers or used by owners but we recommend that they consider our judgment in the selection of a plug before purchasing. Any type of plug which has a short, solid porcelain and small, short electrodes, will be satis-



factory, provided the shell does not project down into the combustion chamber farther than the standard plug we supply. Such a plug must be gas-tight, and preferably without joints or packing.

The correct gap for the standard spark plug on the Hudson motor is from .025" to .028".

The symptoms of pre-ignition are: Back firing in the carburetor and missing under a heavy pull, especially on long hills where the constant load has a tendency to heat the motor above normal temperatures.

If the electrodes are being warped out of place by this heat, the missing will continue. After an experience of this kind, it will be necessary to remove the spark plugs and reset them. This will be only a temporary relief for they will develop the same trouble the next time they are subjected to a long pull or a slight overheating. The remedy is, use the correct type of plug.

Owners will do much towards facilitating the work of mechanics if they will advise them of any symptoms of the above nature having evidenced themselves in driving their cars under the conditions outlined.

Plugs which have seen a season's service may become oxidized at the electrodes to such an extent as to cause the motor to miss when pulling hard. This can be eliminated by cleaning the electrodes with emery cloth.

Clutch

For the past seven seasons' models, the Hudson Company has retained the same design of clutch. It gives so little trouble that few have seen the inside of one.

The principle upon which it operates is the most simple one conceivable, based on the theory that there is a great deal of friction between cork and steel, but that the former element is extremely soft. In consequence the Hudson clutch is very smooth in action, but once engaged, it seldom slips.

The Care of the Clutch

Renewing the oil and lubricating the clutch throwout collar are practically the only attentions necessary from the owner.

The clutch adjustment should be examined periodically, preferably by the dealer's mechanics.

The fact that the cork inserts become saturated with oil makes it comparatively difficult to abuse this clutch as compared with other types. However, its action will be affected if our instructions in regard to the quality and quantity of lubricant are not strictly adhered to.

Never put more than half a pint of mixture in at one time. Always drain the clutch to remove the used oil before filling in any fresh oil.

Do not try to experiment with the mixture. Half kerosene and half good motor oil is best.

Do not slip the clutch except when absolutely necessary and then only when you know it has sufficient lubrication to stand it. If you feel that you must do so, owing to lack of confidence in your ability to handle the car through congested traffic, remember that the lubrication of the throwout collar will need more frequent attention.

The Discs

The driving discs, which are secured in the flywheel by four specially heat-treated studs, are stampings, carefully flattened and machined so as to slide freely on the studs. The driven discs are also stampings but are thicker and have numerous holes in them; into these holes the cork inserts are pressed.

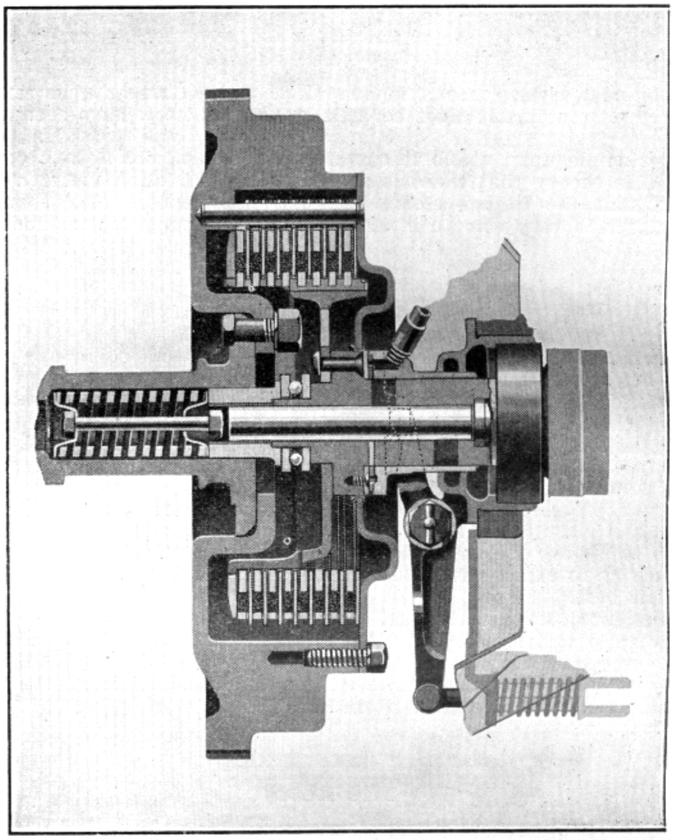
The corks are first soaked in warm water to make them pliable, then they are forced into the holes by a special machine. A considerable amount of cork is left projecting on either side of the disc and this is shaved off to leave about 1/32" after the corks have thoroughly dried out, then the corks are ground flat on a surface grinder.

In making a replacement of corks in a repair shop not properly equipped, the surfacing of the corks is usually accomplished by rubbing the disc on a piece of sand paper. The result is seldom satisfactory, as the corks are not flat and even, and do not give the full bearing surface which is necessary in order to have the friction to hold the power of the engine.

It is absolutely necessary that the corks be perfectly dry and show a full bearing surface. This latter point can only be ascertained by rubbing them flat on a surface that has been covered with Prussian blue or lamp black, using only a very thin coating. The greater the bearing surface obtained, the longer the corks will wear and the lesser the spring tension necessary.

The spring tension can be varied to suit the necessity by putting shims, about the size of a fifty-cent piece, at the back of the spring. This compresses it more, making it shorter when the clutch is engaged.

The cork insert discs drive the clutch drum on which they slide and this sliding, or separating motion is facilitated and equalized by small coil springs interposed between the driving discs.

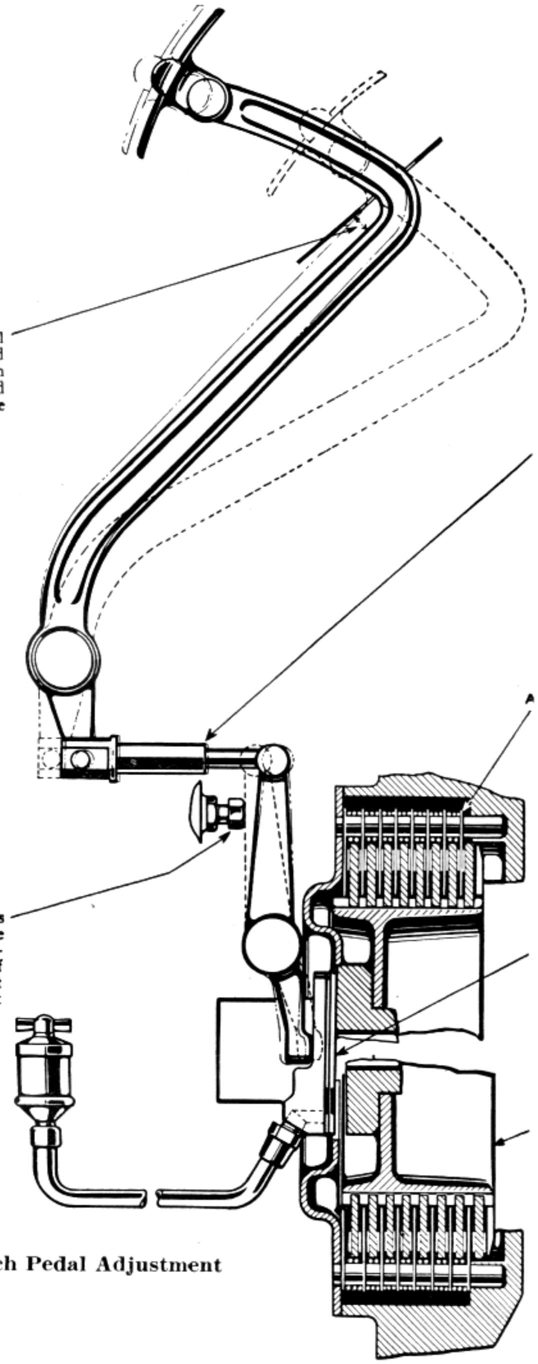


Sectional View of Clutch

Clutch Adjustments

The clutch pedal assembly should be adjusted so that when the clutch is engaged, the pedal is not striking the back of the toe plate. There should be a clearance of ⅜" between the underside of the toe plate and the clutch pedal; this for the reason that after the clutch is run in some what, it naturally settles and packs together more closely. Coincident with this wearing in of the clutch, the throwout collar moves out, and this action, through the adjustment of the clutch throwout fork, moves the clutch pedal farther back through the hole in the toe plate. If there is not proper clearance to allow for this movement, the clutch throwout fork will have constant pressure on the clutch collar and the increased friction will burn out the lubricant and destroy the thrust bearing. It is then in practically the same condition as would prevail were you to keep a constant pressure on the clutch pedal with your foot.

The drag caused by the lack of lubricant or the roughened surfaces of the thrust bearing, stops the clutch spinning the moment it is released. This makes it practically impossible for the driver to shift from one gear to another. The drag on the clutch is like a brake, and the resulting pressures on the gear teeth make it very difficult to shift the gears out of mesh in just the same manner that it is difficult to shift gears out of mesh when the motor is driving the car through them.



Clutch Pedal Adjustment

When you find the clutch pedal and clutch throwout fork in perfect adjustment and no indication that the clutch collar has been burned or worn to excess, but the clutch still fails to properly release or "free" itself, it indicates that the adjustment of the clutch itself is such that the full throw does not allow a complete release of all the plates. This can be overcome by inserting a 3/32" washer on each driving stud at point "A" in the diagram. This washer has the effect of more thoroughly separating all the plates from one another at an earlier period in the action of throwing the plates forward, thus causing them to release earlier.

Needless to say, the question of lubricating the clutch collar is of sufficient importance to be included in the foregoing. All owners should be instructed that the grease cup leading to this collar must be turned down at least every 100 miles, and should be warned of the result if this is not done.

Conditions Governing the Clutch

The thrust of throwing out the clutch is taken on a bronze washer which fits into a recess in the face of the sleeve. It is highly important that this washer be sufficiently lubricated at all times or it will burn out. Other reasons for the shortened life of these washers are as follows:

1. The spring which keeps the pedal from coming back farther than is necessary may be adjusted to too great a tension, thus putting a constant thrust on the washer.
2. The driver may have a habit of driving with his foot resting quite heavily on the pedal. This is unnecessary.
3. The pedal may be improperly adjusted so that it is touching the toe plate. The result is the same except that in a case of this kind the clutch will probably slip so badly as to be noticeable.
4. The grease cup lubricating the pivot pin of the throwout fork may be empty and the fork seized up so that it will not move freely.
5. There is a stop provided for the purpose of limiting the amount of throw given. Since the corks wear slightly with use, and since too much throw is unnecessary, this adjustment should be examined occasionally and always in the event of any repairs occasioning the dismantling of the transmission or pedals.

The adjustment is simple to determine. Whenever you find the the transmission gears stop and the gears can be engaged without the pedal being thrown all the way out, the adjustment needs attention and should be screwed out to meet the sleeve lever until it stops its travel at the correct moment. Too much throw means more effort to release the clutch and often makes the clutch noisy when disengaged.

The two most important instructions are: Don't slip your clutch more than is absolutely necessary, and then only when you **know** it has sufficient lubricant to stand it. Don't drive with your foot resting heavily on the pedal. If you **must** do so owing to congested traffic or natural nervousness, remember that the throwout sleeve will need more frequent attention.

Turn Down the Clutch Collar Grease Cup Every Day

The lubrication of the clutch throwout collar has been facilitated by providing a grease cup connection above the floor boards. This cup may be filled and screwed down without getting out of the driver's seat.

Assembling the Clutch

In assembling the clutch great care must be exercised or these little springs will slip out of place and, becoming jammed between the moving parts of the clutch, will cause it to drag instead of releasing properly. Usually the noise made by the interference will indicate that something is wrong.

Another important feature is to see that the driven disc nearest the cover, at the back or transmission end of the clutch, does not slip out of the slots in the drum; this will cause a loud scraping sound when the clutch is released.

In assembling a clutch ready for inserting in the flywheel the following method is recommended:

1. Put the clutch drum on the bench and drop the disc on; a cork-insert disc first and then a plain disc. The discs should be selected so that they slide freely in the grooves of the drum and with the minimum amount of back lash.
2. After all the discs have been fitted in this manner, take the clutch cover and slip the studs through the holes in the driving discs, placing the separating springs one at a time.
3. This accomplished, and with the spring, the ball thrust bearing and the shims in place in the crank shaft, the clutch cover can be slipped into place.
4. By means of a lever looped into a wire on the motor foot and bearing against the driving jaws of the clutch, the whole clutch assembly can now be forced into place against the pressure of the spring very easily. When it has been entered sufficiently to allow of two cover bolts being started into place, the pressure of the lever may be released.
5. The cover should then be secured, care being taken to screw up the bolts evenly so that the tension on them will be the same all around. Unless this is carefully accomplished, the cover will be strained and the lubricant will leak out.

Making the Clutch Oil Tight

The gasket between the cover and the flywheel should be in good condition and shellacked on to the cover; it should be allowed to set for a while before using so that the shellac is "tacky" and will hold the gasket securely to the cover during the assembling operation. It is advisable to wind a little wicking around the heads of the bolts before screwing them down, to prevent leakage.

The assembling and rendering oil-tight of the clutch is greatly facilitated by the driving studs being riveted into the cover. In this way there are no packed joints in the flywheel except the cover and the screws which secure it.

Also, the cover and clutch can be assembled as a unit with no possibility of the discs slipping out of place by the simple expedient of clamping the jaws at the point where they project through the cover.

As a hint to the man who ever has to do this job, the bronze throwout sleeve may be utilized as a clamp temporarily, by wrapping some paper or thin shim metal around the jaws and then pressing the sleeve over it. There should be just enough shimming to make the sleeve a tight fit, but not so much that the sleeve will be distorted or otherwise damaged in removing it.

Transmission

Except for the use of higher grade materials and improved heat treatment, the transmission remains the same as in previous models. The roller bearings are extra large and provided with adjustment for end play. All bearings, including the thrust bearings, are provided with oil ducts to insure efficient lubrication.

The transmission has four speeds, three forward and one reverse. The gear ratios have been developed with a view to affording the maximum engine efficiency at those speeds which will be used for climbing hills.

On no account should heavy grease, cork compounds, or any other lubricant excepting those of a liquid nature be used in the transmission case.

Heavy lubricant holds chips and dirt in suspension and circulates it through the bearings and between the teeth of the gears when in action. It blocks oil returns and totally fails to pass through the oil holes which circulate lubricants to the thrust bearings. Use a light grade of oil, even ordinary motor oil if none other is obtainable. We strongly recommend that you follow the suggestions of our Lubricating Charts, using Whitmore No. 7, as this is undoubtedly the best type of lubricant for the transmission.

The transmission should be drained off periodically. With most common greases, it is advisable to throw the lubricant away. But if Whitmore Compound is used, it may be strained through cheese cloth and used again, as it does not deteriorate like ordinary oils. The main thing, however, is to remove all dirt and sediment, so that it may not be circulated through the bearings and between the gear teeth.

After having drained the transmission for cleaning purposes, it is a good plan to fill in about a quart of kerosene. This should be done with the motor running slowly and the drain plug out, so that the kerosene will flush its way through. This washes out a great deal of sediment which would ordinarily adhere to the walls of the transmission case, thereby rendering the straining of the lubricant and other precautionary measures less effective.

As soon as all the kerosene flows out of the transmission, replace the drain plug and refill the case with new oil. If it is impossible to obtain Whitmore Compound as recommended, use 600 W. Steam Cylinder Oil.

Transmission Adjustments

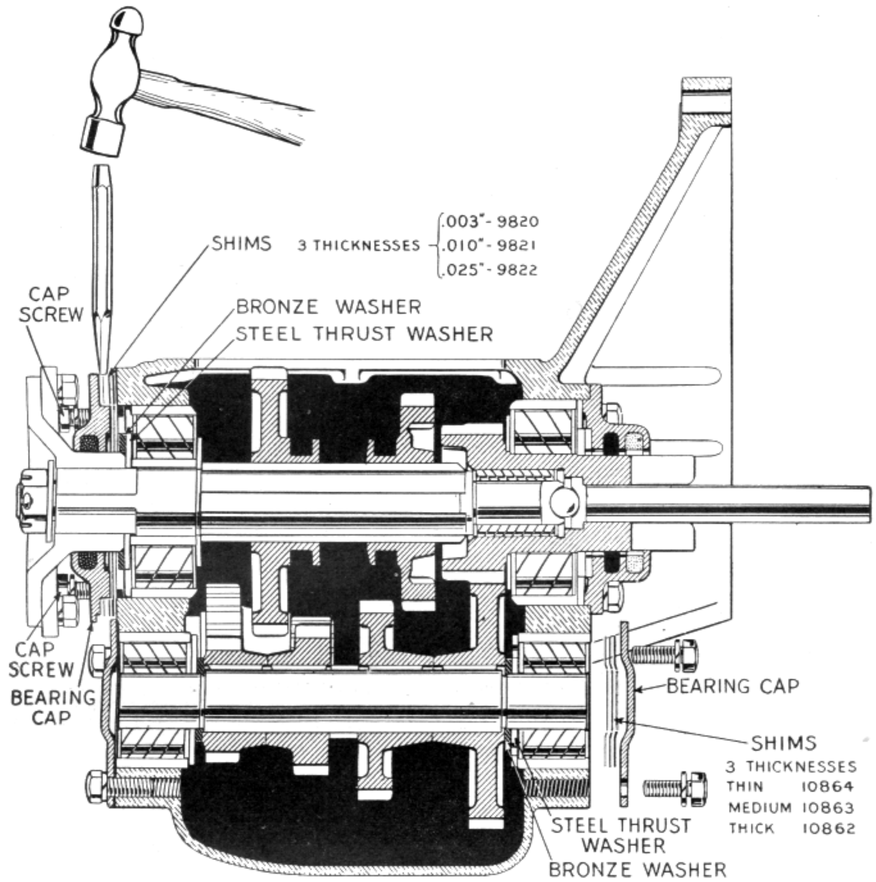
This subject deals with the details of the transmission adjustments in the 1915 Six-40, 1916 Six-40 and Super-Six models. The reasons for wear and general principles may be applied to all other models as this particular type of transmission has been in use for many seasons, with only a few minor changes.

At one time it was not difficult to find automobile dealers and purchasers who believed that a new car, as received from the factory, should show no wear whatever, nor should there be any cause for adjustment during its first year of service. We look at this with a broader viewpoint now, as does also the automobile buying public, and it is generally conceded that in view of the service a modern automobile performs, the periodical inspection of adjustments is necessary.

This reasoning has for its basis two points. First, the modern automobile has many accessible and useful adjustments built into it, thus insuring its being maintained in the pink of condition when given slight attention at more or less competent hands. Secondly, everybody has come to appreciate that all wear is in proportion to the work done. Therefore, those parts which do the most work will wear the most rapidly. Brakes, clutches, wheel bearings, gears, and transmission and rear axle bearings, together with the spring bolts and those parts of the chassis which are exposed to the elements, come in for the hardest share of the work.

Perhaps the first in importance is the main shaft end thrust adjustment. On account of the thrust from the propeller shaft, generally due to the sliding motion in the forward joint, there is a varied pressure on the rear thrust bearing. When the car is tested at the factory, the end play at the forward joint is inspected and an allowance of .007″ maximum and .004″ minimum is made. A small amount of play is absolutely essential in order to insure a film of oil between the bronze and steel washers, hence the minimum allowance of .004″ end play. The surfaces of these thrust washers, however, soon wear in with the result that the first five to seven hundred miles of running will develop more end play. The actual amount of wear will vary according to the accuracy with which these washers have been ground and seated.

Removal of these shims is a simple matter, it being only necessary to back out the cap screws, slip the retainer back as far as it will go, and then, by means of a sharp chisel (as shown in the diagram) split the shim which is to be removed. If there are no thin shims to remove, and the removal of one of the thicker ones results in a permanent pressure on the thrust bearings through the tightening up of the cap screws on the rear bearing retainer, some thinner ones must be introduced to take its place. For instance, if the thinnest shim is .025″ in thickness and it is required to take out at least .003″, it will be necessary to remove the .025″ shim and in place of it put seven .003″ shims.



In no case should a thick shim be removed without replacing it with a sufficient quantity of thin ones to insure the right amount of end play for lubrication. If thick shims are removed and the cap screws on the bearing retainer drawn up tight until the thrust washers bear against one another with no clearance, it will only take a short time for the bronze washer to overheat and burn out. This will develop an end play far in excess of that caused by normal wear and tear.

If end play in the main shaft is allowed to remain without adjustment, the back and forth movement of the main—or spline—shaft will work the faces of the gear teeth back and forth upon one another so as to cause excessive wear. This is especially true when the car is climbing grades in first and second speeds, particularly the latter. The pounding action increases the tendency to wear the thrust washers and it is only a matter of a few hundred miles before the shucking back and forth of the main shaft will be appreciable to the driver. As the main drive gear at the front end of the transmission is held in position endwise by the correct spacing of the end thrust bearing, it is obvious that an excessive amount of play in the main shaft will permit the front main drive shaft to move back and forth. When climbing a grade on second speed, or when accelerating sharply, the clutch pedal will chatter and the driver cannot help but notice it. This is a sure sign that the transmission rear thrust bearing is in immediate need of adjustment or is burned out through improper adjustment.

The excessive wear on the second speed gears soon changes the correct shape of the teeth and the second speed begins to fly out when climbing hills. This frequent slipping out of speed wears the gear teeth on an angle and sometimes damages the ball-stop or interlock plunger on the gear shifting rods. The only remedy is to replace the gears and properly adjust the end play of the main shaft. Strengthening the interlock spring will do no good as the gear teeth are worn on such an angle that the actual tendency of the power transmitted through the gears is to force them out of mesh.

The front thrust bearing of the main drive gear has no adjustment and it is seldom necessary to dismount it. It sometimes happens, however, that the oil return hole becomes clogged, this usually being due to the use of heavy greases or an unsuitable grade of liquid lubricant. The oil return hole is drilled through at an angle so that it enters the transmission case at the right hand lower side of the main drive gear, at a point where the gear teeth come out of mesh with the countershaft main drive gear. At this side, on account of the direction of rotation, there is a certain amount of suction which tends to draw the oil through the return drain. At the point where the drain passes under the outer Hyatt roller bearing shell, it is somewhat narrower in area, and obstructions are liable to occur at this point. Leakage of oil at the front bearing retainer will usually be found due to obstructions in the oil return and can only be eliminated by removing the obstructions so that there is a free passage for liquid lubricant to return to the case. Oil leakage at the rear bearing is usually caused by worn felt washer in the bearing retainers or by a worn bearing itself. When the bearing becomes worn, the shaft chatters and the hub of the universal joint upon which the felt washer bears, has a certain amount of eccentric motion imparted to it. This soon enlarges the hole in the felt washer and the oil leaks out. The only way to remedy this is to replace the rear bearing and felt washer, making sure that the hub of the universal joint is smooth and has not become roughened up or cut through contact with the retainer. In the latter case, the roughened hub would cut away the new felt washer and the leak would soon occur again.

The adjustments of the countershaft bearings are seldom necessary, as there is no tendency to back and forth motion on this shaft except when running in second speed or in case of worn gears. The transmission which has seen a great deal of service may often be quieted by adjustment of the thrust bearings, thus eliminating the slight chatter present without having recourse to the replacement of gears. However, in many instances, the gears are replaced without properly adjusting the countershaft thrust bearings, with the result that very little good is done and the much-looked-for increase in silence is not gained.

In adjusting these bearings, it is absolutely essential that the adjustment be made at the front bearing, not the rear. In this way the shaft is adjusted towards the rear, the main drive countershaft gear being brought away from all possible contact with the bearing protector or washer which is pressed on to the main drive gear ahead of the bearing roller. It is obvious that if the adjustment were made from the rear, the countershaft might be moved forward so as to cause an interference between the edges of the countershaft main drive gear and the bearing. This would make an objectionable noise and might result in considerable damage through chips, etc., getting into the lubricant and finding their way into the bearings.

The method of adjustment is extremely simple, it only being necessary to introduce shims as shown in the diagram. These shims bear against the outer races of the Hyatt bearing and force it inward as soon as the bearing cap is tightened up. Since the steel thrust washers are supported by the outer races of the roller bearings, these, too, must move inward, thereby taking up the end play. It is essential that there is end play of at least .004" to .007" in this shaft, in fact, an end play of even .012" will do no harm whatever and will cause no appreciable rattle. As in the case of the main shaft, it is highly important that no permanent pressure be imposed upon the thrust bearings through tightening up the cap with too many shims in place, as this would burn the bearing out and cause a great deal of end play in a very short time.

In the illustration shown, the thickness of the shims and symbol numbers are given. In order to get the full advantage of this adjustment on monthly inspections, the dealer should have a good stock of such shims at all times, as there is no knowing when their installation may be necessary. They are extremely cheap, but that is no reason why the split ones should be thrown away, as they may be used again after flattening.

Another point to observe closely in connection with transmission adjustment and repair is the removal of the transmission on the Small Six, and Super-Six motors, which should be done as follows:

Remove the bolts and cap screws on either side, first, leaving the extreme top bolt tightened up in position. This supports the entire weight of the transmission and allows no straining of the pilot shaft or main drive gear. As a last operation, remove the nut from the long bolt at the top and when you have obtained sufficient help to insure your being able to withdraw the transmission in a perfectly straight line and with no bending or crimping whatever, pull it off slowly. Leave the bolt in place to pilot the transmission shaft during removal.

If this method is not followed out, a bent or strained pilot shaft will result and when the transmission is put together again there will be an eccentric, growling noise from the main drive gear. This is because the main drive gear is not in line with the clutch and there will be no remedy except taking out the main drive gear and straightening or re-fitting the pilot shaft.

On those models which involve a Bower roller bearing instead of the Hyatt type, the adjustment is accomplished in exactly the same manner; instead of plain thrust bearings, the flanges of the rollers take the thrust and if too many shims are removed so as to impose a permanent end thrust on these flanges, they will invariably crumble up and the chips and steel crumblings will ruin the bearings, necessitating replacement. The same results will be found due to excessive end play which permits the propeller shaft to hammer or pound. The flanges of the rollers will not withstand this pounding action for any length of time without damage to them.

In the foregoing paragraphs, the reference to the slipping out of second speed and other transmission troubles are all applicable to the earlier model transmissions without exception, as are also the instructions regarding the removal of the transmission in a careful manner. In the case of those transmissions which are attached by means of two side arms, it will be necessary to put a jack under the transmission or block it up in some way that will insure the mechanic not having to take the entire weight. Any system of blocking or jacking up which will insure the transmission being removed in a perfectly straight line backward from the motor, will be satisfactory. It is not as easy to handle these transmissions in this manner as those of the later type, but it is just as essential that the necessary precautions be taken.

Note

Thousandths parts of an inch are expressed thus: .006". This may also be written 6/1000ths inch.

The average calling card thickness is .010" or 10/1000ths of an inch.

A worn dime is about .030" or 30/1000ths of an inch.

A sheet of newspaper is about .002" or 2/1000ths. The paper on which this article is printed averages .004" or 4/1000ths.

Universal Joints and Propeller Shaft

The propeller shaft, which transmits the power from the transmission to the rear axle is of the hollow, tubular type, and has enclosed dust tight joints at either end. The light weight of the tubular shaft minimizes the wear on the propeller shaft joints and axle housing by decreasing the strains resulting from centrifugal action. In this way, it differs from the solid type of shaft as there is no tendency to whip.

The Universal Joints depend upon their dust covers to retain the necessary amount of lubricant. As these covers are of necessity removable for assembling purposes, it is possible they may have become loose in service. It is therefore necessary to inspect them with a view to tightening them up or re-filling with grease as occasion requires.

If the covers are allowed to remain loose, not only will the grease be lost but a certain amount of dirt will work into the Universal Joint. All dirt causes abrasive action when mixed with grease. The resulting wear will be out of all proportion to the wear in ordinary service.

The covers are fitted with a felt ring which is compressed into a channel at the outer edge or largest diameter of the dust cover shell. On cars which have seen a great deal of service or on which the tightening up of covers has been neglected, this felt may be worn. If such be the case, tightening of the dust cover will cause friction, possibly cutting the outer shell of the joint. The remedy is obviously to replace the covers, or, if the damage is not too great, to replace the felt packing.

Every thousand miles, refill the Universal Joints with a good quality soft grease. By removing the pipe plug a grease gun may be used conveniently. Be sure to replace the plug after filling the universal joint.

Rear Axle

The rear axle is of semi-floating construction with pressed steel housing and spiral bevel gears. Except for modifications and improvements in the adjusting mechanism, it is identical with the axle used on previous models. A larger section drive shaft and better grade materials insure the higher factor of safety required to transmit the power of the new type motor.

Lubrication

Whitmore Compound No. 45 is used to fill the rear axle housing, 5½ pounds being the quantity required. Filling the housing too full will cause the grease to work out at the rear wheels and front end of the pinion shaft. When this occurs, it will be necessary to lower the level, clean out the case, remove grease from shafts, and renew the felt washers located at the above mentioned places. Unless this is done, the grease will come out even though the level is lowered, due to capillary attraction.

The lubricant in the rear axle should be looked after every 2,000 miles. Clean out occasionally, and refill with the same oil after it has been strained, (if Whitmore Compound has been used) then add new oil if necessary to obtain the desired quantity.

Grease cups are provided (shown at "D" in rear axle illustration) just inside the brake supports. These lubricate the rear wheel bearings.

The grease cup on the pinion housing is intended to lubricate the pinion bearings.

These grease cups should be filled frequently with Whitmore Anti-Friction No. 5 Grease.

Adjustment of Wheels

Through usage, the wheel bearings or drive shaft bearings, shown at "B" in rear axle illustration, are subject to a certain amount of natural wear which in turn allows end play to develop in the drive shafts.

As the wheels are rigidly fastened to the drive shafts by being pulled up on a taper on the shafts, the bearing wear will cause side play in the wheels, which can be taken up in the following manner after the wheels have been removed. For this operation, we provide a special puller included in the tool kit.

"A" in rear axle illustration is the adjusting nut for the bearing "B," and "C" is the locking bolt for adjusting nut "A." After removing the locking bolt "C," tighten "A" by turning towards the right. A special wrench is furnished with the tool equipment for this purpose.

In making this adjustment, care should be taken not to take up all the play on one side. It should be equalized. The lining up of the brake drum and the axle housing on the opposite side to that on which the adjustment is being made, will indicate whether the wheel is out too far on that side.

Take up the adjusting nut so that the drive shafts show no end play but are perfectly free and the bearings do not bind.

Should it be impossible to lock the adjusting nuts "A" when the above results are obtained, back off rather than tighten so that the notches will line up in the adjusting nuts.

This adjustment does not affect the ring gear or drive gear in any way due to the fact that the drive shafts float through.

Adjustment of Gears

Before attempting to make any adjustments, remove the inspection plug at the left side of gear set and differential carrier. (See rear axle illustration.)

See that the back face of the teeth on both pinion and ring gear are flush. The pinion adjustment can be reached by first removing the pinion adjustment lock held in place by two bolts on the top of the carrier, as shown in the small cut in rear axle illustration.

End play in the pinion shaft should be taken up by turning the front bearing adjustment toward the left (when looking at the axle from the front end). This is the inner nut. The outer nut, which is for the rear bearing adjustment, should be held against movement during this operation. Take up the play between the bearings until there is no end motion, but do not bind or cause the shaft to turn hard. Line up the slots in both adjusting nuts, then turn both toward the right to bring the pinion deeper into mesh with the ring gear, or toward the left to withdraw. The proper amount of back lash between the teeth of the ring gear and pinion is from .006" to .008".

The grease cup on the pinion housing is intended to lubricate the pinion bearings. This should be filled frequently with Whitmore Anti-Friction No. 5 grease. It should always be examined when a pinion adjustment is made and an additional quantity of grease added at the adjustment opening.

If the pinion is flush with the ring gear and there is too much lash or too little, the ring gear may be adjusted either in or out to remedy this condition.

The adjustments should be made as follows:

Remove the differential cover plate in the rear of the axle housing.

Take off the differential bearing adjustment locks and back off slightly the bolts holding the bearing caps in place, so that the adjusting nut can be turned easily. Only loosen a very little as the threads in these caps will become cross threaded if the bolts are backed out too much.

To move the gear toward the right, back off the right hand adjusting nut one or two notches at a time and take up on the left hand nut the same number of notches, or, if the gear needs to go to the left, reverse the action.

Take side play out of the bearings by these adjusting nuts.

When the proper results have been obtained, tighten the bearing caps and see that the bearing adjusting nut locks are put in place.

Rear axle diagram see back of book.

Adjustment of Brakes

The internal or emergency brakes are of the expanding type, the brake band bearing against the inside of the drum on the rear wheels. These brakes are enclosed and it is therefore necessary to remove the wheel for any adjustment to the band itself.

For all ordinary purposes, the adjustment is made by shortening the rod "A." This brings the cam lever forward, thereby expanding the brakes. The wheels should spin freely without any signs of dragging. It is therefore essential that the rear of the car should be jacked up when making adjustments of the internal brake.

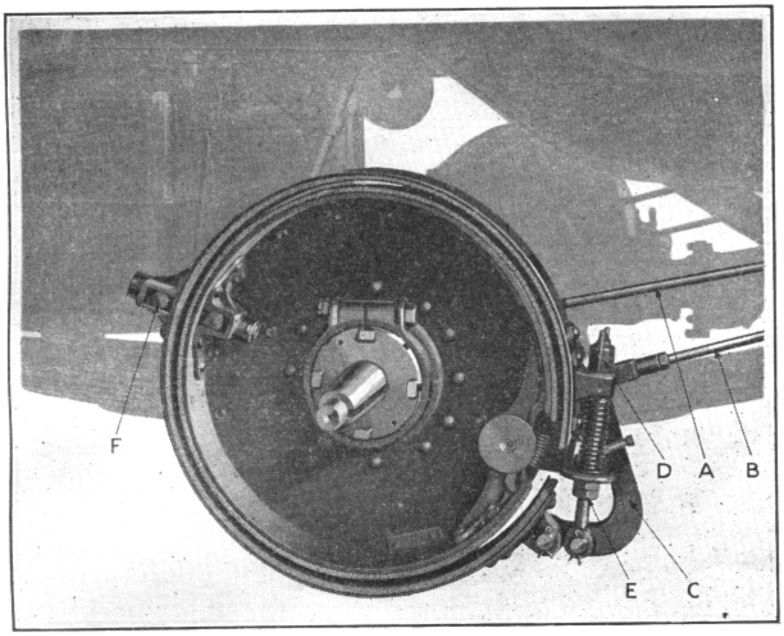
If the brake lining is worn out, proportionately more movement of the cam will be required before the brake will grip. This will give less advantageous leverage and should only be resorted to in an emergency. Since the internal brakes must be relied upon to hold the car on any grade and in any emergency, they must be relined as often as is necessary.

These brakes are not provided with equalizers in order to keep the leverage the same on both sides. Separate adjustments must be made for each brake and shortening of the rod "A" is the only correct method.

On no account attempt to strain or change the leverage and rod length between the hand brake lever and the cross shaft which actuates the pull rods connected to the axle.

Any adjustments under the floor boards can only be for correcting the leverage, should it have been tampered with. The ideal position for this leverage would be such that the levers are vertical at the time the brake is applied and the maximum pull exerted. For this reason, the leverage is set at the factory to the most advantageous position and should not be disturbed.

The external or foot brakes are of the contracting type and bear on the outer surface of the brake drums. On account of their receiving more wear and tear, they have been provided with more accessible adjusting mechanism.



Brake Adjustment

Provided the brake lining is not excessively worn, the method of procedure should always be as follows:

Remove the clevis pin which links the rod "B" to the lever "C." The lever "C" should then spring back and rest upon the bracket. Loosen the top adjusting nut "D" two turns. Now loosen the check nut at "E." This is the lower and smaller nut of the two.

By screwing up (turning from left to right in a clockwise direction) the adjusting nut, the lower portion of the brake band may be drawn closer to the brake drum. When this is drawn up so close that the thickness of a visiting card is all the clearance allowed between the brake lining and the drum the check nut "E" should be tightened so as to lock the adjustment of the lower half.

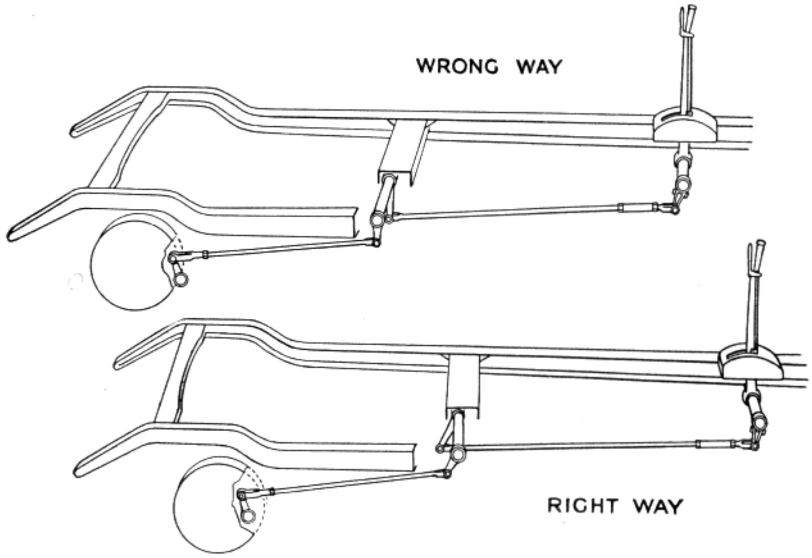
To adjust the top half, screw down on the nut "D" until it has the correct clearance.

Always set the lower half before adjusting the top half. Never attempt to adjust worn brakes without first disconnecting the clevis which connects the actuating rod to the brake lever.

If the brakes are very badly worn, the rear portion of the brake may stand farther away from the brake drum than the front portion. It will be necessary to bring this closer to the drum in order to make a good adjustment at the front end and this may be accomplished by removing cotter pin from adjustment screw at point "F" and turning the latter in as necessary. This will bring the brake band closer to the center of the axle, thereby centralizing it and giving a greater range of adjustment at the front end.

On account of the wearing qualities of the lining with which these brakes are equipped, such adjustments should not be necessary more than once in a season unless the car is subjected to very heavy duty. In this event, it will be more satisfactory to reline the brakes than to attempt to simply adjust the worn brake lining.

If the brake squeaks, it is an indication that it is dirty and needs cleaning, or that it is out of adjustment. In the former case, dirt clogs the pores in the surface of the lining and glazes it over. Kerosene applied with a stiff brush will remove this dirt.



If the brake squeaks, due to improper adjustment, it is because some portion of the brake has been allowed to do most of the work and as a result the lining is worn down to the rivets, which are probably bearing on the brake drum. This will always cause squeaking and can only be eliminated by relining and centralizing the brake band.

If the brakes are properly centralized and kept in such adjustment, the wear will be equalized over their entire surface.

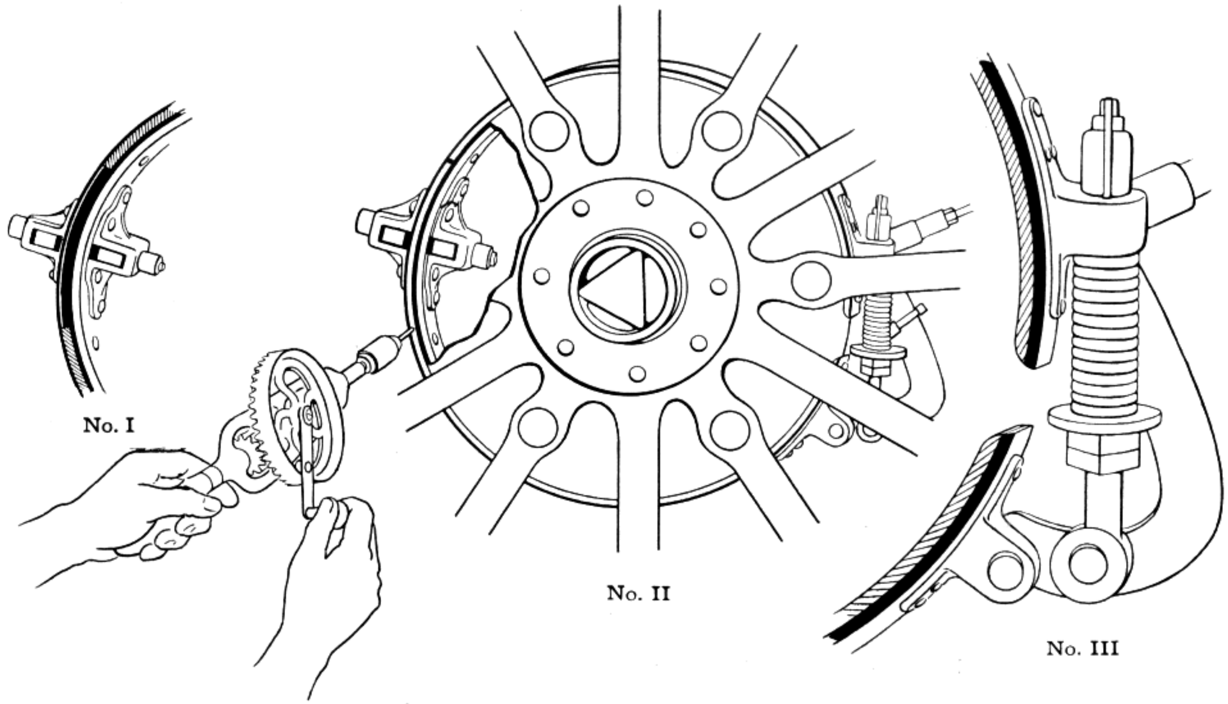
Squeaking Brakes

There are a number of things which have a tendency to cause brakes on any car to squeak. The average repair man is familiar with the ordinary method of realigning and adjusting the bands and cleaning the linings. In cases where the trouble refuses to yield to the ordinary treatment, we have found the following procedure to be extremely satisfactory and very convenient.

The foot brakes should be held in the down position so as to hold the brake band tight to the drum. By referring to the illustration, you will notice a method of removing a piece of the brake lining at the external rear anchor bracket, extending on either side of the bracket approximately two inches or to within one-half inch of the rivets. This is accomplished by inserting a ⅛″ drill between the brake drum and the brake band, drilling the lining through in the two places marked in illustration.

The ends of the brake band should be beveled in such a way that no sharp surface is brought against the brake drum. The illustration shows very clearly how this work should be done. Then when running at a moderate rate the brakes should be applied suddenly and tightly once or twice.

This operation is recommended where realigning and adjustment have failed to give satisfaction.



No. I Shows appearance of lining with piece removed.
No. II Shows method of inserting 1/8" drill.
No. III Indicates appearance of band ends after beveling.

Front Axle

The front axle, while of the conventional design, has been improved. The tie bar adjustment is of such construction that it cannot possibly loosen and disarrange the alignment of the front wheels. The tie bar bushings are of hardened steel and are fitted with grease cups.

The steering knuckles and arms have been strengthened to give added safety at a higher car speed than has been demanded heretofore.

Instructions for lubricating the front axle will be found on the lubricating chart.

Front Axle Adjustments

The adjustment for wear in the steering knuckles is accomplished by introducing shims between the top thrust washer and the axle fork. The king bolt is provided with a passage which conveys the lubricant to the upper bearing and the thrust washers. There is a second grease cup which lubricates the lower bearing. Whenever it is obtainable, we recommend Whitmore Anti-Friction No. 5 as the most desirable lubricant. This also applies to all other steering connections.

Timken bearings are used in the front wheels. The wheel hubs are of pressed steel construction and therefore extremely sturdy. The bearing retainers are for the purpose of confining the lubricant and are not disturbed by the removal of the wheel.

The wheel bearings should be adjusted by the nut so that a slight amount of play is noticeable when the wheel is shaken by grasping the tire. If the bearings are adjusted so that there is no play at all, it will be impossible for any lubricant to penetrate between the rollers and cones, and on account of the excessive pressures that may result from such adjustment, the life of the bearings will be decreased.

Since it is to be expected that any bearing will wear sooner or later, we would caution all against overlooking this important point of inspection. Too much play is almost as bad as a tight bearing but is more objectionable on account of the rattle it causes.

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 5/16" closer together than the rear, measured at the same height from the ground.

The easiest way to check this adjustment is as follows:

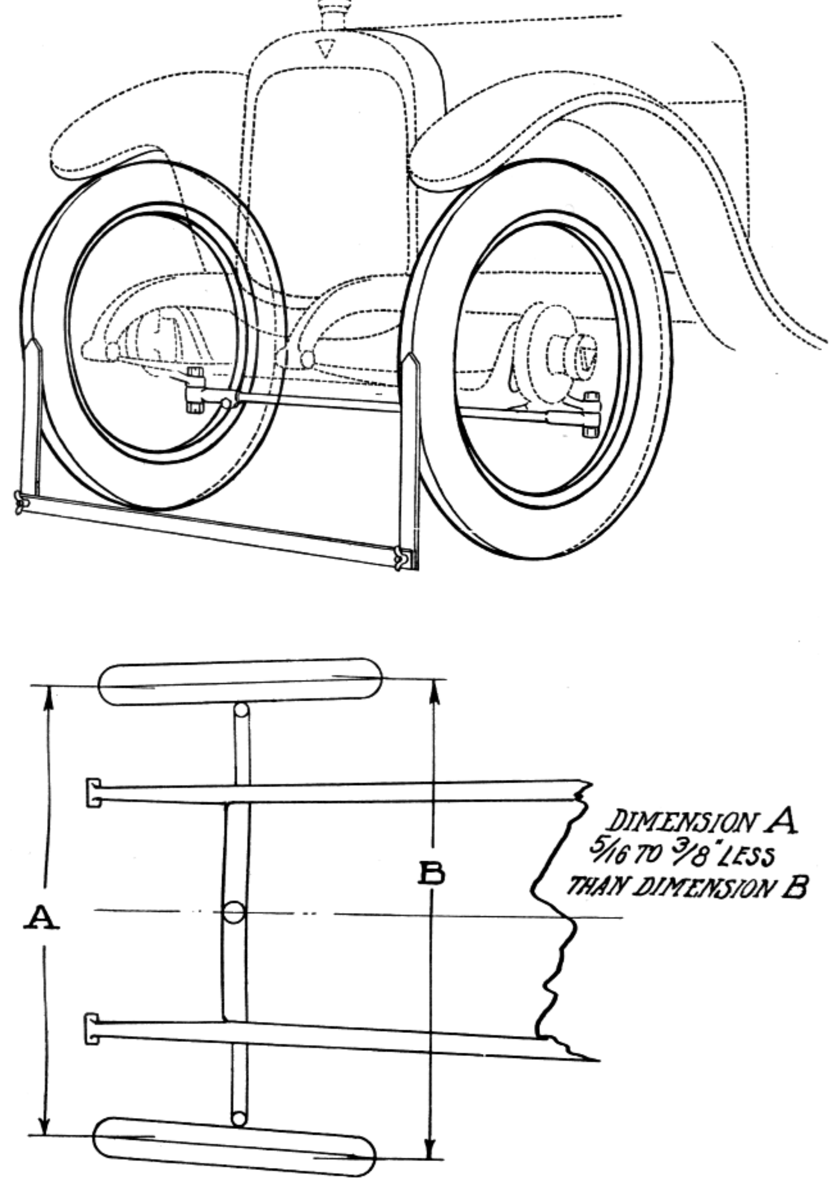
Jack up the front of the car from the center of the axle so that the distance rod is not interfered with. With both wheels free to revolve, a center line may be marked on each tire by holding a soft lead pencil against it when spinning. The pencil must be held steady or the result will not be a straight 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 5/16" to ⅜" 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, it is necessary to 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 backlash 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.



Front Wheel Alignment

Lubrication of Spring Leaves

Few Hudson owners have had the experience of riding in a common farm wagon from which the platform springs have been removed! But those who have, will always remember the ride. The general shaking up that goes with a ride of this kind puts them in a position to imagine what the effect would be if the suspension springs on their automobiles were not doing their work. It would be a very disagreeable mode of transportation, to say the least, and no pleasure could possibly be connected with it as compared with a trip in a Hudson.

We have made this comparison to illustrate that there is a difference in the riding qualities of a car on which the springs are properly lubricated and one in which the springs have been rendered ineffective through indifference or total lack of attention.

It is only a few years since the automobile designer "figured out" the spring suspension system by rule o' thumb rather than reliable engineering data. He was compelled to resort to a certain amount of guess work in his calculations (if he made any calculations at all), and the only good quality that he really made sure of was the actual strength of the springs themselves. This resulted in hard riding cars, the springs being heavy enough to support the weight of the car but having insufficient resiliency or flexibility to afford easy riding. The direct result of this design was frequent spring breakage through crystallization, and lubrication of the spring leaves was hardly a necessity. Today, however, it is a necessity. For with our present knowledge of spring design and spring material, we are able to produce a light spring which has ample strength, besides having wonderful flexibility.

Such springs do a great deal of work, and when a car is being driven over even the most moderately smooth roads, the spring action is considerable.

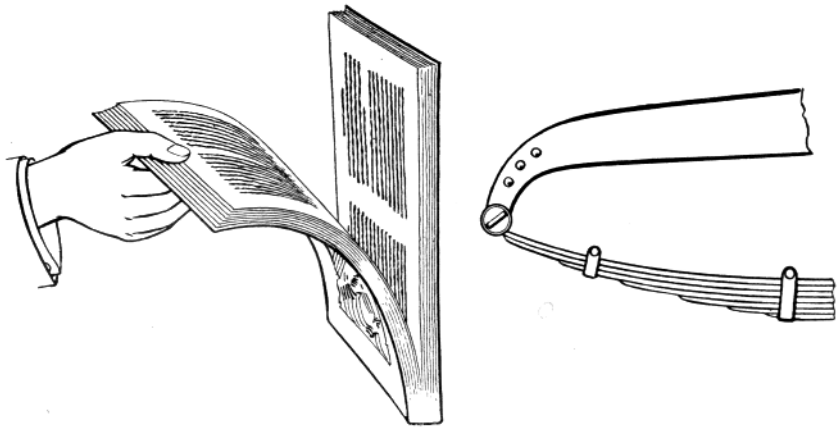
Spring breakages are an infrequent occurrence on modern automobiles of good design. But it is possible, by limiting the flexibility of a spring through insufficient lubrication, to impose upon it such heavy duty and excess friction that not only its riding qualities and resiliency are affected, but the tendency to crystallize and break is considerably increased. Well-designed springs will stand a great deal of abuse but, like all moving parts of a complicated mechanism, they require attention occasionally.

To illustrate this need of lubricant in a spring, we offer the following example:

Compare a spring, which is made up of numerous steel leaves, to the leaves of a magazine. When the magazine is bent from one position to another, it will be noticed that the leaves slide on each other. If several pages of the magazine are stuck together with mucilage, and the mucilage allowed to dry, or if the magazine be wetted so as to cause the paper to stick slightly, it will be far more difficult to bend any quantity of leaves so that they will slide on one another. Any section wetted or stuck together in this manner will become practically solid and stiff.

These same conditions apply in the case of the spring action of your automobile.

When the spring is manufactured, the leaves are carefully ground and polished at the points where they rub against one another. The spring steel is of slightly concave section so that the center of the rubbing surface will retain, to a great extent, any lubricant which is introduced at the time the spring is assembled, or from subsequent applications. However, the springs on an automobile are being constantly exposed to mud and dust which gradually absorbs the oil and grease oozing out between the leaves. A certain amount of mud works into the small spaces between the leaves and destroys the effectiveness of the lubricant. When this condition is reached, friction commences; and the spring stiffens up because the leaves cannot slide freely against one another. The rubbing action continues to some extent because of the enormous strains to which the springs are subjected. But the friction is still there, and if the application of a suitable lubricant is deferred long enough, an abrasive action will commence, with the result that a rusty mixture will be forced out from between the leaves every time the spring is wetted or the car subjected to a washing.



Numerous well-designed "spreaders" are on the market. These can be purchased at almost any hardware store, and some of them, in which the grease injection is made through the center spreading wedge, are very simple to manipulate. At best, however, most owners do not care to fuss with a greasy job of this nature, preferring to take advantage of the repair shop's facilities. But it is quite a simple job and there is really no excuse why it should not be a matter of periodical inspection.

If a spring leaf spreader is needed in an emergency and is not obtainable locally, a screw driver or chisel driven between the leaves will serve the purpose. Such a method, however, is clumsy, and on account of the inaccesibility of the inner ends of the springs, usually results in the hammer blows being misdirected to the detriment of the paint on the springs.

Many attempts have been made to design a spring which will permanently retain a lubricant. Some designs approach this desirable condition to a certain degree, but they are far from reliable. The introduction of any form of retainer between the spring leaves makes it possible for an abnormal accumulation of rust and sediment to form, thus causing a correspondingly abnormal wear not only to the retainer, but the leaves as well. The only safe method at present known is frequent lubrication by means of a spreader.

The Whitmore Mfg. Company of Cleveland, Ohio, manufacture a special lubricant for lubricating spring leaves which is especially desirable inasmuch as it will repel water very much better than common oils and greases. Almost as good is a mixture of high grade lubricating oil and graphite. Some of the larger graphite manufacturers are supplying a grade for this work which is to be specially recommended. When neither of the above are obtainable, good cylinder lubriating oil may be used and will last a long time.

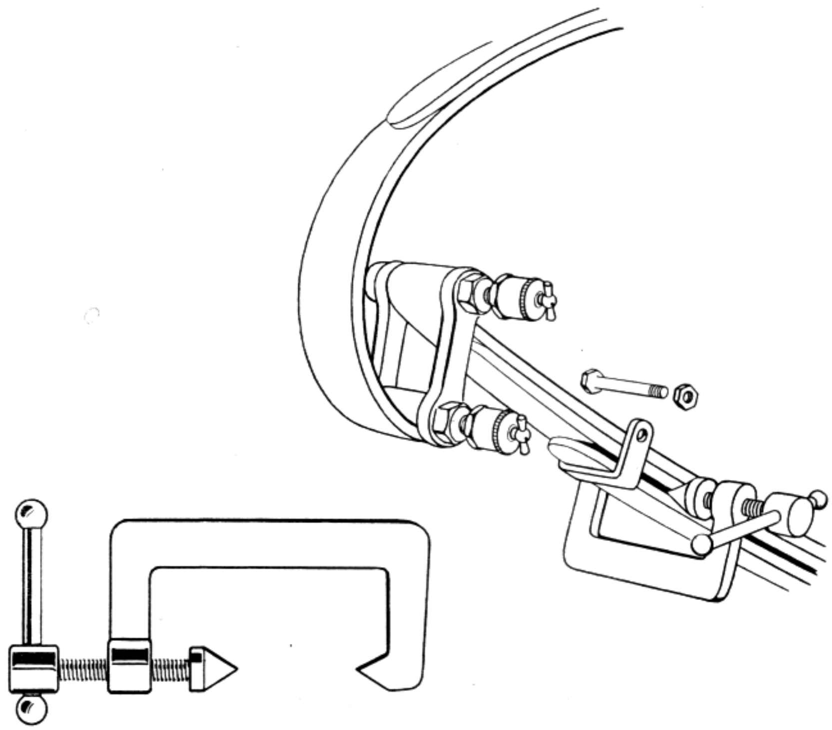
Springs need lubricating on an average of every 500 miles. If used in the winter, or when the roads are in poor condition, and the springs are constantly covered with mud, they will have to be lubricated more frequently. This is also true of heavy closed cars, especially limousines, which are washed more frequently than the average touring car.

It is obvious that although spring leaves are lubricated with a special compound when assembled at the factory, they cannot be expected to retain such lubricant for more than 1000 to 2500 miles, according to the conditions under which the car is driven.

If proper attention is not given to the lubricating of springs, we cannot hope to fulfill our obligation in regard to the guaranty on them.

Tighten Spring Clips

Causes for spring breakages are by no means limited to lack of lubrication or over-loading. Perhaps the most frequent cause is the loosening up of spring



How to Use the Spring Spreader

clips—those U-shaped members which clip the springs to the saddles on the axles. On Hudson cars these clips are made of a special alloy steel, heat-treated to insure the minimum amount of stretch. To prevent the possiblity of the nuts loosening, we use an extra long nut with a lock nut on top of it. Despite these precautions, the enormous strains to which the springs are subjected make it possible for them to loosen up. It is therefore essential that the spring clips be tested for tightness at least once a month, or every 2000 miles. If Hudson owners will follow our suggestions in regard to lubrication and tightening of spring clips, they will not only be far more satisfied with the riding qualities of their car, but they will enjoy the knowledge that the possibilities of spring breakage are absolutely minimized.

Special end socket wrenches may be obtained from the Hudson Motor Car Company for the purpose of facilitating work of this nature.

Model J Shackle Bolt Adjustments

One of the most annoying rattles about a car is caused by side play in the spring ends in the shackles.

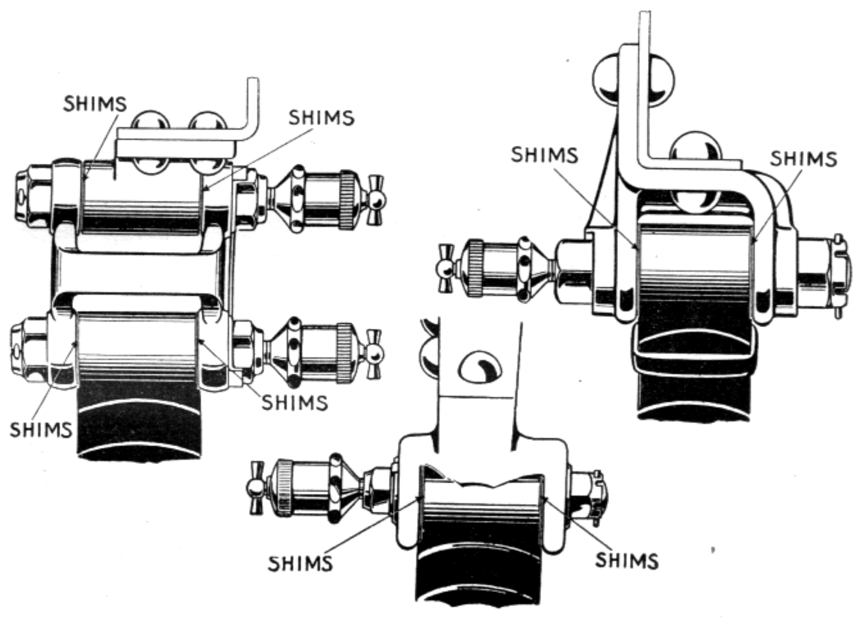
The direct cause of this looseness is natural wear or lack of lubrication. Driving over muddy roads, then allowing the car to stand without proper attention to these shackles, permits the mud to work into the shackle bolts, which naturally brings about this result much more quickly.

A common practice of taking up this play is to tighten the spring bolts, thus clamping the shackle bracket or frame end, as the case may be, against the spring to take up the play. This method, while effective for the time being, is only a temporary relief as the strain is naturally in the wrong direction, in fact, directly opposite to what it should be.

There is only one permanent and satisfactory way of taking up this play and that is by the use of shims. The accompanying sketch shows where the shims are installed between the springs and shackle, or bracket. Force in as many shims as possible by springing open the shackle or bracket. After the shims are in place, the bolts should not be drawn up too tightly. Leave just enough to take up the play. It is well to check up the latter to see that lubricant is coming out of the hole in the center of the bolt and that the passage leading from the grease cup to this hole is entirely free. If blocked, excessive wear will follow.

Turning up the grease cups on the spring shackle bolts once a day will insure the maximum life of these parts; and an owner may be sure that unless he follows our instructions in this respect, the excessive wear on the bushings will call for replacement of the parts within a very short mileage.

Spring shackles are exposed to the mud and dirt from the road and unless the grease is constantly being forced from the interior outward so as to carry with it all particles of grit, it is obvious that the dirt will work into the bushings and destroy them in a very short time.

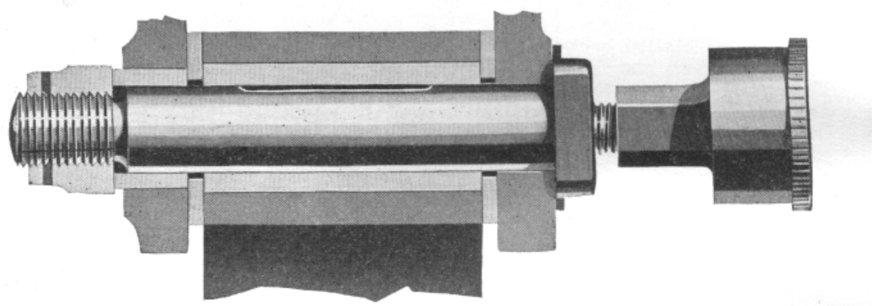


Spring Shackle Adjustment

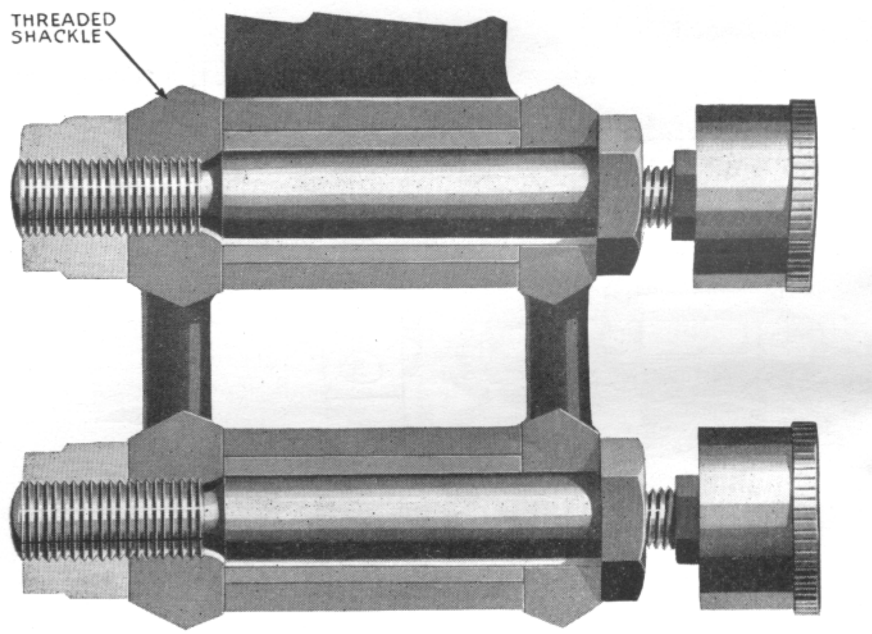
Shackle Adjustment on Model "M''

The front shackle is adjusted, not by shims, as was last year's but by means of a nut and cotter pin. To take up any wear remove cotter pin and take up nut. Replace cotter pin. This applies to front end of both front and rear spring.

The rear shackles are not joined by a cross member as was the case on the previous model. When the cross member is used play must be taken up by means of shims. Model "M'' shackle is adjusted by loosening up nut on shackle bolt, and turning bolt until the threaded shackle is pulled in enough to eliminate play. Lock with nut and cotter pin.



Front Shackle Bolt Adjustment Model M

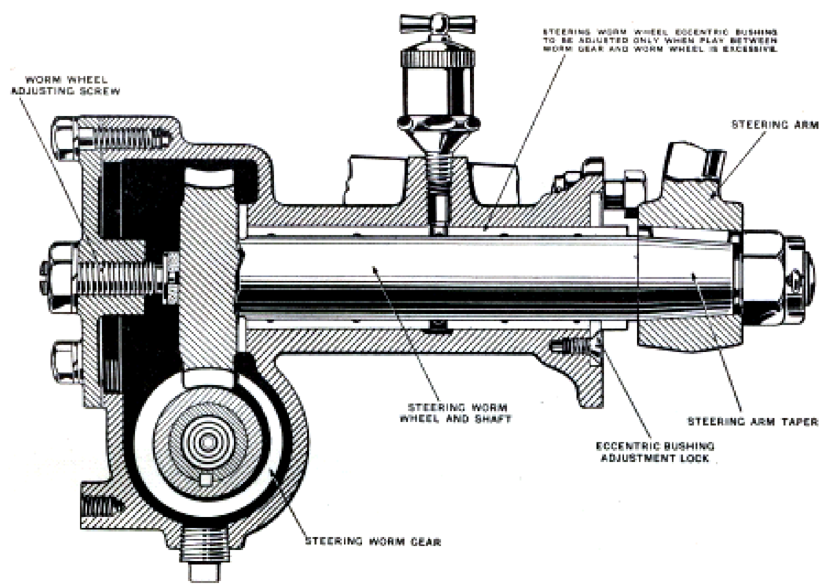


Rear Shackle Bolt Adjustment Model M

Steering Gear—Model J

Aside from the lubrication of the steering gear proper, there is practically no maintenance or attention necessary in connection with it.

The only wearing parts on which adjustment is necessary are the thrust bearings which take the pressure due to the worm gear within the housing. Should these bearings loosen, there will be a certain amount of up and down play in the steering column when the wheel is strained, first in one direction and then in the other. If excessive, this will be noticeable by the driver. It manifests itself in a rattle or pound caused by the nut on top of the steering wheel hitting the bottom of the sector hub. There should always be at least 1/64" clearance between the nut and the bottom of this hub when the wheel is turned against the worm so as to force the column up to the full degree of its end play. Trouble of this nature may be eliminated by removing shims from the bottom of the steering gear, thereby allowing the thrust bearing to be set closer. The shims are of different thicknesses and in the adjusting of them care must be exercised, so that only the proper size shim will be removed. If too much shimming material is removed, a constant pressure is brought to bear on the thrust bearings and their life will be materially decreased. With the exception of lubrication this is practically the only contingency that calls for attention to the steering gear case.

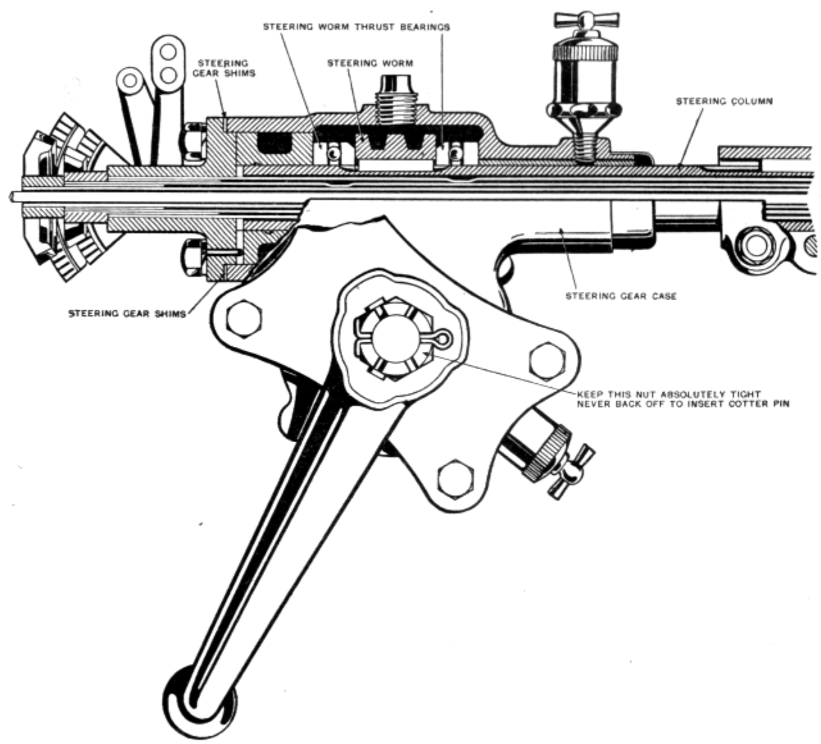


Steering Gear Adjustments No. 1

Steering Worm Wheel End Play

Owing to the fact that the drag link which connects the steering arm to the front axle does not work in a direct line, but transmits its power with an angular action, there is a certain amount of in and out thrust upon the worm wheel shaft. We therefore thought it advisable to introduce an adjustment at this point so that all signs of wear may be immediately eliminated should trouble develop. This is most infrequent, however, but as it is only the work of a few moments, it should nevertheless be attended to.

To check up this adjustment, put a pinch bar between the steering arm and the frame, and pry it out as far as it will come. Then drive it in again with a hammer so as to loosen it up. When it is in the extreme "inward" position, put the ball of the thumb on the steering arm hub and the frame. Upon applying the pinch bar, the slightest motion of end play will be immediately felt at the point where the thumb presses on the steering arm hub and the frame. A small amount of end play does no harm but should it exist to the extent of 1/64", it is possible a rattle will develop. It is quite permissible to have as much as 1/20" end play at this point wihout detrimental results and therefore does not call for adjustment or repair unless it manifests itself objectionably.



Steering Gear Adjustments No. 2

Steering Arm Tight on Taper

The reason for calling your attention to the steering arm on its taper is very obvious. The lives of the occupants of the car depend on the steering gear, for if this were to become disconnected while the car was traveling at even a moderate speed, it is more than likely that a serious accident would result. For this reason, the steering gear is made of the highest grade materials with the most accurate workmanship. The design is such that it may be kept in good condition by periodical adjustments and lubrication with very little difficulty. Every precaution is taken to insure all parts remaining tight. For that reason, a taper connection is used on the end of the worm wheel shaft in order to key the steering arm into place. It is possible that any taper connection may loosen up in service and since so much depends upon the steering apparatus, it is absolutely vital that this nut and taper arm be tested for tightness at least once a month.

If the arm has been allowed to remain loose for so long as to injure the keys and key ways, it will be necessary to change them. There are three such keys and key ways in the arm and hub to safeguard against replacing a key in a key way which has become worn. By turning the worm wheel around, it is possible to fit a new key in the key way without any difficulty.

In a car which has seen considerable service, that portion of the wheel which is in contact all the time that the car is being driven straight ahead, receives more wear than the teeth around the rest of the circumference. By being able to turn the wheel around one-third of its circumference, a new wearing surface is obtained. This means that Hudson steering gears will practically never wear out.

It will be impossible to dwell with sufficient emphasis upon the harmful results that come from lack of attention to the steering apparatus and we are sure that every owner and mechanic will appreciate the importance of following our directions to the fullest degree.

Drag Link

The drag link connects the steering arm with the front axle steering knuckle and must be always maintained with the proper adjustment and adequate lubrication. Boots are provided to keep out mud and dirt but it is possible that these boots will retain a certain amount of mud and dirt if sufficient lubricant is not forced through them from the inside, thereby carrying out with it any accumulation within the ball and socket joints themselves.

The adjustment of the drag link is extremely simple and is immediately apparent upon examination. The only precaution we recommend is that the ball and sockets are not screwed up so tight as to cause excessive friction or that the cotters in adjusting nuts be omitted. In the latter case, the drag link may become disconnected, with serious results. Most important of all in connection with the drag link is sufficient lubrication.

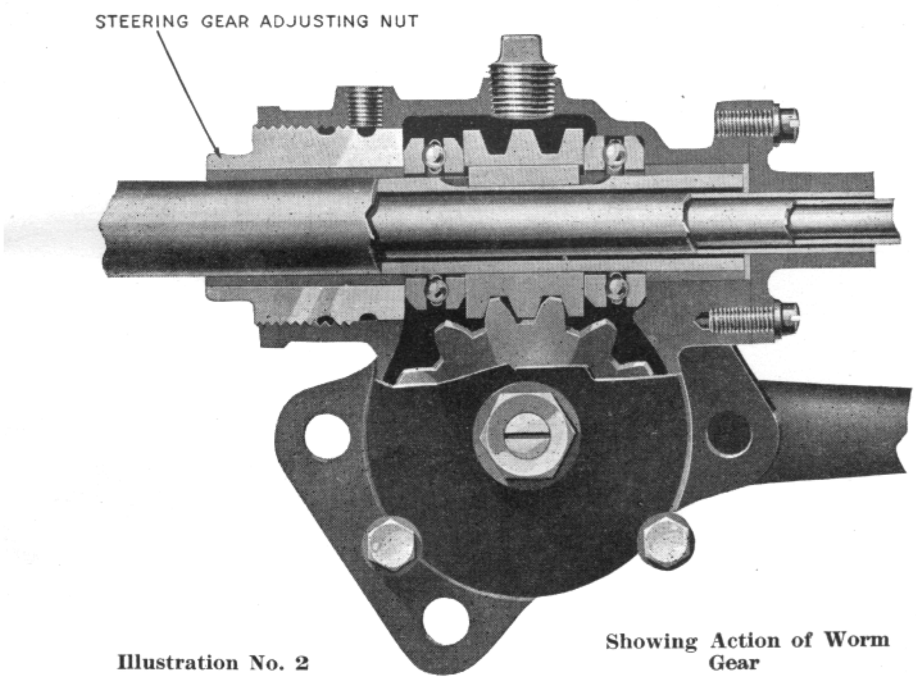


Illustration No. 2 **Showing Action of Worm Gear**

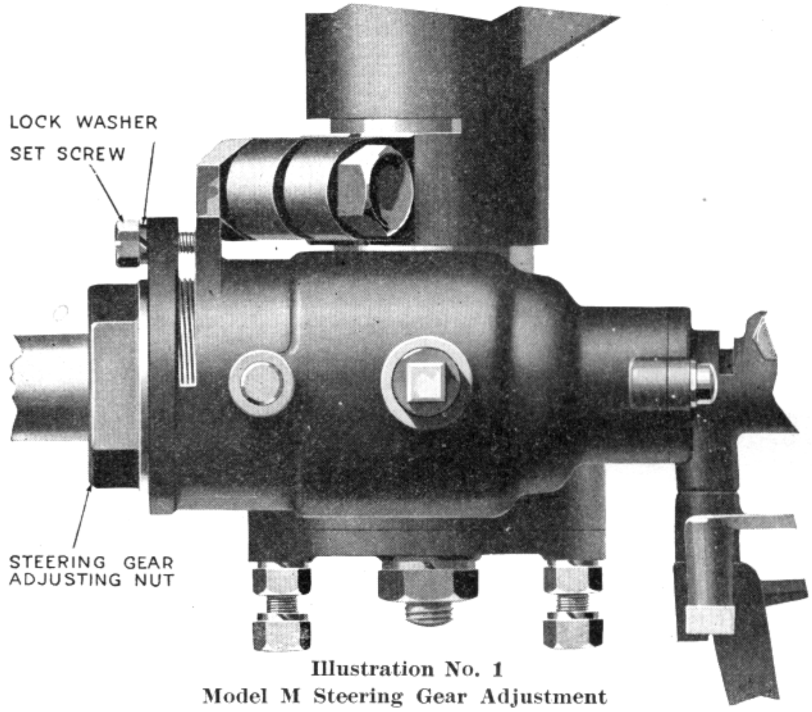


Illustration No. 1
Model M Steering Gear Adjustment

Adjustment of the Model "M" Steering Gear

One of our latest improvements is the method of adjusting the steering gear to remove end play and lost motion. We have substituted for the cap and shim adjustment a much handier and more satisfactory one. This is accomplished by means of an adjusting nut locked by a set screw and lock washer.

To remove end play in the steering gear loosen set screw until large adjusting nut does not bind. The nut should then be turned until all but the necessary play is removed. The set screw should then be tightened to prevent any accidental turning of the adjusting nut. See illustrations Nos. 1 and 2.

The worm wheel shaft, as usual, has an eccentric bushing. See illustration No. 3. In order to bring the worm wheel deeper into mesh with the worm re-

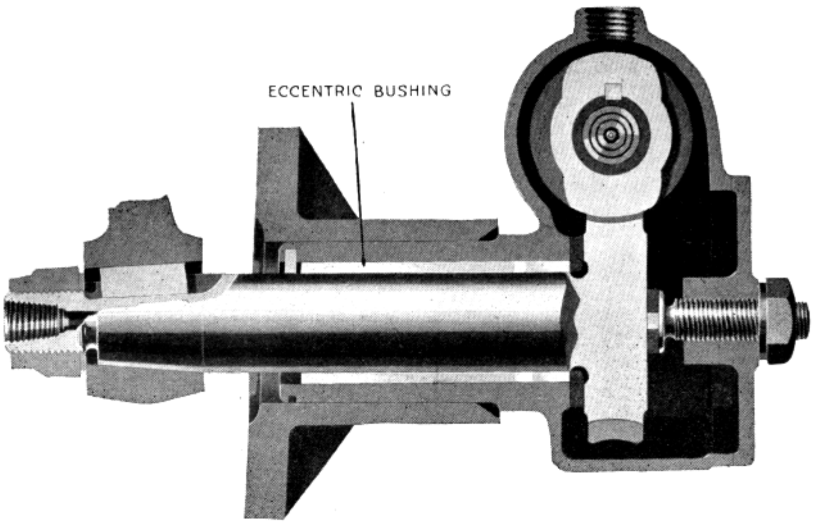


Illustration No. 3

Model M Steering Gear

move the steering arm and the cover from the side of steering gear housing nearest motor. The worm wheel and shaft may then be removed. Examination of the eccentric bushing will show a series of notches at the end nearest the steering arm. The bushing is prevented from turning by means of a pin which fits into one of the slots. The pin should be removed and the bushing turned enough to bring about the desired adjustment. The pin should then be replaced and the steering gear reassembled.

The Gasoline System

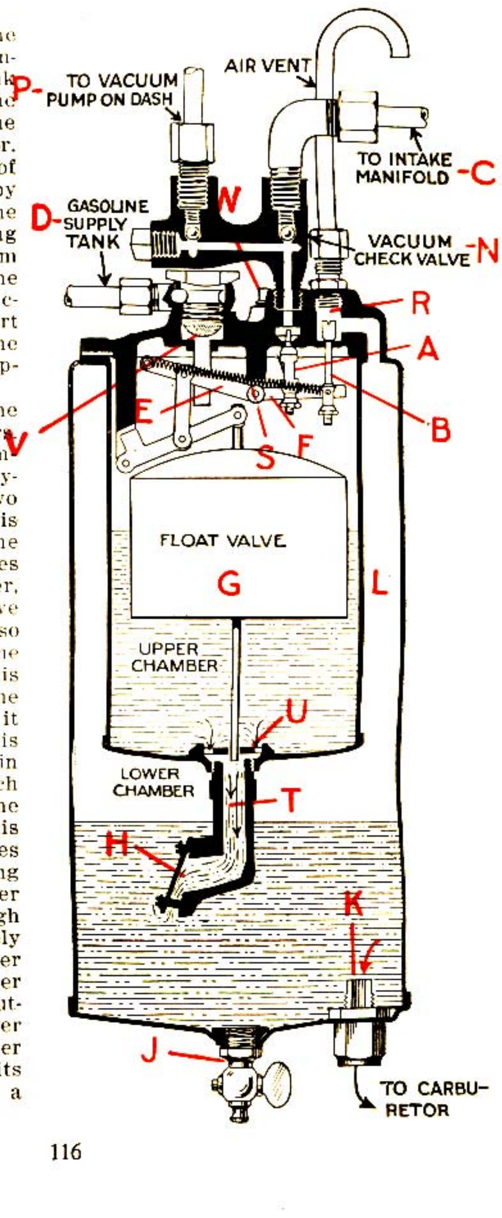
The gasoline is carried in a 20-gallon tank hung at the rear of the car. There is an indicator in this tank which shows the amout of gasoline carried.

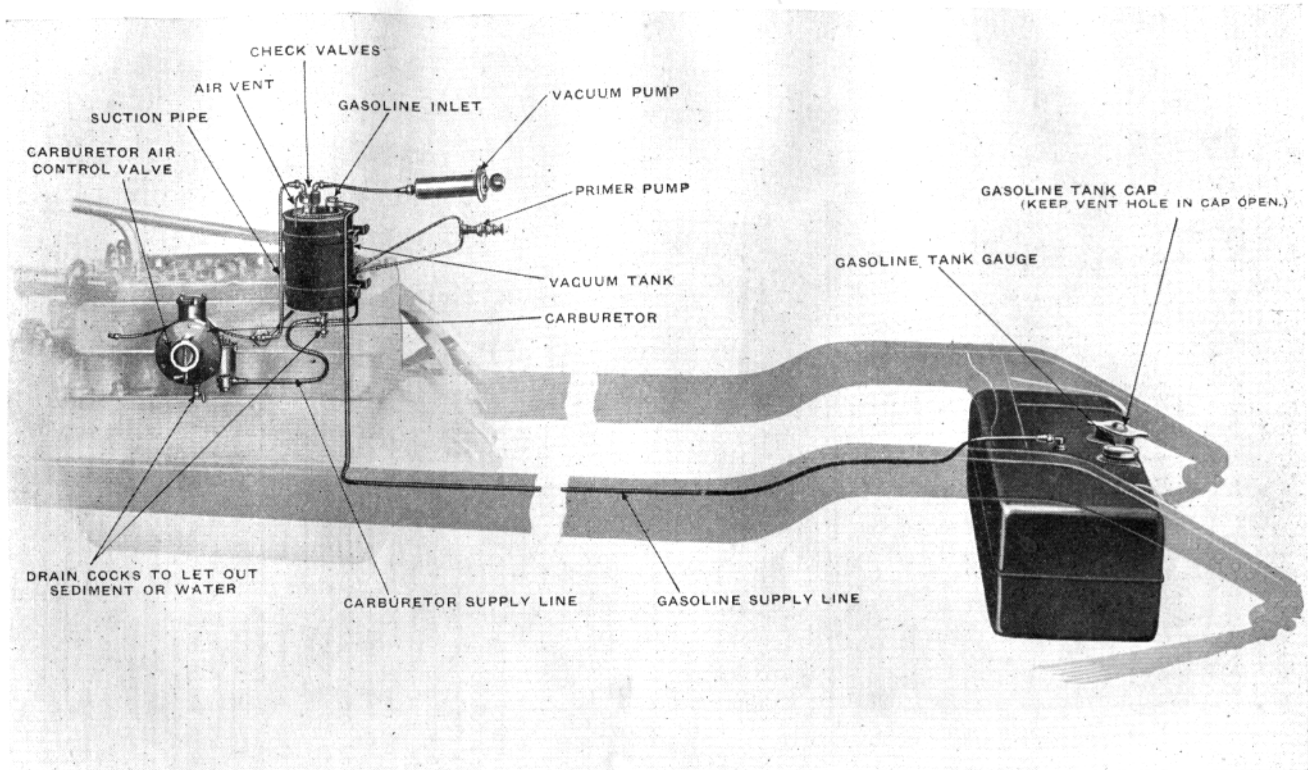
The indicator may be removed for purposes of adjustment or repair. Its construction is extremely simple, the indicating action being obtained by means of a rectangular cork float, running in a guide and revolving a twisted strip of brass as it moves up and down. The indicator needle is attached to the end of this strip of brass. There is nothing that can get out of adjustment except through corrosion or damage to the float. Cleaning is practically the only attention that will ever be necessary.

The Gasoline System

The Stewart Vacuum Gasoline System employs a small tank, installed under the hood. This tank is connected by brass tubing to the intake manifold, also to gasoline supply tank, and to carburetor. Every motor draws its supply of gasoline through the carburetor by reason of the pumping action of the pistons. It is this same pumping action which draws gasoline from the main supply tank into the Stewart tank, through the connection of the manifold and the Stewart tank, and also the connection of the Stewart tank with the gasoline supply tank.

The Stewart Vacuum Gasoline Tank consists of two chambers. The upper one is the filling chamber, and the lower one is the emptying chamber. Between these two chambers is a partition in which is placed a valve. The suction of the pistons on the intake stroke creates a vacuum in the upper chamber, and this vacuum closes the valve between the two chambers, and also sucks or pumps up the gasoline from the main supply tank into this upper chamber. As the gasoline flows into this upper chamber it raises a float valve. When this float valve has risen to a certain point it operates a valve which shuts off the suction and at the same time opens an air valve. This admission of outside air releases the vacuum suction, thus causing the valve leading into the lower chamber to open, and through which the gasoline immediately commences to flow into the lower or emptying chamber. This lower chamber is always open to the outside air, so that nothing can ever prevent the gasoline in this lower chamber from feeding through its connection to the carburetor in a perfect, even, uninterrupted flow.





The Gasoline System

A is the suction valve for opening and closing the connection to manifold and through which a vacuum is extended from the engine manifold to gasoline tank.

B is the atmospheric valve, and permits or prevents an atmospheric condition in the upper chamber. When the suction valve **A** is open and the suction is drawing gasoline from main reservoir, this atmospheric valve **B** is closed. When the suction valve **A** is closed then the atmospheric valve **B** must be open, as an atmospheric condition is necessary in the upper tank in order to allow the fuel to flow through the flapper valve **H** into the lower chamber.

C is pipe connecting tank to manifold of engine.

D is pipe connecting vacuum tank to main gasoline supply tank.

E is lever to which the two coil springs **S** are attached. This lever is operated by the movement of the float **G.**

F is short lever, which is operated by the lever **E,** and which in turn operates the valves **A** and **B.**

G is the float.

H is flapper valve in the outlet **T**. This flapper valve is held closed by the action of the suction whenever the valve **A** is open, but it opens when the float valve has closed the vacuum valve **A** and opened the atmospheric valve **B.**

J is pet cock for drawing water or sediment out of reservoir. May also be used for drawing off gasoline for priming or cleaning purposes.

K is line to carburetor extended on inside of tank to form pocket for trapping water and sediment, and which may be drawn out through pet cock **J.**

L is channel space between inner and outer shells, and connects with air vent **R,** thus admitting an atmospheric condition in lower chamber at all times, thereby permitting an even, uninterrupted flow of gasoline to carburetor.

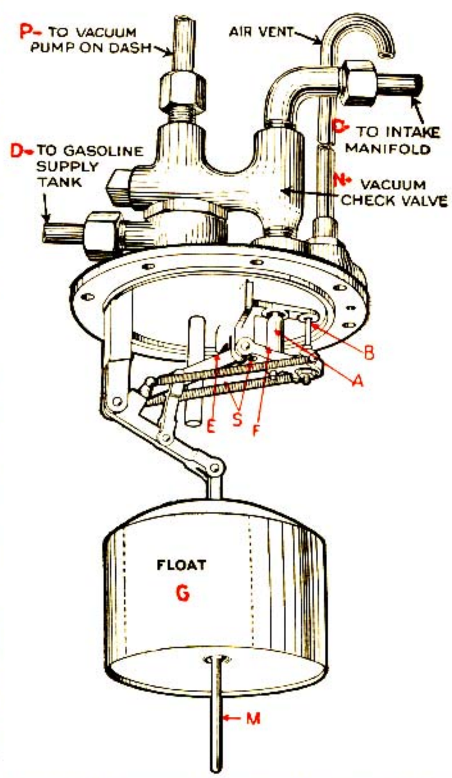
M is the guide for float.

N is vacuum check valve.

P is a line leading to vacuum pump on dash. This vacuum pump which is installed on the dash, can be used for priming, or for filling the vacuum tank should it ever become empty. It is not necessary to turn over the engine, but merely pull plunger in vacuum pump two or three times, which will create sufficient vacuum in tank to draw gasoline from main supply tank.

R is an air vent over the atmospheric valve. Through this tube the lower or reservoir chamber is continually open to atmospheric pressure, so that the flow of gasoline from this lower chamber to the carburetor is always an even, uninterrupted flow.

T is the outlet located at the bottom of the **float reservoir.**



Top of Stewart Vacuum Gasoline Tank removed, showing valve mechanism.

Care and Repair of Stewart Vacuum Tank

Leave tank alone. Don't tamper with it. It is not very likely that it will ever be necessary to open the tank, but if it is opened, then follow directions carefully.

The simple, durable construction used in the manufacture of the Stewart Vacuum Tank makes it unlikely that the car owner will ever need to make internal repairs. If the instructions for care are carried out, the Stewart Vacuum Gasoline System should continue indefinitely to operate perfectly. Before proceeding to repair vacuum tank, make absolutely sure that the trouble is not due to some other cause.

If your vacuum system does not operate satisfactorily, the following suggestions will **enable you to make the necessary adjustment:**

Vent Tube Overflow

The air vent allows an atmospheric condition to be maintained in the lower chamber, and also serves to prevent an overflow of gasoline in descending steep grades. If once in a long while a small amount of gasoline escapes, no harm will be done and no adjustment is needed.

However, if the vent tube regularly overflows, it may be found that the air hole in main gasoline tank filler cap is stopped up. If so, clean it out.

Gasoline Leakage

If gasoline leaks from system, except from vent tube, it can only do so from one of the following causes:

A. A leak in outer wall of tank may have occurred. If so, soldering up the hole will eliminate trouble.

B. Carburetor connection in bottom of tank may be loose. If so, it should be screwed up tight.

C. There may be leak in tubing length **B** or **C**.

Failure to Feed Gasoline to Carburetor

Remember that this condition may be due to other causes than the vacuum system. Do not blame vacuum system until you are sure that the fault does not lie elsewhere. After flooding the carburetor, or "tickling the carburetor," as it is commonly called, if gasoline runs out of the carburetor float chamber, you may be sure that the vacuum feed is performing its work of feeding the gasoline to carburetor.

Another test is to take out the inner vacuum tank, leaving only the outer shell. If you fill this shell with gasoline and motor still refuses to run properly, then the fault clearly lies elsewhere and not with the vacuum system—because you must certainly get gasoline feed from this open, elevated tank of gasoline, unless there is stoppage in the connection line to carburetor.

To Remove Top

In removing top of tank, after taking out screws, run the blade of a knife carefully around top, between cover and body of tank, so as to separate gasket without damaging it. Gasket is shellaced to make an air-tight joint.

If faulty feed is traced to vacuum system, one of the following conditions may be the cause.

A. The float (see **G**, page 118), which should be air-tight, may have developed a leak; thus filling up float with gasoline and making it too heavy to rise sufficiently to close vacuum valve. This allows gasoline to be drawn into manifold, which in turn will choke down the motor.

Proper operation depends upon the float being air-tight.

To Repair Float

Remove top of tank (to which float is attached) as above directed. Dip the float into a pan of **HOT** water, in order to find out definitely where the leak is. Bubbles will be seen at point where leak occurs. Mark this spot.

Next, punch two small holes, one in the top and the other in the bottom of the float, to permit discharge of the gasoline. Then solder up these holes and the leak. Test the float by dipping in **HOT** water. If no bubbles are seen, the float is air-tight.

In soldering float, be careful not to use more solder than required. Any unnecessary amount of solder will make the float too heavy.

In taking out float and repairing it, take care not to bend the float guide rod. If you do bend the rod, it will strike against guide and retard float, producing the same effect as a leaky float, and allowing gasoline to enter manifold. Also note whether surface of rod is perfectly smooth so that it cannot be retarded by guide.

To overcome the condition of a leaky float temporarily until you can reach a garage, remove plug **W** at the top. In some cases the suction of the motor is sufficient to draw gasoline into tank even with this plug open, but not enough to continue to be drawn into the manifold. If, however, you are not able to do this, close up plug **W** with engine running. This will fill tank. After running engine until tank is full remove plug **W** until gasoline gives out. Continue repeating same operations until a repair station or garage is reached, when the leaky float can be remedied.

B. The flapper valve may be out of commission.

A small particle of dirt getting under the flapper valve (see **H**, page 116) might prevent it from seating absolutely air-tight, and thereby render the tank inoperative.

In order to determine whether or not the flapper valve is out of commission, first plug up air vent; then detach tubing from bottom of tank to carburetor. Start motor and apply finger to this opening. If suction is felt continuously then it is evident that there is a leak in the connection between the tank and the main gasoline supply, or else the flapper valve is being held off its seat and is letting air into the tank, instead of drawing gasoline.

In many cases this troublesome condition of the flapper valve can be remedied by merely tapping the side of the tank, thus shaking loose the particle of dirt or lint which has clogged the valve. If this does not prove effective, remove tank cover, as described on previous page. Then lift out the inner tank. The flapper valve will be found screwed into the bottom of this inner tank.

c. Manifold connection (see **C**, page 116) may be loose, allowing air to be drawn into manifold.

d. Tubing may be stopped up, in lengths **A**, **B** or **C** (see page 4).

e. Gasoline strainer (see **V**, page 116) is a screen located in the line from gasoline tank. This screen collects all foreign substances that might get in the rear tank and be carried through to the carburetor and clog it. If tank fails to work, it may be that this screen is clogged, preventing gasoline from getting into tank. Screen may be easily cleaned by unfastening connection at elbow. This cleaning should be done every three weeks. **If tank should ever fail to operate, examine strainer FIRST.**

Increased Gasoline Consumption

Vacuum feed should show the same rate of gasoline consumption as gravity feed, and a saving over pressure feed. If such a condition does not result in your car, perhaps the cause is:

a. Carburetor may need adjustment.

b. Vent tube may overflow. (See **"Vent Tube,"** page 118.)

c. There may be a leak in tank or tubing—note instructions under **"Vent Tube"** and **"Gasoline Leakage."**

d. If the motor speeds up when the vacuum tank is drawing gasoline from the main supply. It shows that either your carburetor mixture is too rich, or your connections are so loose that it is drawing air into the manifold. There should be no perceptible change of engine speed when the tank is operating.

Carburetor Trouble

a. Carburetor trouble cannot be attributed to vacuum system. If gasoline is delivered to carburetor, vacuum feed has done its work.

b. If carburetor pops and spits, carburetor adjustment is needed.

c. If car slows down, or if you cannot get usual speed out of car while running with open throttle, although the car still continues to run, you may be sure the trouble is not due to vacuum system. If all the gasoline in vacuum tank is exhausted the car will stop.

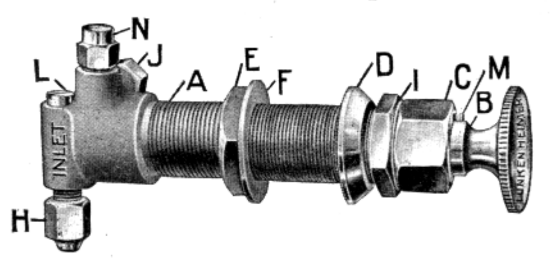
Filling Up Tank in Starting

To fill the tank, should it ever become entirely empty, close the engine throttle and turn the engine over a few revolutions. This will create sufficient vacuum in the tank to fill it. If the tank has been allowed to stand empty for a considerable time and it does not easily fill when the engine is turned over, this may be caused by dirt or sediment being under the flapper valve **H.** Or, perhaps, the valves are dry. Removing the plug **W** in the top and squirting a little gasoline into the tank will wash the dirt from this valve, and also wet the valves, and cause the tank to work immediately. This flapper valve sometimes gets a black carbon pitting on it, which may tend to hold it from being sucked tight on its seat. In this case the valve should be scraped with a knife.

Clean Tank Every Three Months

Unless gasoline is filtered through a screen or chamois when filling the main gasoline tank, from which the vacuum tank draws its supply, some dirt or sediment will accumulate in the main tank. Part of this dirt may be drawn into the vacuum tank. This dirt should be removed from the vacuum tank at least once every three months. To clean the tank remove the top of the tank and take out the inner shell or vacuum chamber (note instructions "To remove Top," on page 119). This will give acess to the lower chamber from which the dirt should be removed. **(Don't take tank off of car —you may not be able to get it back in the same position.)**

Primer Pump



Primer Pump

The Primer Pump mounted on cowl to the right or left of the steering column provides means for injecting a charge of gasoline into the motor intake passages, a necessary aid to easy starting in cold weather.

It is inserted from the back of the instrument board and secured by locknut E and shoulder nut D. To allow ample room for stuffing box adjustment the nuts should be screwed back far enough to leave the pump barrel projecting at least ⅛ inch. The inlet connection H should point downward.

Stuffing box C must be set up sufficiently tight to prevent air leakage and locked in this position with hexagon nut I.

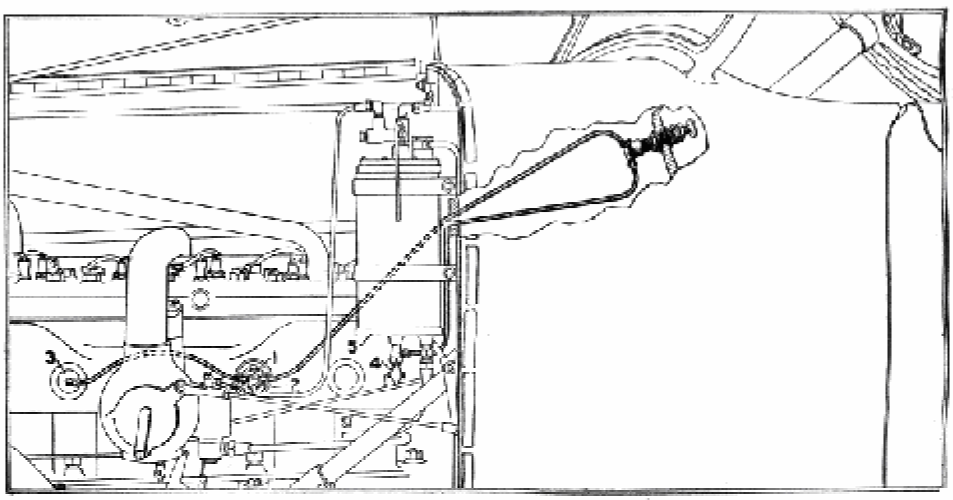
Pump plunger B has a bayonet lock engaged with stuffing box C. To release, turn plunger to right or left until lock pin M emerges through slot in C.

A slow outward pull and quick return of plunger injects gasoline spray into the motor. Two complete strokes should give a sufficient starting charge. If more strokes are required it indicates that the stuffing box leaks air and should be tightened.

Do not fail to lock plunger after each priming operation. To do this, press plunger inwards, entering pin M in stuffing box slot, and turn plunger slightly. Unless this is done, gasoline will be drawn through the Primer when the engine is running, causing it to flood and miss. A spring needle valve at the inner end of the plunger closes the pump ports tightly only when the plunger is securely locked.

Insert a strand of candle wick packing in stuffing box whenever it is found impossible to enter lock pin M far enough to lock it in place.

All union connections should be made perfectly tight and secure and kept in this condition, otherwise the effectiveness of the Primer Pump will be lessened or destroyed.



Illustrating Application

Caution: Keep Primer Closed

Drivers of cars equipped with Lunkenheimer primers are liable to neglect the locking of the primer piston in its closed position after the motor is started.

The result of this is very poor gasoline mileage. It is equivalent to running with the choke partially on, as an excess of fuel is drawn into the motor through the priming device itself.

This primer is so constructed that the plunger, when not in use, may be pushed in, turned slightly, and locked in the closed position. When the plunger is in this position, no gasoline can be drawn into the motor through this device.

It is important that you notify your owners of the importance of this precaution, as too much gasoline means excess carbon, fouling spark plugs, missing, and a dilution of the crank case lubricant.

Rims

Rims Applied Properly

The changing of a tire is usually done in haste and is extremely distasteful to the average owner. Not infrequently he prefers to have this work done in some garage or will be willing to pay any help that comes to hand to relieve him of so arduous a task. Tire trouble has always been regarded as the one feature to mar an otherwise pleasant automobile trip. For this reason, it is a fact that very few owners apply their rims properly or take pains to see that others do so; even though it be under the owner's direction. This results in complaints of rear wheels wabbling and rims squeaking. These may be eliminated if the rim is properly applied.

An important rule to follow in applying a rim is the sequence in which the wedges are tightened as it is obvious that if any one wedge is screwed up too tightly before the others are in place, the wheel will be forced farther over the right flange of the felloe in that particular spot. When the rest of the wedges are applied, it will be impossible to line the rim up so that it runs true and a wabbling wheel will result. On account of the inequality of the pressure of the wedges, a rim so applied will squeak and creak.

To ascertain if the rims are correctly applied, it is only necessary to examine the rim at the point where it bears on the inner flange of the felloe. If it projects more at one point than another, it is obvious that the wedges at this point were tightened up before those on the opposite side and the trouble may be eliminated by backing off such wedges and tightening the ones on the opposite side to counteract the action.

Directly opposite the valve, there is a locking plate which tends to hold the rim to the correct height from the base of the felloe. It will be very much easier to drive this side of the rim too far over the flange and it is therefore essential that the two bolts nearest the valve be pulled up first. They should not be screwed up to the fullest extent but should be set in place so as to support the rim and keep it from being pulled down close to the base of the felloe.

The two wedges to the extreme right and left of the valve should be the next to be inserted. These should be tightened a little in the same manner. The last wedge to be applied should be the one immediately under the locking plate. After the rim has been centered in this manner, all the wedges may be tightened up to the maximum degree; but they need not be tightened excessively as this would tend to pull the head of the bolt and may result in stripping the threads or breaking the bolt off short.

Wire Wheels

Owners, whose cars are equipped with wire wheels, will not find it necessary to change rims when tire trouble is experienced. It, however, results that the wire wheel upon which the tire is mounted will have to be completely changed.

Connected with this operation there is one very important point upon which we feel a word of advice is not wasted.

Whenever it becomes necessary to change 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 extire hexagon surface of 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 and 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 they are 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 wire 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 remove caps, make sure that you are turning the wrench in the proper direction as indicated on the end of the cap.

General Body Adjustments

Body Bolts Tight

The sill, or frame work of an automobile body is necessarily made of wood. In order to secure it rigidly to the frame a number of bolts are required, but, on account of these bolts being set in wood there is a tendency to loosen after the first few hundred miles of service. Body bolts should be checked every month for the first three months. After that time, if there is no continual tendency to loosen up, they will remain tight indefinitely.

Perhaps one of the most frequent complaints on a modern automobile is about the squeaks and rattles which seem to emanate from the body. Few owners appreciate that these are aggravated by neglecting to see that the body bolts are always tight. It is impossible to eliminate a squeak for any time if there is any looseness or working of the sill upon the frame. Therefore, before any attempts are made to eliminate squeaks and rattles, the body bolts must be checked up to make sure that they are drawn down as tightly as possible.

All Hudson bodies are fitted with graphited shims placed between the sill and the sill frame to eliminate all contact between wood and metal. These shims are square in form and have a hole in the center through which the body bolt is passed. This holds the shim in place and insures its being drawn down tight. The graphite with which these shims are impregnated will last for many months, but in extremely damp climates or in a car which receives more than the average amount of mileage on country roads, it is possible that the shims will need graphiting more frequently. To do this, it is only necesary to loosen the bolt, wedge a chisel or pinch bar between the body and the frame, and strain it upwards sufficiently to allow of a seperation of the shims. A knife may be used to spread the graphite between the shims in much the same manner that a spring is lubricated. This will be essential at least once a year on a car which receives more than the average milage.

If the above items are neglected and the body is allowed to remain loose on the frame, a great deal of objectionable noise will result. In addition to the noise, the damage done to the frame work of the body will be serious. It must be clearly understood, therefore, that the rigidity and long life of a body depend entirely upon its being securely bolted to the frame. As soon as it is allowed to remain loose it is weakened, squeaks and rattles cannot be successfully eliminated, and joints in the metal panels are sooner or later opened up.

Oil Door Hinges and Locks and Set Bumpers

Door hinges and door locks attract a great deal of dust and dirt. On account of their being exposed, it is undesirable to oil them excessively for fear it would soil the clothes of the occupants of the car. Nevertheless, a small amount of lubrication is necessary to eliminate squeaks and prevent rusting. For this purpose, ordinary engine oil is unsuitable as it runs away and absorbs dirt very quickly. A better preparation is linseed oil with which a little fine, powdered graphite is mixed. Linseed oil has less tendency to run and spread over a surface as would the common mineral oils. Furthermore, it tends to become gummy and is therefore more effectual in retaining the graphite at the required spot for a greater period of time.

When a body has been allowed to remain loose for a long period the frame work begins to squeak in places. Linseed oil and graphite may be used to eliminate the squeaking. This should be squirted into the joints at the base of the door posts or at the front end of the cowl, wherever the squeaking has been located. It is sometimes necessary to remove the trimming to do this, but the effects are of such lasting quality that it is well worth while.

The bumpers on the doors require renewal in proportion to the amount of usage they receive. New door bumpers are on hand in every Service Station so that they may be replaced whenever necessary. Neglecting to replace door bumpers results in worn hinges and locks. These are more expensive to repair and cause very annoying rattles.

Oil Hood Lacing—Hood Sockets Tight

There is a certain amount of weaving in an automobile which necessitates the hood sliding upon the radiator and the dash. The actual amount of movement is small and will only be noticed on rough roads. To make this as frictionless and noiseless as possible, the hood lacing is used to support the ends of the hood. This lace should be kept soaked in oil so that there will be no squeaking or excessive friction at this point. If the lace is not oiled frequently and kept in good repair, the hood works very stiffly and will tend to loosen the bracket in the body and at the top of the radiator. In addition, it may wear through the lacing and touch the metal shell of the radiator or cowl dash. This causes abrasion of the paint and may result in completely wearing through the metal. To repair such damages is expensive in the extreme, especially since it may be eliminated by a little attention once in a while.

The hood sockets, by which we mean the brackets which support the top hinge at the front and rear of the hood, should be securely bolted in place on the radiator and dash. If these are allowed to become loose, the working back and forth of the hood will be increased and the tendency to damage the cowl and radiator will be very much greater. Excessive looseness at this point usually results in wearing out the brackets on the side in which are fitted the holding down clips. All these troubles may be overcome by attention and sufficient lubrication.

Focusing Headlights

Before new cars are loaded for shipment, we run each car on to a range specially measured off for focusing and adjusting the headlights. During the loading or unloading, or after the car has been put into service, it is quite possible that the headlights may have been moved out of their proper position by some one accidently bumping the fenders or leaning heavily against the lamp tie rod.

To obtain the best results from the headlights for all-around purposes, measure off and use a range as illustrated in the accompanying sketch.

The car should be placed forty feet from a wall and the rays focused against the wall so that each circle of light measures three feet in diameter. The edges of these circles should just touch each other in the center. (See X in illustration.) The lower edges of these circles should strike the wall 1½ feet from the floor.

To focus the rays on the Super-Six headlights, remove the front glass by pressing in on the nickel plated rim and at the same time turning it to the left. Focus by pressing down on the bulb and at the same time pushing in or pulling out to obtain the desired results.

On the Super-Six, the glass is removed in the same manner, but the focusing of the bulb is somewhat different, being accomplished by turning the bulb socket to the right or left as the case may require. The socket turns in a coarse, spiral thread, causing the bulb to move in or out.

Should the circle of light strike the wall too high or too low, it may be adjusted by slightly bending the bracket which supports the lamp; or, if the lamp is adjusted so that the light shines too far to the left or right the brackets and tie rods may both be bent to bring the light into proper position.

Many owners have ideas of their own in regard to how headlights should be adjusted and this depends very much on their requirements.

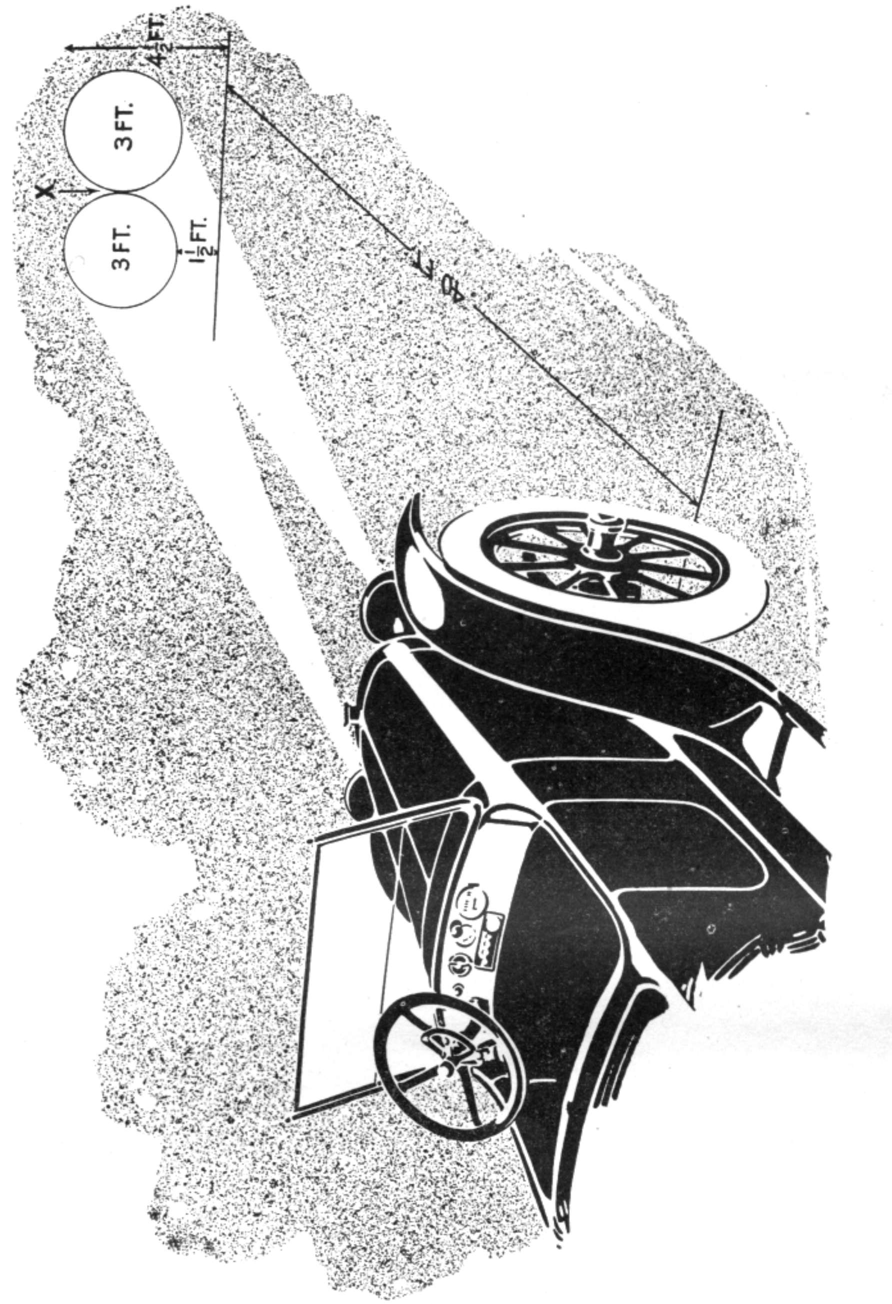
Those who operate their cars in the city do not need very much light; in fact, the glare directed close in front of the car is the most satisfactory.

Owners driving in the rural districts and especially those who like to drive fast, prefer to have the lamps focused to throw the light a considerable distance down the road.

Some consider it an advantage to have one focused for a beam light, and the other for a fan effect to illuminate the entire width of the road.

Should the reflectors become dirty or tarnished, they may be cleaned in the following manner:

Secure a small quantity of Putz Pomade at any drug store. Remove the glass front and bulb and apply a little of the Pomade with a soft chamois skin, drawing the chamois from the center to the outside of the reflector and then polishing the reflector with another chamois in the same way. Never polish a reflector with a circular movement, as this will scratch it and greatly impair its brilliancy.


X
3 FT.
3 FT.
$1\frac{1}{2}$ FT.
$4\frac{1}{2}$ FT.
40 FT.

Greases

Whitmore Compounds for Rear Axles and Transmissions

Sometime ago a dealer in the West wrote us as follows:

"Regarding the Auto Protection Compound you have recommended for differentials, beg to say I had sample of this material drawn from a new Hudson "Six," as I wished to have material matched so we could secure same from local manufacturer in this section, and eliminate delay in securing our needs. The sample was sent to laboratory and analysis is as follows:

Gravity	15.8
Flash	265
Fire	340
Viscosity	102 at 212 Temp.
Tar	30%
Napthine acids	5.8%

We can secure match to above analysis very easily, but we are informed by local concern here, Oil as per sample we are mailing you, will give much better lubrication, and same can be mixed with any other first-class Pennsylvania Oil Product. Kindly examine sample we are mailing you today and advise us if we should use same, also if you are still recommending the use of Whitmore's Compound."

The above opened up a very interesting field for discussion, and we immediately conferred with the Whitmore Company with the following result: The analysis quoted covers a mixture which is made from residual ends, and undoubtedly pine tar and napthine. It is not Whitmore Compound and would seem to be the attempt of an unscrupulous manufacturer to push his own inferior goods against a compound which apparently cannot be duplicated. The purported analysis made, has no bearing on the Whitmore product in any way, their composition being absolutely free from napthine acids and tar of all descriptions. They assert that no chemist has been able to determine, by analytical test, the nature or composition of the Whitmore Auto Gear Protective Composition, for differentials and transmissions. The same applies to all products manufactured by the Whitmore Company, which are secret formulae, and which their competitors have tried in every way to duplicate for several years. All products manufactured by the Whitmore Company are guaranteed to be absolutely free from napthine acids, coal or pine tar products, moisture, acids or anything that would have any detrimental effect on metal, and that there are no lubricants in the entire world that will, under practical, severe, hard tests give the same results as have been found with their goods. This, of course, refers to their special lubricants which they recommend as being adapted to certain conditions.

It is interesting to learn the report of the Isthmian Canal Commission which is appended hereto, bringing to light some interesting facts regarding the Whitmore Compound. At the time of making these tests, they were in competition with 52 different lubricants, and as the tests proceeded, covering a period of two and a half years, and the different lubricants had been set aside on account of failure to cover the specifications required, they were reduced down to two compositions—the Whitmore and one other. The two products were then tested by spreading a thin film of lubricant over metal, which was then subjected to chlorine, acids, gas fumes, and the Whitmore product was the only one that would stand up under this unusual, severe test, and on that account was accepted by the Isthmian Canal Commission, who reports on same as follows:

"The tests were made to determine the relative merits of various lubricants for lubricating the centre pivot of the emergency dams for the Panama Canal. The centre pivot is of essentially the same construction as that used on all centre pivot draw spans, namely, there are three discs, an upper and lower, similar to each other, and a middle disc. The upper and lower discs are each concaved on one face and fit and revolve on the convex faces of the middle disc. The flat face of the lower disc bears directly on a large base casting, weighing approximately 17 tons and imbedded in concrete. The flat face of the upper disc supports the top casting which transmits the entire weight of the structure to the pivot. A cast box, in halves, encloses the three discs, thereby affording protection from dirt and water.

"In the turning of the dam it can be seen that either the surface between the upper and middle disc, or the surface between the lower and middle disc will require lubrication, and in view of this, both convex surfaces of the middle disc have been provided with grease grooves radiating from the centre of the surface. Through all three discs a 2" hole has been drilled and the radial grooves on the middle disc originate in this hole. A 1" pipe connects the 2" hole with a greasing device on the floor of the dam. This device consists of a cylinder, to be filled with the lubricant, fitted with a piston upon which pressure is applied by means of a hand wheel at the end of a screw. The cylinder is 6" in diameter, by 12" long and is located about 20' 0" away from the discs. The lubricant is, therefore, forced into the centre pivot at considerable pressure.

"The discs are all 43" in diameter, the upper and lower discs being 5" through the centre, while the middle disc is 7" thick. The upper and lower discs are vanadium steel, case-hardened on the concave face to a scleroscope hardness of 85 to 90. The middle disc is of forged manganese bronze, having an elastic limit of about 90,000 and a scleroscope hardness of 55 to 60. The weight of the structure coming upon the disc is about 6,700,000 lbs., giving unit pressure over the area of the discs of about 4,620 pounds per square inch. The dam is to revolve about 90 degrees in two minutes and there will be long periods of rest, approximately one month between turnings. It is therefore, imperative that the lubricant used shall be of such quality as to maintain a film of grease between the surfaces during the period of rest, and under the load to which it will be subjected, so that at the first instant of motion there will be no binding of the metals to each other. In consideration of the points under which the centre of the emergency Dam will operate, the apparatus used to determine the most suitable lubricant for the purpose was made to approximate the actual working conditions as nearly as possible. Three discs were secured, two of case-hardened steel each 3½" in diameter by ¼" thick, having a 1½" hole in the centre and a forged manganese bronze middle disc 4½" in diameter, also having 1½" hole in the centre. A lever 36" long was clamped to the rim of the bronze disc so that with a known weight applied to the lever, the force required to rotate the disc under pressure could be measured. The pressure was applied to the disc by a hydraulic plunger and the readings were taken directly from the gauge. The following different lubricants were tested:

No. 1 Whitmore	No. 3 Whitmore
No. 2 Whitmore	No. 4 Whitmore
Standard Albany Grease	No. 600-W Cylinder Oil

The table below gives the results of the test made. It is evident that all co-efficients of friction are starting co-efficients.

Grease	Unit Pressure on Disc	Inch Lbs. to Start Motion	Co-efficient of Friction	Motion	Surface See Note Below
No. 1 Whitmore	1070	2592	.130	Slight	No. 1
No. 2 Whitmore	1330	2592	.104	Slight	No. 2
No. 3 Whitmore	5330	2592	.025	Slight	No. 3
No. 4 Whitmore	800	2592	.157	Slight	No. 4
Std. Albany	870	2592	.208	Slight	No. 5
No. 600 W-Cylinder Oil	1070	2592	.130	Slight	No. 6

Surface No. 1

Film of lubricant over entire surface but unequally distributed, showing a probable tendency to squeeze out.

Surface No. 2

Film of grease over entire surface more uniformly distributed than No. 1.

Surface No. 3

Satisfactory film of grease over both surfaces, practically uniform over entire area, showing no tendency to squeeze out.

Surface No. 4

Appreciable film of grease over entire area very unequally distributed. It is probable that under continued revolution the surface would become dry unless additional lubricant was supplied.

Surface No. 5

Film of grease fairly uniform over entire area, but very thin.

Surface No. 6

Film of oil over entire surface better than No. 5.

Tests were also made as follows to determine the effect of high unit pressure on the discs and below will be found the result of these tests.

Grease	Unit Pressure on Disc	Inch Lbs. to Start Motion	Co-efficient of Friction	Motion	Surface See Note Below
No. 3 Whitmore	13300	4198	.017	Slight	No. 7
No. 3 Whitmore	5330	2560	.025	Slight	No. 7
No. 3 Whitmore	3500	1340	.027	Slight	No. 7
Std. Albany	3200	5880	.100	Slight	No. 8

Surface No. 7

Decided film of grease over entire surface, uniform throughout, grease showing no tendency to be forced out between surface even under extreme pressure.

Surface No. 8

"Film of grease over most of the surface, unequal in distribution and showing numerous dry spots which with further revolution would undoubtedly become abraided.

"Referring to the above tables and notes on the surfaces, it is evident that the grease marked No. 3 Whitmore is the most desirable grease for the purposes, in not only having a lower co-efficient, but under excessive pressure a film of grease is maintained between the surfaces.

"The above shows: at a unit of pressure 5,330 lbs. to the square inch, a betterment or factor of safety of 700% and at 13,300 lbs., 600%."

Inspection of an axle containing Whitmore Compound will reveal the fact that the contact of the gear teeth does not entirely squeeze out the film of oil. For this reason the Whitmore Compound will quiet any axle. It also follows that, there being no direct contact between the metallic surfaces, the life of the gears and other revolving parts is considerably increased. The lubricant will last very much longer than ordinary oils and greases, and for that reason is very much more economical from the user's standpoint. Whenever complaint is made on Whitmore Compound, it has developed, upon investigation, that either the wrong grade of lubricant was used or that the quantity was insufficient for thorough distribution over all moving parts.

We are offering this advice because we believe that many of our dealers are using cheaper grades of oil for economy's sake, or because they have come in contact with unsuitable grades of Whitmore Compound. Since the Hudson Motor Car Company have deemed it advisable to pay a high price for this composition, we believe it behooves every one of our dealers and all HUDSON owners to benefit by our experience and accept our recommendations. Whitmore Compound can be obtain from the Whitmore Mfg. Company, Cleveland, Ohio, and the grade used in our cars are as follows:

Transmission. Whitmore Composition No. 7, 4½ lbs.

Rear Axle. Whitmore Composition No. 45, 6½ lbs.

All grease cups on front axle, steering gear, springs and pinion carrier housing are lubricated with Whitmore Anti-Friction No. 5.

Oils For Winter Use

We are recommending the following oils for winter use in the Super-Six motor:

Veedol—Light
Vacuum—Arctic
Harris—Light
Monogram—Light
Texaco—Medium.

There are many other good oils on the market, but at least one of these may be secured in nearly any community.

Oil should be purchased in sealed containers.

Oil should be drained from the motors every 500 miles. This is even more important than it has been heretofore due to the fact that the heavy, non-volatile products contained in the gasoline today, do not all find their way out through the exhaust. These heavier products get past the pistons and into the oil of the crank case, diluting it, and impairing its lubricating qualities.

The products of combustion are Carbon Monoxide, Carbon Dioxide and Water. When a motor is still cold and has not as yet generated heat enough to vaporize this water, part of it may be seen dripping from the exhaust pipe while some of it is going down past the pistons to unite with the lubricant.

Poor oils absorb a great deal of this water, while good oils reject it to a certain extent. Therefore, during the cold weather, it is particularly important that you carefully watch the cars with this advice in mind, and instruct your owners accordingly.

General Super-Six Lubrication

The following covers proper lubricant and amount to be used in the various parts of the Hudson chassis:

Motor. Use six quarts of a good quality lubricating oil, light grade in the winter time, medium in the summer.

Clutch. Use one-half pint of a mixture of equal parts kerosene and light lubricating oil.

Transmission. Three pounds of No. 7 Whitmore Anti-Friction Compound.

Universal Joint. One-quarter pound of Moore's Universal Joint Grease in each joint. Mix this grease with enough light cylinder oil to insure its getting into the bearings.

Front Axle. Whitmore's Roller Ball Bearing Compound, distributing six ounces per wheel as follows: two ounces in each hub, including bearing cups; four ounces in each hub cap.

Rear Axle. Four pounds No. 45 Whitmore Anti-Friction Compound.

Steering Gear. One-quarter pound No. 5 Whitmore Anti-Friction Compound.

Distributer. E. F. Houghton & Company's No. 7 Absorbed oil. Approximately one teaspoonful in both top and bottom of distributer.

All Grease Cups Except Water Pump. No. 5 Whitmore's Anti-Friction Compound.

Water Pump Grease Cups. Arctic Cup Grease. Medium.

General Super-Six Information

Motor

Bore	3½ Inches
Stroke	5 Inches
Firing Order	1-5-3-6-2-4
Dip of Connecting Rod	1-1/16 Inches
Generator Gear Reduction—Armature to Flywheel	23.35 to 1
Crank Shaft to Generator Shaft Ratio	1 to 1½

Capacity of Various Units

Capacity of Oil Pan	2½ Gallons
Capacity of Radiator	2½ Gallons
Capacity of Entire Cooling System	4 Gallons 1 Quart
Capacity of Vacuum Tank	2.4 Pints
Capacity of Gasoline Tank	19 Gallons
Capacity of Transmission (Grease)	6½ Lbs.
Capacity of Rear Axle (Grease)	5 Lbs.

Rear Axle Ratios

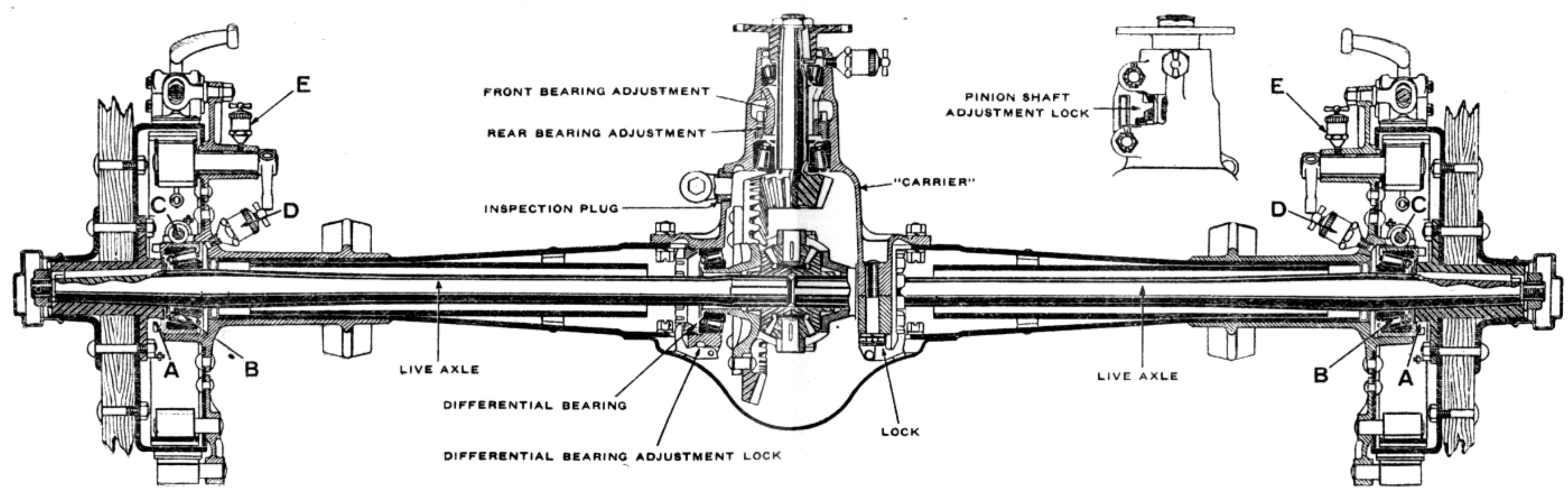
Third Speed Direct	4-5/11 to 1
Second Speed	8.017 to 1
First Speed	13.362 to 1
Reverse Speed	16.435 to 1

Transmission Ratios

First Speed	3 to 1
Second Speed	1.8 to 1
Third Speed	1 to 1
Reverse	3.69 to 1

Miscellaneous

Clutch Throwout	⅜ Inches
Number of Driving Discs—Steel	8
Number of Driven Discs—Steel	8
Weight of Storage Battery	49.625 lbs. Capacity 80 Amp. Hours
Wheel Base	125½ Inches
Length Overall—Top Up	14 feet 8 Inches
Length Overall—Top Down	15 feet 7 Inches
Height Overall—Top Up	7 feet 1 Inch
Width Overall	67 Inches
Road Clearance	10⅞ Inches
Tread	56 Inches Standard and 60 Inch
Tires	32x4½—33x5—35x4½
Turning Radius	23¼ feet to left—18 feet to right



Rear Axle Diagram