1913 Hudson

Instruction Handbook

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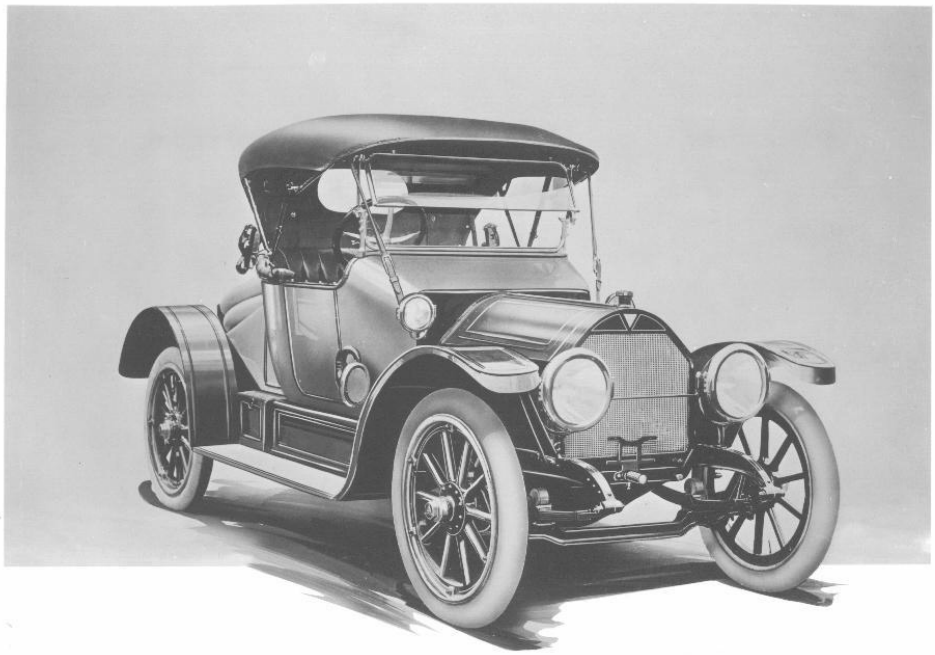
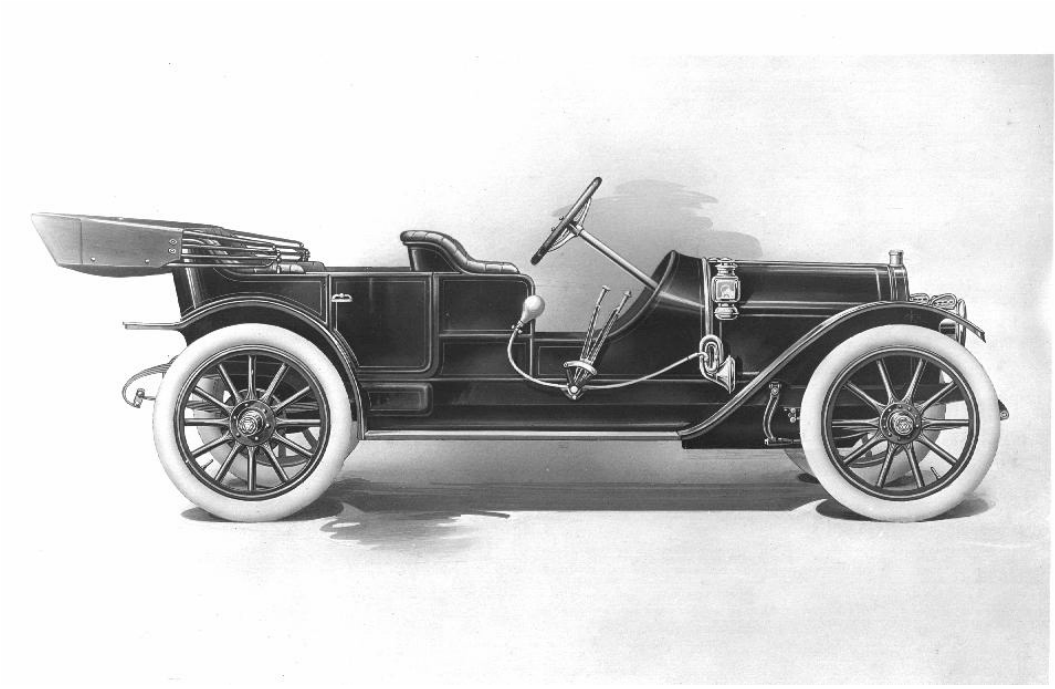


1913 Hudson “Model 37” Roadster



1913 Hudson “Model 37” Touring

ORDER OF ASSEMBLING PARTS ON FRAME
CHASSIS ASSEMBLING
1913 MODELS

The frames as received from the manufacturers are supplied with the front and rear brackets for the attachment of the front springs, the combination bracket for the front end of the rear spring and brake cross shaft, the control tube cross member bracket, the torque bumper bracket, and both front and rear motor supports The muffler bracket, quadrant bracket and gasoline lank supports are riveted to the frame upon arrival and the head lamp bracket and running board brackets are bolted in place. The work is started with the frame supported on suitable horses in an inverted position to facilitate the attachment of such parts as the running board hanger, brake shaft, springs, and front axle.

The attachment of the running board hangers to the frame requires three bolts to each hanger. One a through bolt from bottom to top of frame with a pipe spacer inside channel of frame to stiffen the flanges and prevent springing when weight of person entering the car is on the step.

Brakeshafts. The two shafts which run across the frame and to which the brake rods front the rear axle are attached, are provided with bearings which are made integral with the front end of rear spring bracket. A reamer of the proper size is first run through the holes in these brackets to insure a good fit for the shafts.

Take two of the brake shaft assemblies and remove the center and one end lever and knock out the taper pins which hold them oil the shafts. Also remove the keys which are for the purpose of taking the braking strains. Insert about three quarters of the length of one of the shafts, and replace the middle lever before sliding through the opposite side bearings. Replace the other end lever with key and taper pin, taking care that both shafts turn freely in their bearings, and that the clips in the center of the cross member between which these shafts are carried are bent slightly to throw the shafts out of line about 1/32" to prevent rattling by vibration. There should be no rattling in the beatings or end play sufficient to cause rattling at the sides

Hand Control Set , consisting of the hand brake lever and gear shilling lever assembled on a tube (and shaft respectively, are placed on the frame next. The gear shifting or change speed shaft runs through the tubing on which the brake lever for the emergency brakes is attached- In this way the tubing forms the bearings for the shafts by the fact that it is bushed at ends to the size of the shaft, and the shaft is then carried on a casting in the frame near the center and the assembly is also supported by the main casting oil the side of the frame, The shifting finger is on the end of the shaft beyond the end supporting bearing. This finger is shaped so as to engage the end of the rods which enter the rear end of the transmission to move forward and backward the sliding gears by which the different speeds are obtained. The utmost care should be exercised in getting this shifting shaft to shift the gears easily. The motion of the shift is across the car and. by taking the end of the hand lever in the hand, the shaft should freely move sideways bringing the finger into play with either of two rods of the transmission, as two speeds are obtained with each rod. When the required position sideways is obtained, the]ever is pushed forward or pulled backwards to get the necessary speeds, guided by the two slots in the shifting quadrant. A very slight pressure should be all that is necessary to shift gears. Any sticking of the sliding shaft or of the gears in meshing, should be remedied, To try to force the parts into engagement only strains and bends the levers and throws the assembly out of alignment which is only aggravating the trouble Grease should be supplied oil the shifting shaft before assembly to insure easy action, and lubrication of these parts should be watched afterward. The levers should have enough travel in the quadrant to engage the locking device for each speed

The Hand or emergency brake lever is operated by means of a short lever attached to its tube and a rod running forward from the intermediate brake shafts which we first assembled. A latch is provided on the side bracket which works on a ratchet to lock the brake when necessary.

Front Springs. We will now take the front springs provided with their shackles, bolts, nuts, etc., assembling with the short end towards the front, the spring being made offset from center. The front end of the spring is carried in a bearing provided by the casting riveted to and making the end of the frame called the spring horn arid in the rear by a shackle This shackle in turn is attached to a casting riveted to the frame. By this means the spring is given a chance to deflect under a load or to carry its load over the inequalities of the road with the greatest comfort for the driver. The fitting of the bolts should be so taken care of as to prevent turning in the bearings and they are hardened to take the wear of the springs on them. The head of the bolts at front end fit against a lug on the castings which form the front bearing and the bolts in the shackle are held stationary by a pressed steel strap w Or lugs to fit against the hexagon side of the bolt heads.

There should be no side play of the springs in the hearings or shackle to cause rattle, neither should the bolts be drawn up so tight as to make the spring action too stiff The cotter pins in the nuts on these bolts can be so placed as to get just the right condition, The fit of the shackle bolts should be light in the reamed holes of the bearings to prevent noise, but not tight enough to make it difficult to drive them in. Before putting in the bolts, oil them well to prevent roughing the bushings in the springs and bearing surfaces, and when it is necessary to take them out they should tap out with light blows. After first reaming the bearings, put on the springs and insert the bolts with the end provided for grease cups towards the outside. Tighten up nuts as previously instructed.

Front Axle, including the spindles, steering arms and cross rods connecting steering arms, can now be attached as an assembly. The spring saddles on those axles are forged integral and it is only necessary to insert on the bottom, first a pad of duck and then a curved piece to follow the contour of the spring and attach with two clips per spring. We also place a spacer on the top side of the springs, between the clips to prevent the spring slipping, these pieces giving a flat surface on which to pull the clips down. 'the nuts on the spring clips should be good and tight, a lock washer being used to prevent loosening up, **but to avoid broken springs it is a wise precaution to tighten up on these nuts occasionally.**

The Magnetic latch is attached to the center cross member with the lever assembled for attachment of die operating rods to starting mechanism. This latch is inclosed in a cast housing and is secured to frame member with four bolts and nuts locked with pins. At this point on all torpedo chassis a side shaft is also bolted to left hand frame member for controller mechanism, on account of different location of controller on running board.

The Rear Springs are of the 3/4 elliptic type, the upper part, called the scroll is attached to the frame by means of two gusset plates which extend out from the frame for that purpose. Between these plates with the necessary number of shims to fill tight, the spring is bolted on with three bolts and pinned nuts, one through the spring itself and one on each side. A wooden shim also is used to fill in between frame and side of spring These same bolts attach the bumper plate and bumper. The rear springs are also provided with shackles and the bolts should be fitted with the same care as the front springs. and in the same way, reaming the bearings and lubricating thoroughly before putting in the necessary tight fitting bolts. The front end of the rear spring is carried by a casting which also makes the bearings for the intermediate brake shafts This end should fit snug to prevent side slap. These bolts, as well as all shackle bolts, are hardened to take care of the wear on them, and will, of course, in time show some loosening up on account of such wear, but bear in mind that this is to be expected and should not be considered a defect after a reasonable amount of service has been given. To prevent this wear as much as possible, see that the grease cups provided on each bolt are filled and a rum taken on them every day or so. 1 his grease will harden if riot used and the result will be that the passages through the bolt will become stopped and useless, and the grease will not penetrate to the place where it is needed.

The Torque Arm Hanger which supports the front end of the torque arm, is attached to the cross member of the frame by a bearing through which passes a bolt that allows the hanger to swing forward or back, as the torque arm demands, This hanger is provided with two heavy coil springs backing up a cup on each side of the ball on end of arm. The lower spring being held by a plug in the bottom of the hanger casting, which plug should have a cotter pin to be sure it will not work out. The location of the pin hole gives enough tension in the springs The hanger casting has a slot in the back side to give the arm up and down play and the coil springs are of' sufficient size to prevent the arm striking end of slot or spring bottoming when rear wheels strike a sharp bump.

Hood Locks are next attached, two on each side, provided with coil springs to furnish necessary tension to keep the hood tight. The upper part of the lock just under the handle is rectangular in shape, and fits into an oblong hole in the frame so that handle can be pulled up to disengage the lock arid turned 90 deg, The long side of the rectangle turning across the narrow way of the slot, will keep the handle up.

Rear Axle Assembly. The rear axle assembly consists of fitting the rear universal joint yoke to the pinion shaft of the axle, assembling this joint and propeller shaft and attaching the torque arm to the axle housing. The universal joint yoke is held on the square end of the pinion shaft by a large nut and cotter pin, The fit on the square should be tight and the nut should be set up against the yoke. The torque arm is attached to the axle with a large pin through the axle housing and should fit so as to prevent any chance of rattling The pin should be well greased before being put in place. The nut and cotter pin should go on the bottom. The curve side of the arm should be up.

The Rear Axle is attached to the rear springs by saddles oil trunions split in half and bearing on the housing of the axle, The torque is taken care of by an arm attached to the housing, extending forward arid terminating in a ball which is carried by a casting supplied with coil springs arid hardened cups. This casting is supported by the frame cross member.

To assemble rear axle, first take the upper halves of the saddles, well lubricated with grease, arid place them on the springs and fasten with two spring clips per spring, using, also a spacer on top of' the, spring to separate the two clips arid give a good bearing, We call now turn the frame over first having placed the rear axle alongside ready to receive the saddles on the springs, and with a suitable horse for the front axle. Now put oil the bottom half of the rear axle saddles, first filling them with grease The fit of these trunions should be free enough to assist in the spring action, but should not rattle. The bearing Surface is provided with grooves to retain the lubrication and good sized cups are supplied to keep the bearings well supplied with grease.

Front Lamp Irons for the headlights are bolted securely on the frame with a tie rod to assist in preventing vibration in the lamps. These irons are drop forgings and can be bent readily without fear of breaking where necessary to get the lamps properly in line so that the light rays are thrown correctly ahead on the road

Brake Rods. Put oil next all the brake rods connecting the levers provided on the rear axle with those on the intermediate shafts, and in turn the levers on the intermediate shafts with the emergency brake, tube lever and foot lever. The latter connection can be finished after motor assembly is installed. All brake rods are made so as to provide adjustment, each rod being provided with an adjustable clevis arid lock nut (in one end. The pins for the clevises are a snug fit and the holes should be reamed to line up to receive them, arid cotter pins must in all cases be used to prevent pins working out. All the brake rods should be shaped so as to pull as directly as possible and cafe should be used to prevent them touching any other part or coming near enough to strike and rattle when on the road.

The rods for the internal brake should be attached to the levers on the rear cross shaft, and those for the external brakes to the front cross shaft.

The external brakes are prevented from touching the drums when not in use by coil springs at ends of brake bands, and also by a spring attached to cross shaft fastened to the frame side member. The internal brakes are released from the drums by the springs inside the drum, The external bands on the Model "37" axle should not be set so as to prevent the ends being down in the holding lugs, or rattling will occur.

To adjust the rods to a proper length for applying the brakes, first see that the brake bands on the axle are not bent and that they set the same distance from the drums at all points and the lugs that hold the bands in place are not bent or rubbing on the drums. Work the rods by pulling Up on the levers and see that the springs provided to release the brakes are doing so. Oil all the pins in rod and also on axle thoroughly to assist in this action. Connect up the brake rods now with the brake bands allowing 1 /32" between bands and drum We can then put on our wheels arid finish adjustment

The Rear Wheels are carried on two large roller bearings, and the fit of these bearings should be a matter of great care. The inside shell of the bearings should have a snug fit on the axle spindle but should not drive on, or be so tight as to make it necessary to force the bearing or injure it by using a hammer

Lay rear wheel on floor - drum side up - slip in the inner bearings, flat side down using plenty of grease and follow up with the felt washer and dust ring, locking them in with the spring lock- Now put on the wheel and then - flat side in - the outer bearing, well doped with the spacer and shims between. Follow up with the nut which has the shoulder on one side, the shoulder next to the bearing. Tighten up nuts; if wheel will not spin free put in another shim and try again, repeating until wheel spins free though the nut is fight. Slip in the driving shaft and put on the acorn nuts on the wheel flange. It is not necessary to take off the hub caps on the rear wheels to make any of these adjustments. Now fill up the grease holes in flange with grease gun and screw the plugs into place.

The Steering Gear including the hand wheel, column, housing and gears, with projecting shaft for steering arm, is now put into the chassis, the shaft extending through a hole in the frame and the housing held on the frame by four bolts. After securing these bolts so as to get proper angle of column with Frame, attach the steering arm on the square of the shaft, the hall turning in, and pull up fight on the clamp bolt. Oil thoroughly and fill the gear housing with heavy oil making sure that wheel turns freely. It should spin from one extreme of' the throw to the other If main column has too much up and down motion, or over .010". tighten down on the adjusting nut on the housing. This will give sufficient play for the worm to turn freely

Steering Link. Connect the steering Scar, now, with the front axle by means of the link. This piece has been provided with a socket at each end with a coil spring behind it to take the jar of the road obstructions. The ends of the sockets have a plug to take up the lost motion and when the spring tension has been adjusted, plugs should be pinned.

After thoroughly oiling the steering arm pins and knuckle bolts which hold the spindle on the axle, test the turning of the steering to see if everything is free and there is no lost motion. The knuckle bolt,; and bolts cm cross arm can be adjusted by tightening or loosening up the nuts on the bottom. The knuckle or spindle is provided with hardened washers to prevent as much wear as possible, where the weight comes oil the spindle at the top, and bronze bushings are fitted into the knuckle to take the wear of the bolt. The pin holes in steering arms are also bushed and all pins are furnished with grease cups. 'the steering arms are fitted into (lie axle with a taper fit and should always be kept tight. With the wheels off the floor. the steering wheel should easily turn front one end of the throw to the other, and there should be no lost motion. All front axle assemblies are tested for the proper turning radius to prevent the wheels rubbing on the springs or frame. That is, the steering arms should strike on the axle yokes before tires strike, the forgings are provided with stops to accomplish this.

Motor Assembly. We now take the motor as it comes to us from motor department assembled complete and fit the clutch into the flywheel and attach the transmission,

Fitting the Clutch To The Flywheel In order to assemble clutch in flywheel, first see that the four studs in flywheel are in line with holes in clutch housing cover and driving plates of clutch. Place the clutch spring in crankshaft flange which has been bored to receive it, putting enough shims back of spring to bring spring with 3/16" of rear of flange on "37" and 3/8" on "54." Then take clutch and see if the small coil separating springs are between the plates, Line up the holes in clutch plates with four pieces of stock that fit close in holes and turn clutch over with back side up and drive some small wedges between cover and hardened

collar. 1 his puts enough tension in coil springs to keep them in place. Try the bronze collar in hole in crank shaft to see if it will slip out and in freely. Place thrust bearing on clutch shaft and then bronze collar with the oil grooves in collar next to thrust bearing. Clutch can now be placed on flywheel studs with a gasket in place between covet and flywheel housing Take up on the cap screws in cover equally all around until tight and then pin the nuts on the studs.

With a lever throw the clutch forward and see if shaft is free to turn. Now take up the transmission and place the projecting shaft into the clutch- This shaft acts as a pilot to line up the clutch and transmission. Have the longer bolts ready to go through the joint in motor case and leg of transmission. Tighten these two bolts carefully and also the two lower ones, and pin the nuts, using washers to make the pin holes in bolts come right in the slotted nuts. Try the gear shifting and see that each speed will mesh properly and shaft extending at rear of transmission will turn freely in each speed. Attach the universal joint on transmission shaft and take off dust collar at rear end of joint and slip it over the propeller shaft on the axle- Fill the square hole of joint with grease, Now hoist motor up and swing it over the chassis and lower down the rear end first, entering the propeller shaft into the joint on rear of transmission. As motor is lowered guide the legs down on supporting brackets on the frame putting a fiber piece under each leg and let the shifting finger enter the slot in the shifting rod. The holes in the motor brackets are drilled and reamed in a fixture that absolutely makes all motors interchangeable. The motor legs are also drilled in the same careful way in an inflexible fixture. Put in the bolts to secure motor and tighten them down with the nuts on the underside. While under the car put on the bracket that supports the throttle to carburetor air opening, this bracket being attached to rear motor leg, left side. Connect the brake rod to brake pedal, the pedal being part of the transmission assembly, and see if springs on brakes will bring pedal back to place after setting the brakes. Assemble the carburetor and water jacket extension of inlet manifold on the bench putting the pipe fittings on for hot water jacket- Put on the carburetor and con nee[the distributor rod which runs to steering gear. Try the stud in cylinder casting which supports the fan bracket to see if tight, then put on the fan belt and fan, adjust the fan to run true and take the stretch out of the belt to prevent its loosening up.

The Starting Crank and bracket should be lined up with motor and, if cross member of frame is not square and plumb, bend to correct position to allow the starting crankshaft to engage the pin in crank shaft. Bolt the bracket on and try the alignment and also see that swing crank, will disengage quickly. A spring is provided to throw crank out of engagement. The front license plate holder is supported by same bolts that attach starting crank bracket and is put on at this time,

Muffler and Exhaust Pipe should be put on now, packing the joint at the manifold with asbestos packing and graphite, tightening up the nut to prevent leaking of the exhaust. The muffler is supported by two steel stampings from the frame, and is supplied with a short tail pipe as a part of the rear head The rear end is attached to hangers by cap screws which go into tapped holes in head; the front is supported in a similar way arid also has a flange or packing gland to prevent leakage around the exhaust pipe. 1 here is no provision made for a cut out, its they are not considered necessary, there being no appreciable loss of power through back pressure and in most cities the use of the cut out is now prohibited, The exhaust pipe is covered with an asbestos covering held in place by brass straps to keep body floor cool.

Side strips for Hood. On each side of the motor and fastened to the frame by Small bolts are the hood snips. These strips are used to make a better joint between frame and hood.

Water Connections. The water connections for the radiator consist of rubber how fastened with clamps There is an extension from the water pump with an elbow turn at the bottom to which the inlet how is attached, and on the top of the motor there is a cover plate with hose connections for the outlet of the cooling water,

In our factory testing we do not use the radiators that go out on the finished cars. the wear and teat, going through the road test and adjusting stage of manufacture bangs them up and fills them with mud, making it very difficult to get them clean enough to ship on a finished car The material in the radiator tubes is thin, due to the necessary cooling conditions demanded, and they can be easily made to leak so that care should always be used in working on the radiator There is an outlet plug in front to drain radiator when necessary

and the filler on top is provided with a strainer to prevent getting anything through to stop the circulation of the water.

Brake Adjustment. We can now go back to adjustment of the brakes. Pull up on each set alternately and put your full weight on one side of the wheel, (the axle being jacked up from floor) and adjust the rods until you cannot turn the wheel. This will be sufficient until car can be driven under its own power.

Front Wheel Bearings. In fitting the front wheel beatings, the same care should be used to see that the bearings snugly fit on the spindle. Take the bearings and slip them on the spindle- They should go on easily, but without play. Do not force a bearing on, and if necessary take a little off the spindle with emery cloth- After filling in between the rollers with grease put the inside or larger bearing into the wheel hub, flat side down, and follow with the dust ring. Turn the wheel over and put in the smaller bearing with the taper spacer between them- Now put on the wheel and washer, tighten up on the nut and take out all of the end play on the bearings, and spin the wheel to see if bearings are not too tight (same as in rear wheel,.; so as to clamp the inner races but wheel should spin freely) Put in cotter pin and screw on the hub cap. There is plug hole in the hubs for pulling in grease without removing wheels.

The Gasoline Tank is supported from the rear end of the frame by two bands lined with webbing. These bands are fastened to the frame bracket and provided with a nut to tighten the straps about the tank to prevent any shifting. These straps should always be looked over carefully to see that tank is rigidly in place- The webbing is riveted to the bands to prevent abrasion of the tank and to prevent slipping. The tank filter cap has a leather washer to make a fight joint to hold the air pressure on the gasoline supply system

The Gasoline Line and Air Line leading from the tank to the motor should be fastened to the frame with clips to prevent rattling and wear by rubbing. The tubing should run as direct as possible and should have no sharp bends or dips to stop the flow of the fuel or catch any dirt that might get into the line.

The air pressure is furnished by the small plunger pump operated by the cam shaft and attached to the side of the crank case on the left side of motor. There is a check in this pinup to prevent flow in the reverse direction. To a tee in the tube between pump and tank is attached a hand pump for use when motor is not running.

The rear license plate bracket and tail lamp bracket are bolted to the gasoline tank supports and, to clear body, should not come higher than tank support.

Look the chassis over thoroughly to be sure everything is in place, all bolts are tight, all cotter pins in place. Try hand shift lever and brake and clutch pedals and see if they operate satisfactorily. Also. try the spark and throttle levers with their rods and joints. The chassis is now assembled and after inspection, is ready for the road test.

FINAL ASSEMBLING

The work of final assembling is divided in our factory into three parts, **viz**;

First Division. consisting of fitting the body with all wiring, control mechanism on the dash board, top and curtains and those ignition instruments which are installed on the dash in front.

Second division covers all the parts which are more conveniently assembled on chassis before the body is put on, viz., running boards, aprons, front fenders, storage battery and controller on running board at side of cat, generator, connection of magnetic latch to controller and generator, bumpers, radiator and hose connections, leather boots on steering parts and torque arm hanger to prevent road dirt getting into the joints,

Third Division. Placing of the body and bolting it down to frame, rear fenders, steering gear bracket and floor board fitting, connecting up the wiring from body to motor, and the dash fittings to the tubing for air and gasoline pressure gauges, control to carburetor, lamps, windshield hood and tire irons.

FIRST DIVISION

The Body Assembly consists of the body painted and upholstered, cushions, carpet, robe and foot rail in tonneau, floor boards, irons for top, windshield support, plates to anchor body to frame, hood support, horn tubing, tire iron plate, scuff plates on door sills, name plate and hood tic rod bolt.

The Body Sills forming the bottom frame of body are the foundation on which the body is built, extending to support the side panels. The side panels are connected in front by the dash and shroud, making a well supported body. The door frames are built up on the bottom sills and are braced into the side frames making them rigid to take care of the strains to which a body is subjected in driving. This construction assures that the doors will not sag or present any difficulty in closing, of opening. A word of caution should be given here in regard to cutting these body sills. As we said above, the sills are the foundations of the body and wider no condition should they be weakened by cutting them for installing accessories. All (he Parts On (he assembled chassis are below the sill line for this reason and we have nothing projecting upward to obstruct the room in the body

The Top Irons are firmly secured to the body framing and are located with a template which makes all the tops interchangeable.

The horn has a concealed tube in the blank front door to which the horn is fastened on the outside, and the bulb within. In this way we do away with die unsightly tubing and locate the bulb at a convenient point to be easily reached. There is a plate on this same side for attaching the upper fire support.

The dash and front frame provides a passage way for the side lamp wiring concealing it from a point below the floor up to the bracket through which it comes to the lamp connection.

The rear fenders are provided with bolts set into the wheel house of the tonneau, and the wheel house is recessed sufficiently to cover die edge of the fenders and take care of any irregularities. The pressed steel piece on the dash to support the hood is fastened in place with screws, the top having a small bracket to take the hinge rod of the hood, and by means of the shape of the ledge the hood when fitted is flush with it, leaving no projecting comers. A lacing is inserted in the ledge to prevent any noise between hood and support.

The wiring of the car for lighting is carried in the channel of the frame and, at a point under the floor on the back of the dash, is connected to the body at the common terminal block for all lighting wiring, The current for the lamps is carried through duplex wire heavily insulated and securely attached to frame by numerous clips, and when passing through the frame rubber grommets are inserted in the holes to prevent chafing. The tail and small lamp on dash for night inspection of gauges. etc., are in the same circuit so that if the tail lamp goes out the driver is at once made aware of it by the circuit being broken, resulting in putting out the dash lamp. 1 he wires to the head lamps are carried in the left side of frame and across the frame at front end to the right hand lamp The wires for side lamps run from the terminal block to the lamps through an opening in the dash frame, concealing them until they emerge through the lamp bracket- All the lamps are provided with a connection to which the wires can be readily attached or detached. as needed.

The wiring for ignition, lighting and starting from the batteries comes to a common point under the front floor boards on the dash, From this point the wiring is carried through insulated conduits to the switches, generator lamps, etc. - and for convenience in taking off bodies, the connections for lamps can be broken at this one point.

Our **bodies** come to us painted and trimmed and it is advisable here to say it few words of caution in the handling of them. Finger marks or any cloth such as the elbows of your coats or shirts, will strike right into the varnish and can not be removed- Do not take bold of a body to lift it except with the sticks for this purpose, or allow your body in lifting to touch the panels. In working inside or around a body, do not carry screw drivers or any tools projecting from your pockets, or allow the buttons of your clothes to scratch the finished surface. It is necessary to refinish the entire body to repair a small scratch or dent.

The conduits for the wiring are of wood, metal or loom, to prevent the wires from getting oil and water soaked and to protect them from being detached or cut by passing sharp comers- These conduits ate fastened securely to the body and very little trouble should result from loose wires. The wires come through the dash to the front and are attached to the ignition devices located there, being easily reached for examination.

The fittings for inspecting and operating the different systems of lighting, ignition, oiling and carburetor control are for convenience, located on the dash board facing the driver's seat

The generating system of current for lighting, starting and ignition, consists of' a motor-generator mounted on the crank case and driven by the pump shaft, a storage battery mounted on the running board at side of car, and in addition, five dry cells carried under the front seat as an auxiliary system of ignition only. [he generator takes the place of the magneto in the old models and in connection with the storage battery makes a dual system. The dry cells as an auxiliary system carried in a box under the front seat, can be used to start the motor or in case of emergency for ignition

The switch on the dash for ignition purposes has four buttons- In starting use the button marked "Start" in preference to any other, this button connecting with the dry cells. The B. button is for the dry cell circuit and should only be used in cases of emergency for running. Care should be exercised in not allowing start button to remain in after starting, but change over to your M side of the switch. The button marked "start" produces a vibratory action sending a stream of sparks to the cylinder and is convenient for starting when motor is cold or for some reason of poor carburation Do not run on this button. The top button marked "Off' will stop the motor and when pressed in, will throw out all the other buttons.

The Lamp Switch provides buttons for lighting of head, side and tail lamps. and is connected to the lighting circuit on the dash.

The coil, ignition, relay and resistance unit are placed on the front of dash and their use will be explained in turn later, and the wires from them to the distributor and generator will be connected when body is placed on chassis.

Pressure Gauges. Besides the electrical fittings on the dash, there are the gauge for oil pressure in line from oil pump to motor, air gauge to show pressure in gasoline tank, and the choke rod control and hot air control for carburetor. These are connected up when body is placed on chassis by suitable tubes and rods for operation.

Starting Control. The hand air pump and switch for operating the starter control are placed on the heel board within reach of the driver. and are connected with the air line and the wiring system later in the assembling work.

The Top is put on the body at this stage of the work and the side curtains fitted. The top straps in front are attached to the studs which are placed in the side lamp brackets For that put-pose, and the rear straps are fastened to the rear irons. Bow separators are provided to carry top when folded down. The front straps are tightened until the top sets without wrinkles and the front end meets the top of windshield. Sufficient tension on these straps should be maintained to make the top rigid and prevent any swaying or rocking about. There is a storm strap at the windshield to fasten to the frame of the shield.

The body being equipped, we now take up the chassis and get it ready to receive the body. These two divisions of the work being done simultaneously in actual assembling.

SECOND DIVISION

The copper tubing for the gasoline tank line and the air pressure line are securely fastened with clips inside the frame channel on the left side. These tubes should be free from sharp bends or pockets to prevent the flow through them. In case of the gasoline tube, there is a -hut off cock at the gasoline tank which can be

reached at fear of car and is to be used to Cut off the supply from the tank when working on the line or carburetor, The joints are made with solderless unions, and if put together correctly will not leak. The air line has a tee at the front seat to connect up the hand air pump which is used for starting,

The gauge on the gasoline tank to indicate the quantity of gasoline in the tank is screwed into the end of the tank and has a fiber gasket to make a light joint. The dial is arranged to turn if cover is removed and lock ring holding dial in place is taken out.

The running boards and side aprons are bolted together on the beach and then attached to the hangers and frame, In handling sheet metal parts, be careful not to scratch tip [be paint work with the sharp edges, and do not scratch or chip the enamel on the fenders and aprons. There is usually no trouble in assembling these pails. It may be necessary to line the step hangers to get them in place to fit running boards. The sheet metal part, are made from accurate patterns and fitted on a chassis before enameling, they should go on easily,

The front fender with its splash apron is attached to the frame by rigid irons and the apron is bolted to side of frame with pieces of leather between to prevent rattling, The fenders should be squared up with the running board and be level on top, also at the right height from the tires. No bolt ends or rough rivets should be left to cut the tires and there should be no rattling against the frame or loose flanges or irons, As an additional means of stiffening, the fenders in front are fastened to the lamp brackets with a small clip. At this time the lamp brackets should be lined up square with the front of car.

The Battery and Controller on left running board can be placed and the operating shaft across the car to the latch on cross member connecting up also the rod to the clutch pedal for operating the latch

The Generator is provided with a shelf on crank case and is now carefully lined up and attached, shims being used when necessary to make the armature shaft and pump shaft line tip. The driving of the generator by the motor is provided with a ratchet clutch connecting these shafts and when generator is acting as a motor for starting this clutch allows the armature shaft to run independently. The generator has a train of gears enclosed in a housing at the back, which engage with teeth cut on the flywheel, so that as a motor the generator can run with a gear reduction of 20-1. This will turn the crank shaft about 40 R. P. M. There is a rod running from the magnetic latch which slides the gears into mesh with the flywheel, the teeth of the engaging gears being rounded to facilitate this operation- A metal guard is placed over the flywheel for protection and also to stop oil from being thrown

The radiator is located over the front cross member and secured by two bolts through the side members of the frame. A pad of leather is placed under the supporting brackets to act as a cushion for the radiator to keep it from touching the frame, The front side of brackets should be placed flush with the frame cross member and be squared up so that the hood will fit nicely. The holes for the bolts are slotted to allow some adjustment for fitting the hood. 'the hose connections can now be tightened up on the inlet and outlet of radiator.

Hand Control Sector for indicating the different speed changes and the brake ratchet are assembled on the bracket for the purpose. The levers should act freely and not bind on sides of slots, and can be lined up by bending them if necessary The latch on the brake should be free to act when brake is set or released, A drop or so of oil should be put on the rod running through the]ever to help the action- Each speed should lock- and lever should not strike end of slot before lock becomes engaged,

Leather Boots are provided for the steering rods to keep the joints free from dirt.

An Asbestos jacket is fastened around the exhaust pipe with brass straps, to prevent any of the hear radiating from this pipe. By this means the floor or the car is always cool.

Rubber Bumpers for the front springs are fastened on the springs with leather ,traps to take the severe road shocks and reduce them as much as possible, also to prevent too much action of the springs. 'I he rear springs are provided also with bumpers and rebound straps also on some models to control the spring action. The straps are fastened to a bracket riveted to the side of frame just in front of the rear axle.

The Starting System is now tested out with a portable set of wiring to see if the battery, controller, ampere hour meter, magnetic latch and the operating rods and connections are adjusted. The rods to the clutch pedal and to generator from the latch and from latch to controller are supplied with turn buckles and clevis for this purpose. 'this test is to determine the condition of the battery and to set the meter ready for use, to see if the latch and controller operate correctly and if rod to slide the gears to turn over the engine is adjusted to the proper length.

THIRD DIVISION

Placing the body on the frame with all its fittings must be done as carefully as possible to prevent marring the paint work. The body is picked tip from the horses on which it is setting, by three long carrying sticks - a man on the end of each; the sticks are long enough to extend away from body so that the men do not touch the sides, Come up to the chassis at the rear end and carry body forward, raising the front end to go over steering gear, then lower, guiding the hand levers through the opening in sill for them. Allow the body to rest on the front end, pull out the front and middle sticks and let the back end down easy- Square the body up on the frame at front and back and locate it endways from the front cross member. To prevent the bodies from being sprung fitting the tops and pulling down on the body bolts, shims arc used to level the sill. In this way if the sills are sprung so as to make the doors stick or not stay shut by shimming and tightening down the bolts, this trouble is avoided.

The doors are provided with rubber bumpers against which the locks hold the doors tight. In case of the doors working loose after a few months driving and beginning to rattle, which is apt to occur as there is always considerable working in the body and frame, renew the bumpers, which probably have been worn down and, if necessary, shim behind the hinges of the door to throw the door towards the lock and taper the shim to throw door in towards the body.

The wiring assembled in its protecting conduit-, and attached to body, can now be finished, the connecting of the units being next in order. As stated before, the common point of all the wires is under the front floor on the dash. From this point the dash wiring extends to the instruments attached (a front and rear of dash and the wiring to the controller, magnetic latch and dry cells is carried through another conduit to running board and battery box.

The hand switch for starting, on the heel board, and dry cells located under the left front seat in a metal box, are connected up and also the wires to the controller. The wiring between storage battery and controller it, carried under the battery box cover and consists of connections to the positive and negative terminals of the four divisions of the battery, The spark plug)Aires and the wiring to the distributor are cat-tied from the dash to the distributor and to the plugs through a metal tube supporting the wiring over the motor, The distributor bead assembled with the plug wires is put on the distributor with the rotating brush holder under it on the shaft.

As final check on the wiring refer to the diagram for that purpose and check up all connections. See M., Diagrams 1. 2. 3 and 4.

The free ends of lighting wires inside the frame should now be attached to the terminal block on the terminals indicated by the letters T. S. & H. for the different lamps and the lamps assembled and connected. We can now test the lamp circuit by means of the switch on the dash, pressing in the buttons corresponding to the different circuits

The air line can be now attached to pump on heel board and the gauges on dash connected to the air and oil pump on the motor.

The rear fenders are fitted to the curve of the body and attached to the running board and body. The holes in the fenders for the body bolts are elongated to assist in assembling and a substantial iron stiffener and support is attached to the body at the side. The fenders can easily be taken off when necessary and should be, before the body is taken off. The enameled surface should be protected when working on a car and covered with cloth or pad to prevent scratching and marring the finish and when off the car, should not be piled on top of each other for the same reason. Align the rear fenders with the front and running board and square them up level.

The toe board of aluminum is fitted into the body and fastened to dash and body frame. It can be easily removed for repair work on parts below them. The foot pedals come through slots in this board and for convenience of assembling, there is a detachable part of the plate around the steering post which cuts through the slots and allows the pedals to come through. This small pail of the plate need not be disturbed when taking out the floor.

The throttle and accelerator shaft is carried on the under side of the toe board and the rods to connect the carburetor to the fool and hand throttle control are attached to this shaft, A coil spring is attached to bring the valve in the carburetor back to closed position,

The pedals should line up with each other and not rub or strike on the sides or ends of slots The action of' the pedals can be adjusted to prevent this and they can be bent so that they do not strike on side. The accelerator pedal should be set to give the full throw of the throttle valve in the carburetor.

The rods for the strangler on dash can now be connected to operate the air opening in the carburetor, setting the lever on the dash and making the rods the length required to get the full range. Set shutter in carburetor on slight angle to deflect air upwards towards jets when full open.

Put on the **top tire support** on the blank front door attaching to bolt for the purpose

Put on the **steering gear bracket** to support the steering column, This bracket forms a support to the column and has a recess oil the top side for the nickel plated outer jacket of the column- It is bolted to the dash board and has a foot also resting on the Floor boards- Do not throw column out of line in bolting support to body as this will cramp the gear and make -tiff steering. If necessary cut dash to fit angle of column.

The speedometer is attached to the dash by a bracket for its support and the tube for the driving shaft goes through a hole in the floor board. The sprocket for the speedometer is on the left front wheel and is put on before wheel is painted. See that the small sprocket is meshed into the larger so as not to rattle or grind, This can be adjusted by removing the clamps and moving the sprocket in and out.

The windshield, sod pan and hood are now fitted on, The shield is supported on the top of the shroud, the side frames projecting down are attached to the casting on the shroud. A rubber filler is put in between the shroud and the bottom of the shield and two nuts hold the frame down snug against the filler. Two braces also help support the shield being attached to the stud in the side lamp brackets to which also are attached the top straps. This short brace is just as efficient as the old style braces running to the front of the car, and is not in the way when it is necessary to open the hood to work on the motor, etc.

The **sod pan** is fastened to the frame with spring hooks and is quickly attached or taken off. The front end has a plate to catch on the lower flange of the front cross member so the opening at that point is as small as possible, the pan going above the flange. The sides fit close to the frame all around, leaving no opening for dirt or water to get through. In fitting a pan, do not allow any rattles against other parts.

The **hood** should fit on the radiator ledge and dash ledge following the contour of each and pull down tight with the lock handles. The ends should fit close up to the shoulder on the dash ledge and the bead on

the radiator, but must not be too tight to make it difficult to open and close. It requires some skill to fit a hood properly, but if care is used the work can be accomplished without a chance for a rattle or an opening to allow water to get through- If the paint on the hinges makes them work stiff, work the joints back and forth carefully to relieve this, otherwise the hinge may be ruined if forced open.

We are now up to the point where the car is ready for tuning or the final adjustment, viz., carburetor adjustment, checking the timing of the ignition and valve setting, air and cooling systems and all necessary adjustments of the parts which influence the working parts of the car.

TUNING

We will take up under this heading the starting and ignition systems, checking the valve timing, distributor setting, carburetor adjustment and gasoline line, the gear shifting mechanism, air pressure system. spark plug adjustment, water connections, spark and throttle control, clutch pedal action, brake adjustment and the details of equipment and general finish, After which, the car being ready to start, examine the gasoline and oil supply and the cooling water,

Valve Timing To check up valve timing take off the cover plates on sides of motor, exposing die valve springs- valve stems and tappets for lifting the valves from their seats, The opening and closing of the valves is timed with relation to motion or the piston up and down in the cylinder so that the inlet valve-, may open to take in a charge of gas and close to allow it to be compressed and fired, the exhaust valve opening to free the cylinder of burnt gasses. Each cylinder is performing a different operation and is fired in the right rotation, The cams being so shaped. the valves are opened and closed by means of the rotation of the camshaft, the cams lifting the valves by means of the push rods or tappets. To avoid noise we set the tappets as close as possible to the lower end of the valve stein. This clearance should be .002 to .003 on inlet and exhaust valves, but should not be finally set until motor is warm on account of expansion due to hearing

We now turn Engine over by hand and get piston No. 1 in its highest position- In this position the motor is on dead center and the flywheel marking should so indicate. To check this absolutely remove the oil pan and measure piston travel below cylinder marking lowest point, rotate shaft back and forth to be sure.

The opening and closing of the valves is also marked on the front side of the flywheel ran and there is a pointer on the crankcase to indicate these operations. To make this clearer, remove the caps over the valves so that you can see them operate and also watch the tappets and valve springs.

Adjustment of Tappets. One side of the Cams only having a point to lift the valves the tappet should be free to turn when the valves are closed or when the tappets are resting on the back or heel of the cam. By watching the valve action it is apparent when the cams are lifting the valve-, and when the valves are closed. Taking a gauge of the right thickness try the opening between the tappet and the valve stem turning the tappet slowly to get the lightest spot, as the tappet and valve stein may not be true and in line. To adjust this clearance hold the tappet from turning and loosen the lock nut a little. You can now move the screw in the top of tappet up or down as necessary. Lock the nut again and try the gauge. Repeat the process until the correct clearance is secured. Try each valve this way turning the motor until the piston compresses a charge against the valve heads seating them. If the selling does not allow enough clearance, The valves will remain open- loss of power and culling of the seats will result and the other extreme is too much clearance and a noticeable tapping noise when motor is running, The valve springs should have a flat bearing on the ends and the coils in line and each spring the same tension

The valves should be free to move in their guides and not stick and hold open. In taking out or putting in a valve the stem may be bent causing it to stick in its guide. The valve guides should be fight enough to prevent air legs and they are so fitted in the factory, only .00 1 clearance being allowed. Do not try to ream out these hearings without the understanding that this fit is close and easily spoiled, A motor will how some wear at these point,,; after considerable work and to avoid this the stems should be oiled occasionally.

Spark Plug Adjustment. Spark plugs should be clean on the points and the opening of all the points should be set .035, a full 23rd of an inch, a gauge being furnished with the car for this setting.

Carburetor Adjustment. When the Zenith Carburetor is used the only adjustment is setting the screw for controlling the throttle valve on the mixture. This should be set with the hand lover on the steering wheel clear down and allow the motor to idle in this position. The rods and connections can be adjusted to give the full opening of the valve also. The Accelerator pedal can be set in the same way. The coil spring is attached to bring the valve back to a closed position. The jets for the gasoline supply are never changed after the size is once determined and unless the car is working under unusual conditions our standard jets will take care of every demand upon the motor.

To Set the Distributor. Turn the motor over by hand until cylinder No. 1 begins the compression stroke, this can be determined by holding your finger over the cup in the top of the cylinder and note when the air begins to blow out, Now took on the flywheel front face for the marking, letter "A." This cylinder is due to fire when "A" reaches the pointer on the crankcase or in advance of the dead center 511, to 6 inches on the flywheel, Take off the distributor head and the rotating brush holder both of which come off by unfastening the latch on the distributor top and motor will pull up easily from the driving shaft. There are then in view two sets of breaker points; one of the generator and storage battery circuit and one for the dry cell circuit First set generator breaker points with proper opening by turning flywheel until points are closed on top cam and flat spring is about one-third the distance down in the slot, then turn wheel until breaker points open full and set opening by adjusting the screw and nut to .010".

Set battery breaker in same way. When fly-wheel point A reaches the pointer on crank ease with spark lever fully advanced the cylinder should have the spark to ignite the charge. so that points should first open on generator side at that time as the spark occurs when points open. With the dry cell breaker the spark occurs when points close- it is only necessary to set generator breaker with flywheel and adjust points on both to have same opening - use the small wrench furnished with car to adjust the points. Now replace rotating brush holder, noticing that firing brush comes under No. 1 cylinder plug wire when distributor head is put on again,

The Wiring for the ignition lighting, and starting should be examined. Trace out the plug wires to the different cylinders to check the firing sequence, seeing that the distributor head and the wires leading front it are correctly connected to fire the cylinders. For model "37" the firing order is 1- 3-4-2, or 1-5-3-6-2-4 for model "54". Examine the terminals for imperfect joints, or chances to short-circuit. All the terminals should be made permanent by soldering the wire to them and the insulation should not be taken off except close to the terminal The terminal.,, should be additionally protected by a short piece of rubber hose over the end of wire close tip to terminal. Trace the wiring from the coil and resistance trait on the dash to the distributor and generator and see that the right wires are on the correct binding posts. To make it easier to follow these circuits, we are using different colored wire coverings.

Wheels and Axle Adjustment. Jack up the front axle and examine the spindle bolts and adjustment of the wheel bearings. Wheels should turn freely with no end play in the bearings. Shims between the races arc used to lock bearings with the nuts. Spin the steering wheel and look for lost motion in the steering parts. All the Joints should be snug, but wheel should turn easily.

There will always be a little and play up and down on the steering column but should not be more than 1/64th. If the column jacket strikes the wheel spider, back the jacket way, first setting the nut on the gear housing to limit the motion in the gear. Another chance for rattling is between the sector and the nut on the spider. Give this clearance by Moving the sector away from the nut Now jack up the rear axle and see the brake bands are not too fight and that the brakes release, Oil the pins and brake connections and free tip the joints by working them back and forth but, if necessary, take out all the pins and scrape off the paint to free them up. The brakes should not drag on the drums as this would soon bum out the lining and also waste the power.

Examine the bolts that hold on the rear axle flanges and the hub caps. Inspect the fit of the bearings by rocking the wheels. There should be no end play here to get the proper service out of the bearings, but wheels should spin freely.

The Change Speed Lever must operate freely for each speed. Try each in turn, rocking the car slightly to admit the gears. There should be no sticking in the side motion from one slot to the other of the sector and the lever should not touch the sides of the guide. Hand lever should he so bent as not to interfere with brake lever. If an) speed should shift hard, examine the finger on the shifting shaft to see if slots oil shifting rods are in line, bending or filing these parts slightly will usually remedy this trouble. Take off the transmission cover and look for interference's, the gears may not be assembled correctly, the shifting forks bent, the sliding gears may not be free to slide or something may have dropped into the case. Do not force the operation of the lever. It will work freely if everything is clear.

The Starting Crank should be examined to see if the ratchet on the shaft will engage the end of the crank and is free to spring out of engagement again. Turn motor over slowly and see if compression is uniform in all cylinders. We can now disconnect the crank handle by driving out the pin and taking, it off the shaft. A sleeve is supplied to fit over the shaft property finished to match the car trimmings- Put the crank handle in the car for cases of emergency

Starting the Motor. Be sure that the gasoline tank is filled by examining the gauge in the end of the tank and that the oil supply is sufficient testing this by opening the cock on the side of the crankcase. Oil should just run from this cock at high level. Also examine the radiator to see 1 if it is full of water. In cold weather, a non-freezing mixture should be used and a car should not he left standing with only water in the radiator as freezing will result in a broken cylinder or pump.

Pump air into the gasoline tank with the hand pump until the gauge on the dash shows two pounds pressure. Examine the air line for leaks if the pressure does not hold, and test the seating of the check in the motor pump- Be sure the filler cap is tight on gasoline tank and the leather gasket is in place. If you cannot detect a leak of air by hearing, take off the connection on the gauge on back of dash and try and pump to see if air is circulating. If it is, gauge must be out of order if it does not indicate pressure. If all the joints are tight there will be no trouble with this system.

When the motor is running the pump on the motor will keep the air pressure at two pounds. If this pressure exceeds three pounds the gasoline economy is affected, Remedy this by shims between the pump and crank case, increasing the volume in the chamber and reducing the pressure. Having fuel, oil and water the car is ready to start. Set the throttle on the steering gear cleat down at the end of the throw and the spark lever about 2" from the bottom. To start on compression use button on the switch marked "S" moving spark lever to get contact. If motor does not start, push in button marked "Start" and then the button on heel board holding it in while you push the clutch or left-hand pedal as far as it will go, allowing the gears to mesh into fly wheel teeth- but do not force it gears do not enter at once. When motor starts release the clutch pedal quickly allowing the pedal to spring clear back. Press down the accelerator pedal and advance the spark lever to within two inches of the top Allow motor to run at a fair rate of speed for a few seconds to warm up. If the motor does not start after a few revolutions, close strangler on dash shutting off the air to carburetor. The start button delivers a stream of sparks to the proper cylinder and will fire a weak or improper mixture to better advantage than single spark. Do not run on this button, but switch at once to the "M" button- If motor does not start after waiting about thirty seconds, do not continue to crank, but push in the top button on the switch and look for the trouble. If the battery will crank the motor, the trouble lies some place else, as carburetor, ignition wires or spark plugs. Continual cranking will run down the battery in twenty minutes.

Try the battery button marked "B" every few days to see if motor will run without a change of speed when the “Bl" button takes the place of the “M". Switch back and forth, pushing the two buttons alternately and any difference in the action of the motor can be easily detected. If the dry cells show weakness they should be replaced after testing each one with an ammeter. A new dry cell should test between 29 and 25 amperes and a cell testing less than ten should be taken out. In putting a new set of dry cells into the battery box, turn the zinc terminals towards the outside to prevent a chance of short-circuiting from one cell to another- The dry cell circuit is only to be used for emergencies when the Generator System is out of order, and for starting.

Oil Circulation. When motor starts, see at once if oil gauge shows the oil pump working. This can be determined by the motion of the hand on the gauge, showing a greater pressure as the speed or motor increases If pump is not working, stop and find out why, as the oil must circulate to the bearings.

Cooling. Inspect water piping and hose connections for leaks, also radiator and stuffing boxes on water pump. Look at fan and see if belt is tight enough and lined up true and that fan does not run out of line or too near radiator.

Compression and Exhaust Leaks. See that spark plugs, valve caps and priming cups are tight. Test with an oil can, putting enough oil around the threads to see if any bubbles show. Test in the same way the joint in the exhaust pipe.

General Finish. The body paint, work should be looked over for varnish runs and blemishes - the leather for poor fitting cushions and trimmings, and freedom from smears of varnish - tacks improperly put in and open joints in binding. Doors should fasten, not rattle and easily open; door cappings match up and joints should not be too wide. Top to set well and curtains should fit and have all necessary fastening and be loose enough to allow for shrinkage and buttons should be put in neatly. Lamps should not rattle and should be lined up true and focused properly. Fenders should not rattle or have the enamel scratched or show runs or specks All fenders should be in line and level. Hood should open easily and close tight enough to not rattle or allow dirt or water to get through the joints. Paint work on hood and radiator should match the body color.

Windshield should be tight and glass should not rattle. Adjusting clamps should operate and hold upper glass in any position required. Floor boards should be tight so as not to rattle and covering should be properly put on. All bumpers and rebound straps should be in place; a bumper on each spring and straps to control the action of' the rear springs when striking bad holes.

Road Testing. Take the car now on the road to test the brake adjustment, shifting of gears, clutch action, etc. Inspect for rattles of fenders, brake rods, torque arms, etc., motor adjustments and noises and rear axle gear noises, final adjustment of carburetor, body and spring squeaks. Test both brakes in turn so that both the wheels will hold equally and lever should not strike end of slot. Brakes should not drag on the drums when released, clearance all around should be allowed. Nor should brakes seize on the drums when used for ordinary driving. This necessary adjustment can be made by lengthening or shortening the Pull rods. The clutch should release quickly and take hold gradually, Dragging of plates may happen when a car is first started in cold weather but will quickly disappear when the oil gets warm. If clutch does not release, it is very difficult to shift gears as the transmission gears keep spinning and prevent the sliding gears getting into mesh with them. Gummy oil will make the clutch drag, keeping the discs together the discs driven by the motor dragging the others. The clutch should be cleaned out frequently and fresh oil put 'in. The clutch pedal is adjustable and should have a little shake to prevent clutch collar wear and to be sure clutch is released.

Fenders should not rattle if securely bolted on and brake rods should be bent to clear all other parts. The torque arm can rattle in the hanger only when the blocks on either side of the ball end stick, due to insufficient lubrication. Body squeaks are caused by the body being loose on the frame and the nuts should be lightened.

Spring squeaks are due to lack of lubrication on the shackle bolts, lack of clearance around the end of front spring where it is carried in the frame or lack of graphite grease between the leaves of the spring. The first is easily taken care of The second is unusual and it is necessary to take spring out and file off a little of the metal To lubricate between the leaves jack up the car, taking the weight off the springs, and open the leaves with a flat tool and work the graphite in with a thin strip of steel, putting in a liberal supply.

The **universal joints** should be tried for play and should be supplied with ail the grease caps Securely fastened on. The back lash should not be excessive in the axle gears. The limit is arrived at by ad - adjustment of the driving, pinion and differential gear, If these gears are meshed too light, or too loose, the resulting noise, when running, is objectionable. .010" is about right for back lash- The square on the propeller shaft at the front end should fit well into the square hole in the universal joint; a clearance of .002" or .003" is allowed here. The square should be free to slip in and out. More clearance permits shaft to rattle when motor changes speed.

Section "B"

1913 Models

Preparing the New Car for Operation
1913 Models

Do not, in your enthusiasm to demonstrate the operation of the starter and in your anxiety to see the new car running, neglect to go about getting the car operating, without due regard for the storage battery. Look first to see if the motor is provided with oil and fuel and the radiator is filled with clean water. Put in your ignition button "S" and try the spark at the plugs. Now take your seat in the car. Set throttle lever clear down and spark lever about two inches up on quadrant. Press the button on the heel board. This causes a six volt current to flow from the storage battery to the motor, turning the armature shaft to allow the gears to mesh with fly wheel teeth when clutch pedal operates the rods for shifting, and at the same time the coil in the magnetic latch under the floor becomes magnetized and pulls the arms in the latch over so clutch pedal rod can connect with it. When pedal is pushed down the gears are first shifted into mesh with the operating rods, then shift the knife switch in controller to the starting side, connecting the battery cells in series and giving 24 volts for cranking If the starting latch is fight, you will hear a click as the arm is pulled over against the magnet, Push down on your clutch pedal and allow gears in generator housing to engage the teeth in fly wheel. Do not force them, but if they don't enter at once, work the pedal up and down and allow the teeth to get in position to mesh,

The storage battery will crank the engine over by using the generator as a motor and by means of the gearing between armature shaft and fly wheel cause the engine to begin rotating. As soon as the engine starts, let the clutch pedal come back sharply and advance the spark and press accelerator pedal.

If engine does not start, do not crank over half a minute. Closing the strangler on the carburetor will help in cold weather. This is operated by the lever on dash near speedometer, If the motor is not too stiff, battery should turn it over, if fully charged, at a speed sufficient to start. If battery will not turn motor over, try the hand crank to see if motor is tight. In shipment, motors usually stiffen up; the oil becomes stiff and all the moving parts become set. If you can turn the motor with difficulty and decide it is due to stiff bearings, start car with hand crank and allow motor to free up. If motor is free and latch under the floor boards does not operate, look the wiring and switch over that operate this latch. See if storage battery terminals are connected up to right wires. (See Diagram No. 2, Sec. M Page 2.) Arm may be up against the hook inside latch preventing the clicking sound you expected to bear. In case of that, the clutch pedal is not coming back far enough.

If pedal does not engage hook on arm, allow pedal to come back as far as possible. pulling it with the hand as the joints may be stiff with paint or lack of oil. Adjust the length of the rod at the turn buckle to get arm to engage with pedal if other means do not get results.

When clutch pedal is used other than for starting, there should be 11/32" clearance for hook to pass the arm on the latch. If, when button is pressed armature fails to turn look for loose wires or dirt under the brushes. Look at the terminals on the wires to see if joints are soldered. Only enough solder being used to make a permanent joint. Care should be used to prevent solder flowing down onto the surface which lies under the binding nut.

If brushes on motor are not making good contact, take a piece of the finest sand paper, and with sand side next to brush pull paper back and forth across commutator. This will give you a surface on the brush to fit curvature of commutator Do not use emery cloth for this purpose or a round file. Once a month the commutator should be cleaned by wiping with a soft cloth free of lint into which a small quantity of vaseline has been worked. This will remove all the gum as commutator slowly turns.

To set the control rods for operating the starting mechanism, first set the clutch pedal with a slight amount of play so as not to bind the clutch throwout collar too close against the clutch and burn out the fiber friction washer. This adjustment is made by the set screw in the throwout lever and turn buckle in rod to pedal. Disconnect the clevis at back of generator which is attached to rod that pulls sliding gears back. Locate this clevis so gears will spin free of fly wheel and pinion on armature shaft. Open inspection door on gear housing to see this. Then put pin into clevis and set lock nut. Next adjust the switch in controller to throw equally both ways and get a full contact on the blades. This can be done by the adjustment in the rod back of battery box. Care should be used to get controller to lock in both positions and the arm with notches for this purpose is on the front at the bottom of knife switch. You will see that when rod operating the knife switch starts to work, the first part of its motion is taken up by compressing a coil spring. This is done to allow gears to get in mesh with the flywheel before control lever is shifted over to the 24 volt side, otherwise speeding up the motor might break teeth out of fly wheel.

TO START THE CAR

When button on heel board is pressed the starting latch is pulled over in position to engage the clutch pedal rod and the armature shaft in the generator starts turning slowly. This allows the gears to enter the fly wheel for turning over the motor. Do not force the gears into place with the clutch pedal but with a light pressure of the foot they will slide into place when the teeth match up.

The gear that meshes with the pinion on armature shaft does so before the other gear on the countershaft meshes with the fly wheel. This is necessary as the armature is turning and will allow gears to mesh.

The controller rod should also be adjusted to prevent controller switch being changed from the 6 volt side to the 24 volt side until gears are in place. When this change occurs the armature shaft increases in speed and if gears were not properly in mesh some damage might result trying to overcome the inertia of the fly wheel at this speed.

OPERATION OF CAR

There are a few things that should be kept in mind in driving the car that it would be well to mention here, viz;

For economy sake, do not neglect the oiling of all the parts. Refer to the lubrication chart (See Sec. O, Page 2), and get familiar with the location of all the oil and grease cups and the right time to change the oil in the motor clutch, etc. Take care of the storage battery keep it filled to correct level with distilled water and keep battery charged. See Sec. L., Pages 2-31.)

GEAR SHIFTING

Practice to shift gears without noise and get accustomed to the different speeds of car and motor. The clutch is used to connect the motor the road wheels and by means of gearing the motor can take the load imposed on it providing this gear selection is correct. Starting in low speed it is necessary in order to shift to intermediate to have a higher motor speed so that motor will take up the load without hesitation. To do this accelerate the motor when in the low speed and when car has increased its speed sufficiently, shift into next high gear. A little practice is necessary to do this well. It is not necessary to race the motor, Gear shifting from low to high can be done at low speeds as well as high, The principal point to get thoroughly in mind is to get accustomed to guage the speed of the car and particularly in climbing hills is this important.

Do not keep in high gear when the next lower speed would save your car. It is not a disgrace to be unable to climb everything on high. and a driver that uses judgment and takes care of his car is the better man.

In shifting from one speed to another, the gear teeth should enter into mesh without grinding or clashing. First see if lever has the right throw and that Clutch stops spinning when disengaged and if gears are not burned up on edge of teeth. Do not allow trouble to be neglected. Investigate it once and find out the cause and then repair it.

Give the motor time to take up its work at different speeds without forcing it to loosen its bearings or make disagreeable knocking noises or allow the lost motion of clutch, universal joints and driving gears to cause a jerky driving action by getting into high before motor can take care of it. Starting gradually the load call be taken up by the motor smoothly and without a disagreeable noise.

Section "C'

1913 Models

MOTOR
1913 MODELS

Repair work on the motor of this year's cars is greatly simplified by some changes in design from last year's models and the feature of accessibility is strongly emphasized. A number of parts arc interchangeable in the two motors of the "Four" and "Six" cylinders which makes it convenient for the repair man. The bore and stroke of both motors are the same. We use the same piston, connecting rods, piston rings and pins, connecting rod bearings, valves and small parts in both.

TO TAKE MOTOR OUT OF CAR

To take out the motor with the body on the car, it is first necessary to take off the transmission and foot pedals. (See E., Page 1). Remove the radiator by taking out the two bolts that fasten it to the frame, disconnect the hose and tie rod to dash. Take off the generator. (See N., Page 1) and the wires connecting. to dash. Remove the distributor head, wiring tube and wires to spark plugs and fasten the whole to dash or body out of the way. Take off the muffler by loosening the screws that attach it to the hangers unscrew packing nut at exhaust manifold and take exhaust pipe off with the muffler. Disconnect the air and oil tube at dash gauge and the air tubing at front end of tee on air pump and the strangles rod. Take off the starting crank assembly. Remove the six bolts in motor legs and move engine forward as, far as possible, and then hoist out the chassis,

TO TAKE OFF CYLINDER BLOCK

When it is decided to examine the condition of the cylinder walls or fit of pistons, rings or piston pins, it will be necessary to take off the cylinder castings. To do this, proceed as follows: It is more convenient if radiator is taken off but not absolutely necessary. Take off the fan by loosening the nut on spindle and take spindle out of' slot on arm. Disconnect the flange of water connection on side of cylinder on the four cylinder and water manifold on exhaust side of six cylinder.

In four cylinder model. take off muffler and exhaust pipe as one piece leaving exhaust manifold on cylinder, but in six cylinder cars the exhaust manifold must be taken off. When replacing this manifold do not tighten down the nuts until all are on the studs as the nuts on the next to last flange will not go on except when manifold is just on end of studs. Disconnect the water tubes to water jacket on inlet pipe on both sides of four cylinder block and in case of six cylinder, from rear block if it is taken off. Loosen the flanges of inlet manifold and take manifold and carburetor out of the way. Take off generator on four cylinder model (Sec See. N. Page O. and also on six cylinder if rear casting is to be taken off. Remove the side doors over valve openings and take off the holding nuts. Blocks should be lifted carefully straight up to prevent bending connecting rods, When pistons are free do not allow the rods to fall side ways and strike against crank case. This will bend rod and is also likely to chip case.

Examine the cylinder walls for marks of scoring and check size of bore for out of round .001 only is permissible in a new motor. Tight rod bearings will cause piston to work against one side of wall and will wear the bore out of round. This will in time cause a piston slap. Dirt in the oil, loose piston pins, broken rings or neglecting oil and water supply are the usual causes for scoring. If walls of cylinders are badly scored, there is no remedy as it would be impossible to get pistons to fit after boring out the cylinder, but small scratches may be removed by lapping and fitting a new piston. The standard clearance between cylinder wall and pistons is .004" for four cylinder and .005" for six cylinder motor. This allowance can be checked by using a narrow strip of shim stock that thickness. The pistons are straight from the bottom up to the second ring from top. The top is smaller to allow for the expansion when hot.

Of the four **Piston Rings**, the top one has grooves in its upper side to prevent ring slaps. All the rings should be free in the slots but are only allowed .001 clearance and are ground to fit close. The rings should fit the bore and have .012 clearance in the opening on top ring and .006" on all other rings.

Piston Pins are ground slightly (.007") under 1-7/32" and the bushings are all reamed after being put into the rods to exactly 1-7/32", This fit between pin and bushing should be such as to allow the pin to move back and forth freely but without any shake. The piston pins have a light drive fit in the pistons. In driving the pins into piston, use your hand only. Use an expansion reamer if necessary and enlarge the hole in the piston. Driving pin with a hammer will easily throw piston out of round.

All Pistons and all connecting rods in each motor weigh the same to insure perfect balance of the moving parts. The bushings for the rods are supplied with oil holes and grooves. The oil can follow the oil groove around the bushing on the outside and come through to the pin through two holes at 45 degrees from the vertical. This arrangement gives a full bearing surface for pin free front grooves or oil holes at point where greatest pressure comes.

The piston pin is locked in place by a set screw and this screw is fastened by a cotter pin as an additional safety device to prevent any chance of pin getting free to move endways in piston

To Take Up Connecting Rod Bearings with the block off, it is better first to take off the piston rings, then the pistons, to prevent breaking pistons when turning crank shaft over. The walls of the pistons are necessarily light and failing over against rods or catching on the studs that project from crank case might easily break them. Rod bearings should not be tight enough to grip on the shaft. To test this fit, take hold of the upper end of the rod and move it back and forth quickly on the crank pin. If about right, you should feel no gripping. When moving slowly, just a slight tendency to take hold should be felt. There should be no looseness on the pin that can be detected and only end play sufficient to prevent friction on ends of bearings should be used on rod cap nuts.

Main Bearings should be set up one at a time beginning with the center so as to be able to test the friction on the shaft without interference from the other bearings. The main bearings should be free enough so that motor will rock on compression when assembled. To take up main bearings, it is only necessary to lower the oil basin on the bottom of motor. Rod bearings should not be taken up without removing the cylinder block, a thoroughly satisfactory job cannot be, done as it is possible to get bearings too tight. If rod bearing caps are taken off, be careful not to push piston upwards except when on lower half of stroke is the top piston ring will pass by the end of the bore and become locked and it is a tedious job to remove it and can only be done by removing valve caps and working ring back down.

The center main bearings on both motors take all the end play. An allowance of .005 as is the limit. To test shaft for end, play, make a wooden lever of hard wood, with a hook on the end that you can attach to frame or to a block on floor and of sufficient length to reach across the fly wheel and car. Take up the end play on back, side of bearing and attach an indicator to flywheel rim, then change your lever to the front end of crank shaft and throw all the play back and the indicator will show how many thousandths end play in total on the center bearing, If this play is considerable, it will be necessary to fit new center bearing. Gauges of thin stock can be used also advantageously instead of an indicator.

TO LINE UP PISTON AND RODS

Rod bearings and pistons being adjusted, it is necessary to see that connecting rods will allow pistons correct alignment in cylinders. See that pistons are round first and fit their cylinder with proper clearance- If necessary to trim up pistons this can be done by tapping the thin shell with a soft hammer. Tendency to catch indicates that piston is not inline.

When piston is straight with bore, the clearance between the bosses inside and connecting rod should be equally divided. This can be determined by using a mirror and lamp. The bending of rods and alignment of pistons will necessarily have to be done together as one operation influences the other. If rods are so out of line as to bear against one side of piston, there will be a tendency for the piston to wear on side of cylinder wall, and in order to keep the cylinders round, it is important to keep the rods properly in line.

MOUNTING THE BLOCK

Clean the ring grooves thoroughly and fit the rings and then oil each ring well. Oil also the pistons and cylinders. Piston ring clamps should then be put on protecting the rings and allowing block to go on easily. These clamps are steel rings that are placed over the piston rings. The cylinder casting should be lifted over the pistons and let down square and carefully, each pan- of pistons being admitted in turn and watched to see nothing prevents block going down. When clamps are free of end of piston they will fall down and can be taken out below, a slot being provided to allow rod to pass through the clamp.

TIMING GEARS

Under ordinary conditions, there will be little repair work on the gears. In case of accident, if it should be necessary to replace any of the timing gears, it would be necessary to order gem of same size. You will find marked sizes on them if they are not standard. The letter U meaning undersize and L oversize, followed by the variation in thousandths of an inch. If the gem have been run several thousand miles, a new gear would not run well with the old ones as there is going to be some wear. The back lash between the teeth is practically nothing or say .001 and if more than that, noisy gears will result. There is very little leeway in fitting the sets as a disagreeable hum will result if gears are too tight. If a reasonable amount of humming is present, it will likely decrease as the gears get worn in to a good running surface. Gear pullers should be on hand to remove the gears when necessary.

Any end play in distributor shaft can be taken out by shims back of the thrust washer in front or back of shaft bearing. This shaft can be taken out by taking off fan pulley and front cover which also involves taking off the radiator. Then take off the pump gear, put shim back of gear and see if gear is tight against bearing, or disconnect the shaft at the coupling at rear of distributor housing and take off the water Pump. Take off the distributor and vertical shaft by taking out the three screws in flange and distributor. Shaft can now be taken out through the housing opening at the rear and shim can be placed against rear of bearing.

Valve Seats should be concentric with the reamed holes for valve stems. Valve sterns and tappets should have but .001” clearance in their guides. The guides are easily removed in case it is necessary. More than the allowance for the fit between valve stem and guide may result in producing changes in the mixture as it enters the valve chambers.

To Remove the Valve Stem Guides, first take out valve springs and the valves, then drive the guides down by inserting a tool for that purpose, through the valve chamber. In driving be careful not to strike the guide anything but a direct blow on top. Striking a slanting blow might break cylinder bosses that hold guides. The fit for driving is .0005" and it should not be difficult to get the guides out without injury to the cylinder casting.

To Remove the Tappet Guides, it is not necessary to take off the cylinder block. After first taking out the tappets, and removing the clamping device on top the guides can be taken out, The driving allowance is the same here as on the valve stem guide

To Put in New Guides ream hole in guide to fit stem tight and draw guide into place and then ream guide to fit stem with correct clearance as the hole will close some when putting guide into place. Be careful not to ream this hole too large as this clearance is so small, .001" only being allowed.

If valve seats are very bad, it will be necessary to remove rough spots by resealing or cutting a new seat as it would be an unreasonably long job to grind such a seat without this operation. Shoulders and high spots on valves can also be ground off before resealing Be careful not to spoil the bevel surface an the valve. Grind valves in until seat and valves show bright metal all around for at least 1/8" on bevel seat.

PISTON SLAPS

Piston slaps are noticeable at various speeds, but particularly at slow speeds under a load. To trace these slaps short circuit the spark plug of each cylinder in turn The slapping can not be heard when charge in the cylinder is not fired.

Piston slaps are caused by too much clearance between cylinder wall and piston. For this reason particular care should be used in fitting pistons and in lining up connecting rods. A rod bearing that is too tight will cause wear on one side of bore and a rod that hasn't sufficient clearance between piston and rod bushing will also cause wear on cylinder wall and result in making bore out or round and increase piston clearance.

The proper clearance for Model "37" between pistons and cylinder wall is .003". A thickness gauge .004" thick should not go in. For the Model "54" the correct clearance is .004" or a tight .005".

There will be a slight taper in cylinder bore, the diameter at the bottom being about .001" larger. In testing piston clearance for this reason try the gauge well up in the bore.

EXCESSIVE VIBRATION

A perfectly balanced motor will run with very little vibration. As perfection is beyond reasonable workmanship, there will always be some vibration. It is our aim to reduce this to a minimum and for that reason the moving parts are carefully balanced. Pistons, connection rods, fly wheels, crank shafts, etc., are carefully weighed and tested, but if these parts are not properly assembled or in repairing - this point is not kept in mind - there will be as a result of poor work a piston heavier than the others, or a poorly balanced motor due to changing fly wheels if new wheel is not properly balanced.

Another cause of vibration is poorly fitted main bearings. In putting in a new bearing always be sure that it is no higher or lower than the other two. In cases of this kind the crank shaft will be sprung out of line and cause a bad pounding and a great deal of vibration.

Section "D"

1913 Models

Clutch

CLUTCH

1913 MODELS

The action of the clutch will be at all times smooth and easy of operation if kept in good condition by cleaning out thoroughly every 1000 miles- To do this, take out drain plug in Clutch housing and turn motor over slowly., After draining out fill with kerosene, removing all the gummy oil and sediment. Refill with one-half pint of light cylinder oil and kerosene in equal parts.

To Take Out Clutch: First, it is necessary to take off transmission. (See E, Page 1). Then take off the four nuts and the screws in clutch cover. Do this turning each by degrees until spring tension in clutch spring is relieved. Take out the clutch plates as one piece and the ball thrust collar and brass collar will follow. The clutch spring is in the crank shaft in a recess bored out for it and can now be taken out with the shims back of it. These shims are put in to give correct spring tension and distance from end of spring to back face of crank shaft flange, 3/16" being correct distance for the Model "37" car and 3/8" for the Model "54." If at any time the spring tension should become insufficient, the trouble can be remedied by shimming back of the spring until a new spring can be secured.

To Replace the Cork Inserts in the Clutch Plates, it is necessary to get corks of the same diameter on both ends, 11/16" diameter and 1/2" long, These should be soaked in warm water until soft and pliable. We can supply you with a tool to use in inserting the corks. This tool is a tube with a taper hole to reduce the diameter of the cork to that of the]role in the clutch plate and a plunger to force cork through the tube into plate. Under ordinary conditions, it will not be necessary to replace corks as this feature of the clutch has given practically no trouble. Corks should be no thicker than 1/4" when in place. Corks that are too thick will not allow plates to separate enough to clear each other and will cause a dragging action. Slipping due to worn corks should not be expected during the life of the average car.

In each clutch there are 16 discs one-half of which have cork inserts. Between these discs are small coil springs to separate them when clutch is released and also to insure silence. The releasing springs are carried on the Four studs which drive the plates. In taking clutch out, it is very easy to lose these small springs, and extra care should be used to see that they are all in place when ready to reassemble.

On the four studs just referred to, there is a small collar 1/2 " long which is placed in front of the last plate to prevent clutch going too far into housing. These collars have one end chamfered to clear fillet on flange of stud

To Take Discs Out of Clutch, it is necessary to take off large flat nut that holds center shaft and body together. With this nut off, back plate comes off and discs are free to come out. It is well to note that first disc is without corks and the next one has them and that with an even number of each the last one to come out or the first one to be put in has the cork inserts. Also that a set of separating coil springs are first placed next to the collars on the four studs and none between last plate and cover. The four studs in the fly wheel driving one set of discs, the friction between these and the other set drives the clutch body and transmits the power to the transmission through the three jawed clutch on clutch shaft.

The holes in discs to fit the studs are only 1/64" larger than diameter of studs and the width or the slots in clutch body allow the same clearance for the lugs on the driven plates. These parts being, hardened, it is impossible to get much wear at these points or cause for rattle.

In handling the clutch discs, care should be used to prevent getting them scratched and any burrs or rough edges should be removed. Discs should also be straight and if not, should be straightened in a press to get them perfectly flat.

The clutch body and hardened collar that comes in contact with throwout collar are keyed to clutch shaft and also held in place with the locking nut. To prevent this nut loosening, a pin is put through it into the clutch hub. The front end of the clutch shaft supports the bushing that compresses the clutch spring putting the correct tension in this spring to drive the car.

TO ASSEMBLE CLUTCH ON CAR

First see that clutch spring is placed in recess in end of crank shaft with correct number of spacers behind it to give correct tension. (See clutch details.) Next try the bronze collar in shaft recess to see if it is free to slip and there are no tough spots or burrs to cause the collar to stick and prevent clutch releasing. The allowance for sliding is .004. In placing collar on clutch shaft, the oil grooves go next to the ball thrust bearing and front end should have outside comers rounded to assist the sliding action when clutch is released and engaged. The clutch being assembled, secure four pieces of stock the same size as the hole in clutch plate (1/2" diameter) and put them through these holes to line up the discs and the small coil springs which are between them. Then turn clutch over with cover side up and compress the plates together and drive some wooden wedges between cover and the steel collar. The pieces of 1/2" stock can now be taken out and the clutch can be assembled on the fly wheel. In entering the fly wheel studs into the clutch discs be careful to see that none of the coil springs slip from place. Work the discs on carefully and draw cover up tight against the gasket with cap screws in edge of cover. To prevent oil leaks around the threads on the four studs that come through the discs, pack the threads with a little wicking and put on the nuts with cotter pins. Try the clutch with a lever against the back to see if it will release.

PROPER USE AND CARE

Keep the clutch clean and supplied with oil and kerosene in equal parts, Do not slip the clutch excessively. If it is necessary to prevent stalling the motor throw the gears out and let the car coast. A reasonable amount of clutch slipping is not poor driving and will not injure the clutch discs. Do not throw out clutch and then allow pedal to come back suddenly with the motor turning over at high rate and car running slowly. This throws heavy strains on all the clutch, transmission and axles parts as well as wear on the tires. For the same reason do not encourage getting started quickly from a standstill. Starting in high gear or even intermediate is poor driving and bad judgment. Excessive wear and strains are the result making short life for the car.

Section "E"

1913 Models

Transmission

TRANSMISSION

1913 MODELS

TO TAKE OUT TRANSMISSION

The removal of the transmission is not a difficult operation and should be done in the following manner. Take down the sod pan and remove all the floor boards. Disconnect the propeller shaft just back of the case at forward universal joint. Take out the pins attaching, the foot brake rod and magnetic latch rod to the foot pedals. Get under the car and take the shifting finger from the shaft that operates the gear changes. Remove the four nuts on the bolts that fasten transmission to the engine case and drive bolts back as far as joint in leg but not out of engine casting. Slide the transmission back keeping it level until the pilot shaft which extends forward into tile clutch is clear and then lower down to the floor. Do not allow weight to be taken entirely on pilot shaft and use care not to bend this pilot after transmission is out.

The foot pedals and lever for throwing out the clutch come out with transmission, also the bronze throw out collar and fiber friction washer inside it. This fiber washer is provided to reduce the friction between the bronze throwout collar and the steel flange on back of clutch. In case it becomes worn or broken, a new one can be put in place by cutting the washer in one place and slipping back the throwout collar. without the necessity of taking out the transmission.

REMOVE THE FLOOR BOARDS

The aluminum board in front should be taken out if at any time it is necessary to trace wiring troubles or to attach electric horn as the lighting and horn terminals are located under this board on the dash. Take out the pins that attach rod to throttle at carburetor and pin on the other side that connects steering gear lever to accelerator shaft rod. These two pins are more accessible at the front end of the rods. Disconnect the coil spring on accelerator shaft which is attached just back of dash beside the generator and can be reached from front of dash where it is attached to a clip. Take out the four bolts at top of board which go through dash and the wood screws on the two sides of the board, Disconnect speedometer tube just below the speedometer and remove board by drawing it directly back bringing the two rods through with it.

REPAIRING THE TRANSMISSION

Taking out the two shafts and gears for repairs can be done in this way. First drain out the oil through plug in bottom and wash thoroughly with gasoline in order to see what repairs are necessary before starting any work of disassembling. If it is decided to take out the main shaft on which the sliding gears operate, take off the rear bearing cap. The rear end of shaft can then be pulled through . This leaves front end of shaft in place. Be careful not to drop the roller bearing and thrust ball into the bottom of case. This bearing comes in the from end of main shaft. In the front end and between the two parts of the shaft there is a 5/8" steel ball to take the end thrust. The front end of the main shaft also has an extension to line up the transmission and clutch. TO remove front part of main shaft take off front bearing cap and then pull shaft out. Pilot extension can be driven out.

The main shaft has four splines or keys to drive the gears. The fit of the sliding gears is on the diameter between these keys .002" being allowed for sliding. This is sufficient unless a chip or dirt of some kind gets wedged under the gears and causes them to stick. To avoid this keep Oil clean

To Remove the Shifting Rods. You will notice that shifting forks are fastened with clamp bolts, and are also on a threaded part of the rods and that the rods are locked by plungers and springs outside the case. One lock prevents either rod shifting, when the other is in use. This lock is the large flat headed plug held in place by a taper pin, the center is drilled to hold a 9/16" steel ball which falls into slots in the rods forming the locking feature. The second lock consists of a plunger backed up by a coil spring for each shifting rod and held in place by a stamped cover and a 5/16" screw. This lock prevents the rods from shifting out when once

placed in any speed without the hand lever being operated. Note that plungers are grooved on one side to prevent turning. After taking out these locking devices and releasing the clamping bolts on the shifting forks, the side opening in case permits access to nuts on these bolts. Take out the shifting rods by unscrewing them out of the forks, the lower one first. The forks and gears will not be free. The two main bearings can be replaced by taking off the front and rear caps. End play in main shaft can be taken out by removing a shim from under the rear cap, except when new oil retainer is used on front end, then shims are put in front. There should he just enough play end ways to allow one-half of the shaft to spin without the other

To Take Out the Lower or Countershaft, take the caps at both ends and the screws and washers which hold the bearings. Slip out the bearings and the shims back of them. The shaft and gears will now come out through the large hole in top of case by tilting up on one end. If the gears have to come off of counter shaft they can be pressed off under an arbor press, by providing the necessary equipment of tools. The end play in countershaft is taken up by shims between the end gears and the bearings. The large gear should be in line on front face with driving gear on main shaft and the other gears will then be placed to get full width of face in mesh with sliding gears, If gears are taken off, be careful to get them back in pairs with the long side of hubs together and with the spacer collar in center. The bearings should be held between the gears and looking washer outside so inside race is stationary endways using the necessary shims to do this- Shaft should spin freely however but without end play.

To examine **reverse idler gear** in bottom of case, there is an inspection plate on side opposite this gear, which can be opened and gear removed if necessary after idler pin has been pulled out. The gear is bushed with bronze and runs on a hardened pin which is stationary in the case, being held from turning by a snug fit and a screw in countershaft cap, the running fit being between the pin and bushing. To take the end thrust, a hard washer is placed next to the aluminum case at back of gear. The idler gear pin is drilled for lubrication and supplies the surfaces in contact from the inside through oil holes of ample size,

A transmission gear to be quiet must be cut correctly, the same back lash between each pair of teeth and not be out of round or flat. A gear may be near perfect until the hardening is reached and then warped out of shape or have spots in it. The extreme allowance of back lash is .0065" and minimum 0025". Depth of case hardening is 1/32" with a soft and tough core to make a gear that will stand lots of abuse and not be brittle enough to chip.

TO ASSEMBLE TRANSMISSION

Thoroughly wash each piece in gasoline. Clean the case well and blow out all the dirt or wipe out with cloths. Put in the idler shaft first and see if it spins freely without side play, then the countershaft. Be sure to get enough shims to lock the bearings and take up the end play, Put in the caps and spin the shaft. It should be free to turn but should not have end play. Clean and oil the bearings thoroughly before putting them in place.

Put in the front main bearing and cap with front end of shaft then the shifting rods, top one first, and forks with sliding gears. The two forks should be together in the center. The setting of the forks can be determined by slipping in the main shaft and setting the sliding gears in line with the other gears so as to get full width of teeth in mesh. When satisfactorily located, tighten the clamps and try the locking devices. Try each speed in turn and see if there are no interferences. Take up the end play in main shaft by shimming under main caps so shaft can spin freely.

If, when assembled, the slots in shifting rods in which shifting finger acts, do not line up after gears are lined up and locks set it will be necessary to give finger freedom to travel across from one rod to the other by filing sides of slot, or beading finger slightly

When putting in main shaft, be sure the 5/8" steel ball is in place at front end. Hold this in place with some heavy grease then put in roller bearing well lubricated and then the shaft.

Do not put in the interlocking ball until both shifting rods are in place, as the ball may otherwise get into the holes for rods and get into transmission.

Putting on universal joint yoke on rear end, do not drive on with heavy blows or you may injure bearings. This is a light drive fit.

PUTTING TRANSMISSION ON CAR

See that the bolts are in the motor case ready and the bronze collar and fiber washer well lubricated with grease are on transmission on pilot shaft. Now enter pilot in clutch keeping back end of transmission up level and put bolts through from engine legs - this is all the lining up necessary, Put enough flat washers on the bolts to bring cotter pins in line with holes and tighten nuts. Put on the shifting finger on shifting shaft and try each speed in turn. See if finger shifts cross without striking, and hand lever locks in each speed but does not strike end of slots in quadrant. Connect up the proper shaft getting universal joints properly in line and the rods to foot pedals. (See: Assemble Generator On Engine, Sec. -N, Page 2.)

Section "F

1913 Models

UNIVERSAL JOINT AND PROPELLER SHAFT

1913 MODELS

To get true universal action, the yokes of the two universal joints must pair up, that is - the yoke on transmission and pinion shaft should be in one plane and two others on the propeller shaft in opposite plane or turned 90 degrees.

The fit of the square that slips at front end of propeller shaft should be particular. Not over .002" to .003" clearance between square and broached hole is advisable to prevent rattling. A loose fit here will cause a rattle which is usually blamed on the clutch. These parts with the exception of the yoke on transmission shaft are interchangeable on the Model "37" and "54" cars.

In putting the yokes on again, do not drive with heavy blows as such would be detrimental to the bearings. The fit on the squares is such as to provide an easy entrance of yokes on shaft and light blows are sufficient, using a lead hammer to reduce the shock and to protect the parts from being roughened up.

Large grease cups are provided on the joints and a locking wire prevents the caps being lost off when screwed on in place.

Section 'G"

1913 Models

Rear Axle

REAR AXLE

1913 MODELS

The axle adjustments are two in number called pinion adjustment and differential adjustment. It is so arranged that disconnecting the rear universal joint and taking off the housing on front of axle and the wheel flanges, so as to allow the driving shafts to release the differential gears, the assembled driving gears and differential carrier with bearings can be taken out for examination and adjustment on the bench.

The pinion and ring gear should be adjusted to run together with faces of teeth flush one with the other and with about .010" back lash between all the teeth. The pinion may be moved out or into the ring gear by loosening up locking nuts at front of housing. Remove the rectangular plate on side and turn the adjusting sleeve which has a right hand thread one notch at a time and the pinion will move back or ahead as desired. The plate on the side has a lug that locks this adjustment by projecting into the notches on sleeve. The nuts on the front end of pinion shaft should be set for adjustment of the bearings and take up end play. The bearings should not be set up tight enough to prevent shaft spinning freely. A test of bearing adjustment is to be able to turn easily the pinion shaft and also differential by a thumb and finger on one tooth of the ring gear, The differential adjustment moves the ring gear and differential either to right or left. Adjusting nuts are provided to accomplish this. The threads on both are right hand. First, take off the locking clips that are placed to engage the notches in the adjusting nuts. If you wish to back ring gear away from pinion, turn the left hand nut toward you until free and then turn right hand nut also toward you until the desired adjustment is made. Keep in mind the number of notches turned, now back right nut off enough to free bearings and set left hand nut up with enough freedom so gears will turn easily on bearings, Then lock the nuts with the clips. In making changes in adjustment, make a note of each and the number of notches tamed so that if first attempt is not successful you can proceed with a better understanding.

If you wish to move the ring gear towards pinion, turn the nuts from you, loosening up the right hand nut first and then the left hand side should be turned the desired amount.

Differential bearings can be taken out by taking off the caps on carrier and taking differential and ring gear out and then slip bearing off. To take end thrust back of ring gear, there is either a ball thrust bearing mounted back of' the plain roller bearing, or a roller bearing alone with rollers set on an angle. A ball thrust bearing is also used back of pinion. To adjust the wheel bearings, it is necessary to take out all end play, but wheels must spin freely. Enough shims are put in between the inside races of the two wheel bearings to lock them with the adjusting nuts but not so as to cramp the bearings.

Pinion can be taken off its shaft by using a puller. This gear is fitted on a taper shaft and locked in place with a nut.

Ring gear is attached to the differential case with bolts that make it a short job to remove, avoiding the old method of cutting rivets to get off this gear.

Section "H"

1913 Models

Steering Gear

STEERING GEAR

1913 MODELS

The steering gear is of the full gear and worm type, On each side of the worm is a thrust ball bearing and an adjusting nut is provided to limit the up and down play of the worm which should not be more than 1/64".

It is possible to turn the worm gear and secure a new wearing surface by taking the steering arm from the shaft and turning shaft one quarter turn. The arm is fitted on the square end of shaft and secured by a clamp bolt, The shaft is supplied with bushings for bearing surfaces in the housing that can be renewed in case of wear.

To test for lost motion, which is the most common repair, jack up the front axle and turn steering wheel vigorously in alternate directions. Examine the square of the shaft in the arm and see if tight and then all the steering rods and connections. Tighten up any loose joints and lubricate thoroughly.

TEST FOR STIFF STEERING

If wheel does not turn freely when steering link at arm has been disconnected, (the pressure of one finger should easily turn to both extremes of the throw), try the nut at top of housing and see if it is binding on the column and also take off dash bracket to see if body is cramping the column. Either of these remedies and plenty of oil should make this repair. If the gear turns freely, the stiffness is likely in the knuckle bolts of the front axle. These large bolts on which depends the turning of the front wheels must be free to do their work, Daily attention should be given to supplying them with lubrication. If they get tight they should be taken out and cleaned thoroughly and when back a liberal supply of grease should be used. Some of the connections may be too tight or dry or front tires too flat.

If column jacket rattles, see that it does not strike on the end inside of spider of wheel. Allow 1/64" for up and down play of wheel and clamp jacket in dash bracket. Remove jacket and expand bushings on inside to hold jacket in one position if rattle is between outside of column and spider or between the jacket and inside tube. Allow clearance between sector and nut on top of wheel to prevent a rattle there, The rods and tubes inside may be wrapped with wicking if they begin to rattle. To do this, take off the small bevel gears at lower end of housing and control rods can be withdrawn after sector has been taken off releasing spark and throttle levers.

Gear cannot be taken out of car without first taking off the generator, (See N, Page 1) and water pump. Take off wheel and sector with levers and the arm on steering shaft. Take out the bolts attaching housing to frame and move inward towards motor and lift gear out.

Section "I"

1913 Models

Wheels

WHEELS AND BEARINGS

1913 MODELS

Bearing adjustment should be given particular attention. It is advisable to make a point of watching these bearings in order to see if sufficient lubrication is provided and that wheels spin freely without any end play. Out wheel bearings will give excellent service if properly adjusted bill cannot be expected to do their work if either neglected or carelessly put into the wheels. On the rollers of the bearings we are using there is a shoulder to take end thrust and to do this properly wheels must be free to spin. Shims are used between the two bearings of the wheels to space the races properly so that locking nuts will prevent end play. Try the wheels to see if they spin freely and add of remove shims until there is no end play.

To take off front wheels: Remove hub cap and the nut and washer holding the bearings in place- Place a jack under the axle and wheel can be pulled off easily as soon as weight is removed from it.

To take off the rear wheels: By taking off the six nuts on the flange, the driving axle and flange can be taken off. To do this quickly provide a socket wrench with a brace handle from kit to fit the nuts. With the hub flange removed the two locking nuts that retain the wheel bearings can be taken off, The bearings should be adjusted by using shims between the inner races, so that when nuts are on tight the wheels will spin freely and without end play.

Section "J"

1913 Models

Body

BODY

1913 MODELS

The usual body troubles consist of door rattles and body squeaks. Door rattles are caused by the twisting of the body and wearing of the rubber bumpers. There is always a certain amount of twisting in the body which comes from uneven roads and this will loosen body bolt and cause squeaks and working of the body parts. For this reason, the body bolts should be tightened occasionally. In case of doors not remaining locked shut, the lock plate or hinges may be shimmed out to bring door over and take up the opening or by changing the body shims under the sills, the doors may be made to remain closed. In case of sticking shut, the same thing can be done. Taking out a little of the center shim, will close doors, and putting in an additional shim will change the door opening the desired amount. Doors are also caused to open by sagging of rear end. This trouble can be corrected by putting in the plates for this purpose and shims at rear end and an extra body bolt through gusset plate. By keeping body bolts tight there should be little trouble from body noises.

The body paint work should never be washed with soap of any description. Cold water is the best tonic for a freshly painted body, as it assists in setting the varnish. Mud should not be allowed to remain on a body and should be removed when wet if possible. Soak the body well with plenty of water. In using a sponge, do not use a wiping motion as this would collect grit in the sponge and scratch the finish. Use a sponge only in this way: lightly touch the surface lifting straight up and not a wiping motion. Plenty of water, a soft chamois free from grit are all that are necessary to wash a body. In using any kind preparation to bring out the luster, use only those that are prepared for this purpose. The finish on a varnished body is easily spoiled. The use of any polish to excess is also detrimental to the finish.

The wheels and axles may be washed with soap to remove to grease, but only soap free of acid and Alkali should be used.

WINDSHIELD

The windshield is attached to the body and should always have to adjusting screws tight. When shield is set in any desired position, see that no unnecessary strain is put on the parts by not having the clamps tight to make shield rigid to stand the wind pressure against it. At high speeds the air pressure is very great.

TOP

The top should always be carefully folded down when not in use. Avoid wrinkling as much as possible and use the dust cover to preserve the top covering as much as possible. The bows can be held rigid when top is down by the separators on each side at rear. In dusty weather keep top clean and if this precaution is taken, you will avoid spotting and discoloration if top should become wet. A car will run smooth a with much less expenditure of power with top down and you will find that there will be a considerable reduction in the noise of the rear axle and transmission.

BALANCING

To balance the body properly, extra casings should be carried right side to offset the weight of the storage battery and controller.

Section "K"

1913 Models

Carburetor Adjustment

CARBURETOR ADJUSTMENT

1913 MODELS

We are using the Zenith Carburetor on account of its simplicity and because of it-, constancy in carburetion, viz. it will insure the proper quality and quantity of mixture under the most variable circumstances. We get good economy, quick pick up, the motor will idle well and, when cold will start easily without preparation.

There are four variables in this carburetor which, once determined, never need changing. They are a main jet drawing up gasoline as furnished directly from the at chamber this is the high speed jet. A second jet independent of the first being supplied from the bottom of a well which has its free end in the open air, The gasoline is supplied at the bottom of this pipe and regulated by a gauged opening, the flow through which is only dependent on the head of the gasoline in float chamber. This head is constant in consequence of the principle of the float chamber- This jet is called the compensating jet, being independent of the change of pressure inside the carburetor and has a constant flow for a given time. This jet is the low speed jet. The third variable is the size of the choke tube or venturi tube, which regulates the velocity of air around the jets. The fourth variable is in the adjustment of the well in relation to the small tube through which the fuel passes to feed the manifold at the point of the butterfly valve. There is a small well within the larger into which this feed tube dips, the opening in the bottom of this small well controls the amount of fuel supplied to the manifold when the motor is idling.

The carburetor adjustment which we use at the factory is adapted to the local climatic Conditions. Attitude and relative humidity of different localities may necessitate a change in this setting. We therefore suggest that you oil study your conditions and make adjustments accordingly, or otherwise advise us of these conditions and we will supply you with the proper settings.

The float level will not ordinarily need changing, as the level is set by the manufacturer, and the only reason for such change would be when adjustment has been changed by mistake or where the density of the fuel is considerably different. The he present setting will take care of gasoline up to 71 gravity. Beyond that some adjustment will very likely have to be made. The size of the jets and choke tube is settled on here, and there will be no occasion to change them, but if it is necessary, they are easily removed by firs[taking out the plugs on the bottom of the carburetor and then, with the too] famished for that purpose, take jets out. The numbers marked on the jets are the sizes of the holes in fractions of a millimeter, through which the fuel passes. These holes should not be changed, as they are accurately tested to supply under constant pressure, a certain volume of liquid in a given time. The air control operated from the dash is supplied to help in starting, Close this opening to start and open when running,

To lift "he needle valve from its seat in case of dirt in the gasoline, take off the small cap over the float chamber and lift up on the stem and give it a few turns on its you whirling the stem in your fingers. This should free the seat of any particles of dirt or sediment that would hold valve open and cause flooding.

To drain carburetor, to free line from dirt or water, take out the plugs under the juts and allow gasoline to flow for a few seconds.

To clean the float chamber, remove the cover by turning the spring on top to one side and take out float. This chamber is easily reached and can be quickly cleaned or examined.

RECOMMENDATIONS FOR THE ADJUSTMENT OF ZENITH CARBURETORS

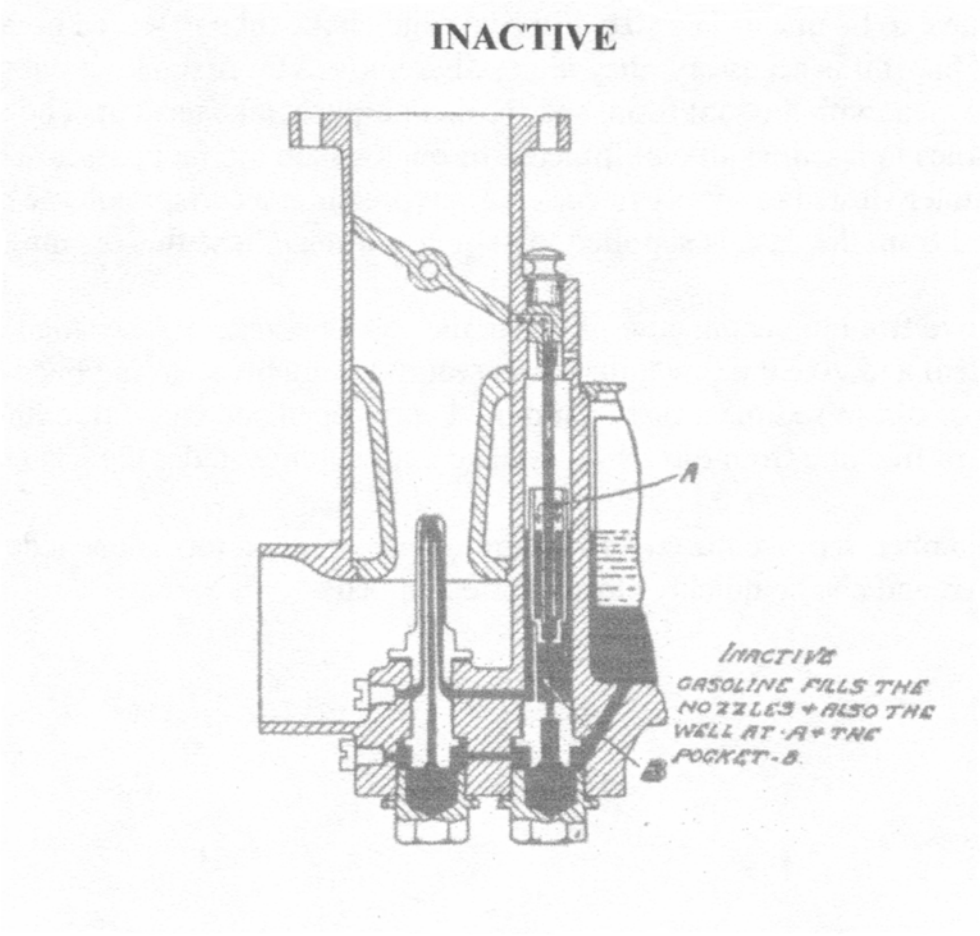
To eliminate excessive gasoline consumption proceed in the following manner

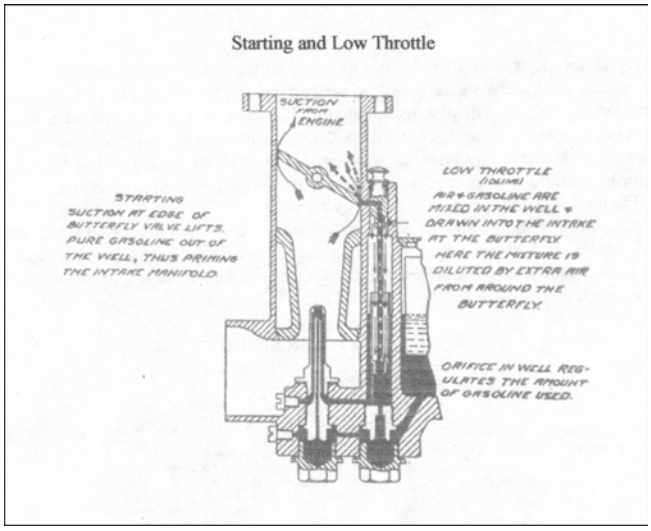
Be sure that your float chamber cover is seated properly, that the float is not punctured, that there are no leaks in the carburetor or in the gasoline line, or that carburetor does not drip gasoline owing to poor seating needle valve or dirt under same, and that air pressure in gasoline tank is not carried too high

All of the above are the most common causes for excessive gasoline consumption where the carburetor settings are approximately standard. A to reduce the consumption on an otherwise perfect carburetor, first change the jet, By doing this we make an adjustment which reacts upon the motor in the same manner as in any other carburetor. To the inexperienced, therefore, such changes will show the quickest results,

On the adjustment of compensator we must be very much more conservative as a compensator which is one size too large will cause the motor to load up at low speeds and to be extremely rich when the moor is idling. This is especially true in the case of the Model 54 where the suction is more constant. Theoretically, the compensator does not work when the motor is throttled down idling, but in practice it has been found that the compensator does actually deliver gasoline to the cap jet at idling speeds.

The adjustment of the compensator, then, should be the secondary adjustment and the range should not exceed one size larger or one size smaller, with the recommendation that the smaller size 'be tried first and only after the jet has been reduced to the minimum.





The well, theoretically, affects idling only, as it should be understood that the well pocket becomes exhausted as soon as the throttle has opened sufficiently to allow the compensator to come into action. The ranges in wells therefore, will be as small as the compensator.

The changing of wells should be as conservatively handled as the changing of compensators, as it is not possible that more than one size either way will be required. The difference will be noticed in idling of the motor, the small well making the motor gallop and probably stop, and the large well enriching it to such an extent as to make it smell badly and load up.

It must be understood that at all times the shutter of the strangler must be tilted so as to point slightly upwards about 1/8" This is so as to deflect the incoming air upwards toward the venturi and eliminate checking of the passage.

Refer to the three prints of the Zenith carburetor, showing its action under four different conditions. These four stages represent inactive or still position, starting, (showing the priming action), low throttle or idling, pick up (or acceleration from low throttle), and high speed or fully opened throttle.

These diagrams represent the theoretical action of the carburetor. As previously mentioned, there is undoubtedly some-discharge from cap jet at low speeds, especially in the Model 54. This is why the compensator affects the idling 'in cases where it is too large and is the reason for our recommendation of the cutting down of compensator one size rather than going up on it,

The action of the well will be seen to be that of a small surface carburetor, the amount of gasoline delivered being limited by the orifice 'in the bottom of the well pocket. To sum up: The sequence of operations in adjusting the Zenith carburetor should be as follows:

1. Cut down jet to the smallest size, noting the action of the carburetor on pick up at speeds above 15 Miles per hour, at which point the jet will act in the same manner as In any other type carburetor.

2. Cut down compensator one size and note whether there are one of two changes take place. 1st. Less tendency to load up. 2nd. A better smelling exhaust and less tendency to soot.

If the carburetor spits an a low speed pick up, or tends to die away entirely when the throttle is open about one third, it is a sign that the compensator has been reduced to a disadvantage and should be set back.

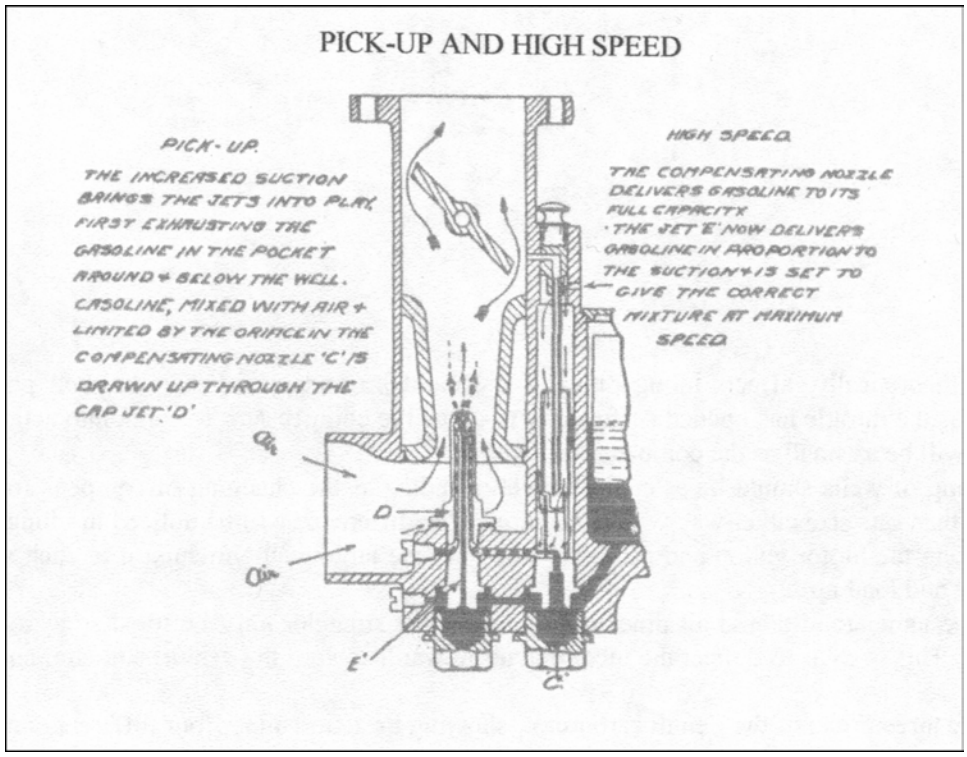
Loading up will be the result of too large a compensator and the symptoms will be as follows:

When driving at speeds around 10 miles per hour, or on the Model 54, about 20 to 25 miles, and then closing the throttle suddenly for a few yards, it will be noticed that the motor fails to pick up when the throttle is opened again to the same extent. It will pick up eventually, but there is a dead point for a few seconds which indicates that the mixture has become too rich and has loaded up or flooded the manifold.

It should always be borne in mind that the compensator does affect the idling but nevertheless, cannot be considered satisfactorily adjusted until the well and the jet have been gotten to the correct size.

3. The third and last operation is to adjust the well.

If the motor has been sooting badly, or smells very strong and sputters in muffler when idling, it is safe to assume that the well can be cut down one size, but seldom more. This can be done only after the compensator and jet have been set to your satisfaction. If the well is too small there will be a tendency for the motor to gallop and it should, therefore, be increased one size.



Before making any changes in wells, it is always advisable to see that the ignition system is in perfect working order and that the valves are not riding or do not need grinding, also, it should be borne in mind that the motor must be warm. It cannot be expected to idle properly if it is cold or if the hot water manifold is shut off. In cases where a man has been complaining of excessive gasoline consumption, it is well to overhaul the ignition system and grind in the valves, retiming them for tappet clearance before making any carburetor adjustments, as poor condition of ignition and valve seating will prevent obtaining a good well adjustment. This point is most important and it is our recommendation that all motors be thoroughly overhauled as to these features before any carburetor adjusting is attempted.

To remedy excessive air pressure (which should register not more than 3#) the pump can be shimmed up with one or more paper gaskets. If the pump pressure is so excessive as to prevent results being obtained in this way, it may be necessary to bore out the air chamber in pump, thereby increasing the volume of the chamber and lowering the pressure proportionately. 2# is heavy enough pressure at all times, and if the pressure is allowed to run over 4#, excessive gasoline consumption will result.

If the only trouble complained of is poor idling and low throttle, it is also well to look to the fit of the butterfly valve stem, as air admitted at this point will weaken the mixture and cause the motor to gallop and stall easily. The side of the carburetor next to the motor can be soldered up at the point where the stem passes through it by shortening the stem slightly and soldering a cap over the end of the boss. The other end can be peened with a hammer and re-reamed if it is a poor fit. In any case, this should be looked to if poor idling is the only complaint.

It should be thoroughly understood that the carburetor is a self priming one and that it is not necessary to open the throttle when starting. Starting is not facilitated in any way but is hindered with an open throttle. Neither is it necessary to flood the carburetor.

In starting, one foot should always be an the accelerator pedal and as soon as the motor is heard to start, the pedal should be pressed down just enough to allow it to pick up, but motor should not be raced. The action of the accelerator pedal and clutch pedal becomes mechanical after a little practice, the clutch pedal releasing and the accelerator pedal depressing slightly as soon as the screech of the starter gear is heard indicating that the motor is turning over under its own power. By leaving the starter gears engaged after the motor is started considerable drag is put upon it and starting is made more difficult as the motor will not pick up easily.

Carburetor adjustments should never be attempted unless the person who is going to make them thoroughly understands the principles of the carburetor as outlined before he is prepared to tackle the job along the lines recommended by us. The most important of all is the thorough tuning up of the valves and ignition systems, as we find that these are more often in need of adjustment than the carburetor, which is one part of the automobile that does not wear.

GASOLINE TANK

The gasoline gauge, fitted in the end of tank, can be taken out and replaced only by using a socket wrench. The common repair's on the gauge are leaking float which is attached to magnet stem inside and occasionally a magnet may become loose on its stem to which it is attached by a set screw. The float can be soldered after removing the gasoline inside. There is a solid wall between magnet and dial outside. The magnetism passes through the wall and causes the needle to follow the motion of the magnet. The needle is only set on the pin which carries it and should be carefully handled. When putting on a gauge, first offset float stem slightly to prevent float striking end of tank. Tighten up on thread and get a good joint. If dial does not 'indicate properly, remove glass face and needle, then the locking ring against the dial and turn dial until the "Full" mark is at the top. Set needle on and screw cover back into place.

In case of a leaky supply pipe between bottom of tank and point where pipe comes out of tank, it will he advisable to replace tank as it is very difficult to remove this pipe. This leak will be indicated by a failure to get gasoline from any point below the leak. The filler cap should be made tight by using a leather gasket. It is not necessary to exert much strength in putting this cap into place. The weight of one hand can strike wrench hard enough to prevent air leaking. Filler neck may be loosened if a greater leverage is used.

Section "L"

1913 Models

Storage Batteries

STORAGE BATTERIES

1913 MODELS

Manufacture and Construction. The remarkable success of the Delco Starting, Lighting and Ignition system has made the detail of the Exide Storage Battery Equipment used of particular interest. The battery, one of the leading factors, upon which depends the success or failure of the system, was especially designed to meet the unusual conditions of the service. Exhaustive tests were made, both by Engineers of the Dayton Engineering Laboratories Company, and of the Electric Storage Battery Company, and the results were the storage battery used in connection with our system.

The storage battery used on this year's cars has four divisions of 3 cells each made up of 12 separate cells of 2 volts each, and the wiring is so arranged that we get a 6-volt current for ignition and lighting and 24-volt current for starting, the cells being connected either in parallel or series. The change from one to the other is taken care of in the controller, which by an arrangement of 2 sets of knife switches, the necessary connections are made.

The four groups of cells are not interchangeable on account of the terminals, which are marked plus and minus. The positive or plus terminals should always be on the two long sides of the box and the negatives, or minus, at the ends of the battery box. If arranged in this way there will be no danger of reversing the charge through the plates.

The capacity of the battery is 80 ampere hours and a full charge will light the car for about 12 hours.

The internal construction of the cells consists of two negative plates, always gray in color, and one positive plate, always brown in color, separated by wood and rubber separators. The rubber separators are placed one on each side of the positive plate and the wooden separators between the positive and -negative plates with the flat side against the negatives. These plates are contained in a rubber jar with terminals extending through a soft rubber cover.

The rubber cover has a vent tube projecting through it, the lower end of which nearly touches the rubber screen over the top of plates. This vent is used to determine the amount of electrolyte in the cell and to add water when necessary. The syringe used for filling should be placed in this vent, the lower end resting on the screen, if any liquid can be drawn up no additional water is necessary. In case it is necessary to add water, only a small quantity will be needed and be careful not to fill above the lower end of the vent tube, or otherwise it will slop out and decrease the gravity of your solution.

When the plates are put into hard rubber jars, which serve as containers, the groups of plates are placed together with the positive and negative plates alternating. Against the positive plate is a thin sheet of perforated hard rubber, which serves to check washing away of the active material, due to rough usage and vibration of the car, To prevent the positive and negative plates from touching each other and causing short circuits, a corrugated separator of especially treated wood is used. This separator is flat on the side which goes against the negative plate. The side which goes against the rubber separator next to the positive plate is ribbed vertically to permit circulation of electrolyte and escape of the gas during charge.

Just above the top of the plates and separators, and resting on the two straps, is a bent strip of perforated hard rubber, which serves as a splash cover, breaking up the wash of the electrolyte. The jar cover proper is made of soft rubber and provided with a flexible rib around the edge. This soft rubber cover fits snugly inside the jar, and all around the posts, giving a very effective seal which eliminates splashing and seepage of acid. In the center of the cover is a hole into which fits a hard rubber -tube, known as the "vent tube." It consists of a straight open tube reaching to the solution level 'in the cell, and projecting about one inch above the cover, Two ring flanges grip the cover and hold the tube securely in place; being an open tube, it never has to be removed. The four small holes below the lower flange allow the gas to escape, without any danger of acid loss while the bottom of the tube is sealed by the electrolyte.

The terminal posts in the cells, from which current is to be led to the controller switch, are of different construction from the posts oil which the alloy connector fits, which connects two adjacent cells. These terminal posts have a flat recessed face, to which is bolted the alloy terminal lug. 'Me terminal lug has sweated into it a rubber covered cable, which conducts the current to and from the battery to the controller. 'Me wires and alloy castings are known as "terminal leads." The cells are assembled in a wood case and divided into four 3-cell groups.

Each group is selected by the controller, different combinations being used for different functions; thus, for cranking the motor all l2 cells are in series, giving a battery of 24-volt and 20-ampere hours capacity. For lighting and ignition as well as charging, the four 3-cell groups are connected in multiple giving 6 volts.

The terminals should be kept greased with vaseline to prevent corroding but if this precaution is neglected, the acid fumes will soon destroy the terminals.

The essential active elements of a lead storage cell are peroxide of lead for the positive plate, and spongy metallic lead for the negative plate, in a solution of dilute sulfuric acid, known hereafter as "electrolyte."

When a lead storage battery discharges, a portion of both the lead peroxide in the positive plate and the spongy lead in the negative plate unite with the sulfuric acid from the electrolyte, forming lead sulfate on the plates. The lead sulfate being insoluble in the electrolyte, remains on the plate and is readily brought back to peroxide lead and spongy lead respectively, by recharging. After the active materials have been brought back to their original state, that is, when the battery is fully charged, the further passing of current results merely in the decomposition of the water of the electrolyte into its two components, hydrogen and oxygen, which rise through the electrolyte in the form of gas. Since a battery is not 100% efficient, a certain amount of overcharge is necessary. This is why we ask you to set the ampere hour meter back. If a battery is continually overcharged, the result will be that the active material will begin dropping out very rapidly. This naturally decreases the life of the battery. 'Me ampere hour meter with our system cuts off the charge, when the battery is fully charged.

The "active material," lead peroxide and spongy lead, have to be supported. The plates are, therefore, constructed with grids or frame work of metallic lead or alloy. These grids also serve as conductors for the current from the active material. The grid of the "Exide" plate is of a sort of double ladder form. 'Me vertical grids extending through the thickness of the plate while the horizontal grids are at the surface, those on one side being ill staggered relation to those on the other. A vertical section through the cross bars makes this point clear. The active material is thus held in the form of a series of vertical bars between the vertical ribs, and firmly locked in place by the horizontal ribs.

The active material is supplied to the grids in the form of a dough or a paste of lead oxide, so constituted that in drying it sets hard like cement. The plates then go through an electro-chemical process, which converts the material of the positive plates into brown peroxide of lead and that of -the negative into a gray, spongy, metallic lead.

Operation. The Delco System insures the proper charging of the battery and also prevents the harmful overcharging. It is necessary, however, once every two weeks to give an "overcharge" in order to equalize the cells and keep them in good condition. The method of giving the overcharge is explained below:

Overcharge. As already stated, our apparatus is so designed as to prevent continuous overcharging. Continuous overcharging causes the active material to wash or fall out of the plates, which shortens the life of the battery. It also causes the water in the electrolyte to evaporate excessively. Undercharging of a battery will cause the plates to become sulfated. A sulfated plate means that the sulfuric acid in electrolyte has gone into the active material of the plates, and allowed to remain, and with this condition a storage battery will not do its work. 'Me sulfate can be removed by charging the battery at a low rate for a number of hours. In a sulfated battery the specific gravity will necessarily be low, and by the long, slow charge, the electrolyte will gradually reach a maximum which will be from 1.275 to 1.300.

Once every two weeks, or as near this interval as the use of the car will permit give the battery an overcharge. To do this remove the cap of the top of the ampere hour meter and set the hand back 20 points wherever you find it but never past 70. This automatically gives the battery the overcharge so necessary to its satisfactory operation.

If, for any reason, such as excessive cranking, or all lights burning for a number of hours the engine not running, the battery should be come discharged, it should be given an overcharge, as above, in addition to the every two weeks overcharge.

Evaporation. It is a well known fact that water will evaporate and that sulfuric acid will not evaporate. This is the reason why we ask you not to add acid to the electrolyte when replacing evaporation. If the electrolyte

has been spilled or lost due to broken jar, it is then necessary to add electrolyte, and only under these two conditions.

Every fifteen days, test each cell in this way and make up the lost by evaporation by adding distilled water, Add water regularly, although the battery may seem to work all right without it. Acid should not be added at any time.

Adding Water. This point is just as clear in the instruction as the English language can make it, yet some of your customers will put it any kind of water available, and others will not put in any water at all One case is as bad as the other. The result is that the battery will not do its required work and the customer will feet that the apparatus is defective. Impress upon the users of cars that it is absolutely necessary to replace evaporation, that is, keep the cells filled up to the propel height with distilled water.

Water. Nothing should be used but distilled water, melted artificial, ice, or fresh rain water. Any druggist will supply you with a quart for about ten cents which is sufficient to last several months.

Never keep the water in a metal container, such as a bucket or can It is best to get a bottle of distilled water from your druggist, or the local ice plant. A quart will last a long time.

The whole point is to keep metal particles out of the battery.

Spring water, well water, or hydrant water from iron pipes will contain iron, etc. in solution and will ultimately cause trouble if used.

By looking into the vent tube, the liquid can be seen if it is up to the proper height. If the liquid is low, the splash cover will show, and distilled water must be added with the filling syringe, provided for this purpose, until it shows through the holes in the splash cover. The amount of distilled water required will vary according to the climate conditions, In cold weather, it may require only a spoonful, and in hot weather, considerably more. Be sure to keep the liquid up to the proper point, by the addition of distilled water. A storage battery can't give service without this little attention.

If electrolyte has been spilled from the cells, replace the loss with new electrolyte and follow with an overcharge by running the engine for several hours, or charging from an outside source. The specific gravity of the electrolyte to be used for replacing the loss spilled from the cells, should be the same specific gravity as that of one of the adjacent cells in the battery. This can be determined by the use of the Hydrometer Syringe. Never add electrolyte or acid to the cell s except to replace loss by spilling or a broken jar.

New Electrolyte. When new electrolyte is required, either to replace loss by spilling, or when removing sediment or replacing broken jar, it should preferably be obtained from the Electric Storage Battery Company (communicate with nearest Sales Office, see Sec. L, Page 7), but it can be made by mixing especially pure sulfuric acid (1.840) specific gravity), and distilled water in proportion of two parts of acid to five of water by volume. A druggist will be glad to mix the water and acid for you. If you attempt to do this work yourself, be careful, as sulfuric acid will burn anything that it comes in touch with, with the exception of glass or lead. Acid must always be poured into the water. A glass, earthenware or other acid-proof vessel, thoroughly cleaned, should be 'used and the electrolyte allowed to cool before using. If a specific gravity lower than 1.300 is wanted more water should be added to acid.

Charging. The best way to ascertain the condition of the battery is to test the specific gravity (density) of the solution in each cell with a hydrometer. This should be done regularly, but not just after adding water. A reliable specific gravity test cannot be made after adding water and before it has been mixed by charging the battery or by running the car.

To take a reading, insert the end of the rubber tube in the cell, squeeze and then slowly release the rubber bulb drawing up electrolyte from the cell until the hydrometer floats. The reading on the graduated stem of the hydrometer at the point where it emerges from the solution is the specific gravity of the electrolyte. After testing, the electrolyte must always be returned to the cell from which it was taken.

When great accuracy is desired, correct for temperature by adding one point to the reading for every three degrees in temperature of the electrolyte above 70' F., the specific gravity corrected to 70 degrees F. is ten points less than the reading, of 1,280.

When all cells are in good order, the gravity will test about the same (within 25 points in all). Gravity below 1,200 indicates battery more than half charged. Gravity below 1,200 but above 1, 150, indicates battery less than half charged.

When battery is found to be half discharged, use lamps sparingly until by charging the battery, the gravity is restored to at least 1,200.

Gravity below 1, 150 indicates battery completely discharged or "run down." The charging rate on the car is 10-12 amperes. In case of charging on a bench, it is better not to charge faster than 6 amp. to prevent heating up and the plates will charge better at a lower rate. Never use anything but direct current and always in the right direction-positive to positive and negative to negative.

If a battery is allowed to stand run down, it will be difficult to get it to come back to standard capacity and should be carefully charged at a very low rate. The temperature should never exceed 110 deg. F. when charging. If it comes up to that reduce the rate of charge or stop entirely for a time. A run down battery should be given a full charge at once.

A run down battery is always the result of lack of charge or waste of current. If, after having been fully charged, the battery soon runs down again, there is trouble somewhere else in the system, which should be located and corrected.

Putting acid or electrolyte into the cells to bring up specific gravity can do no good and may do great harm. Acid or electrolyte should never be put into the battery except by an experienced battery man.

Gravity in one cell markedly lower than in the others, especially if successive readings show the difference to be increasing, indicates that the cell is not in good order.

If the cell regularly requires more water than the others, thus lowering the gravity, a leaky jar is indicated.

Even a slow leak will rob a cell of all of its electrolyte in time and a leaky jar should immediately be replaced with a good one.

If there is no leak and if the gravity is, or becomes, 50 to 75 points below that in the other cells a partial short circuit or other trouble within the cell is indicated.

Electrolyte should be added only when it is determined that the S. G. is low due to the addition of too much water. To determine this start charging, test all the cells separately for S. G. If some are lower than others, charge them at a low rate. If the gravity increases, it is an indication that these cells had only been run down lower than the others and simply needed additional charging. if, however, with continued charging the gravity does not come up and the temperature does not increase very rapidly, it is known that the gravity has been lowered by the addition of water to take care of a loss, possibly due to leakage. There may be a broken jar and the cell should be examined for the cause. It may be necessary to remove cell from battery and to do this disconnect the wires, the 3 cells in each group come out as one, or the plates can be pulled out by taking hold of the terminals. Place the plates at once in water, do not allow them to be exposed to the air. After plates have been removed the jars can be inspected.

A partial short circuit, if neglected, may seriously injure the battery and should receive the prompt attention of a good battery repair man.

A battery charge is complete when, with charging current flowing at the normal charging rate, all cells are gassing (bubbling) freely and evenly and the gravity of all cells has no further rise during one hour. The gravity of the solution in fully charged cells is between 1,275 and 1,300. In the action of discharging, the battery plates combine with some of the acid of the solution, lowering the gravity of the solution, as explained under Section 5.

In the action of charging, the battery plates give back the acid to the solution, restoring its gravity in proportion to the amount of charge. The battery is fully charged only when all of the plates in all of the cells have given back all of the acid, of which the best indication is that charging will produce no further rise in gravity.

If, for any reason, an extra charge to maximum specific gravity is needed, it may be accomplished by running the engine idle or by using direct current from an outside source.

In charging from an outside source, use direct current only. Limit the current to the proper rate in amperes by connecting a suitable resistance in series with the battery. Incandescent lamps are convenient for this purpose. Connect the positive battery terminal (marked POS) to the positive charging wire and negative to negative. If reversed, serious injury may result. Test charging wires for positive and negative with a voltmeter or by dipping the ends in a glass of water containing a few drops of electrolyte, when bubbles will form on the negative wire.

The normal charging rate for batteries used on our 1913 models is as follows: Three Amperes when charged in series and 12 Amperes when charged in multiple. Charging from an outside source, is done in multiple. Experience has shown the best results, both while charging and discharging can be obtained when the battery temperature is between 70-90 degrees F. A lower temperature will decrease the capacity but a return to a normal temperature will restore the capacity of the battery. Any increase in temperature above the normal will cause excessive wear on the plates. Be careful to keep all dirt and foreign substance out of the battery. For instance, any metallic substance falling into a cell may ruin it before it is discovered.

Short circuits are indicated by short capacity, low voltage and low S. G., excessive heating and evaporation of the electrolyte. Short circuits are caused by several things. Constant care should be used to see that the sediment in the cells does not touch the bottom of the plates. This sediment is caused by the gradual wear of the plates. It is difficult to say at what stated periods this sediment should be removed as the time element depends on the work of the battery and the care it received. It is advisable after a battery has been charged 50 times to cut out one cell from the center and inspect it for this deposit. Then from this height, determine when it should be cleaned out, but never allow the height to come closer than 1/4 below the plates. The older the battery the more rapid the accumulation of sediment, so allowance should be made of about 20% so that after 100 charges, if you estimate that it is time to clean out the batteries, deduct 20% or clean out after 80 charges.

Charging from an Outside Source. It is necessary that the charging be done with "direct" current. The simplest method is, when there is a 110-120 volt direct current circuit available, to connect three 32-c. p. I 10-volt carbon lamps in parallel with each other, and in series with the battery to he charged (See Diagram, See. L, Page 7), this combination giving the proper charging rate (2-amps). The cells must all be connected in series while charging, and the positive terminal of the battery connected to the positive side of the charging circuit and the negative terminal of the battery to the negative side. The diagram (See Diagram, See L, Page 7) illustrates just how these connections should be made. The charge should be continued until all of the cells have been gassing or bubbling freely for five hours and there is no further rise in the voltage of the battery or specific gravity of the electrolyte over the same period. This will probably require from 25 to 50 hours charging, all depending upon the condition of the battery.

To determine the polarity of the charging circuit, if a suitable voltmeter is not at hand, dip the ends of the two wires A and B into a glass of water into 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 the negative wire.

If only alternating current is available, a current rectifier must be used.

Laying up Car for Winter. If the car is not to be used for some time, say the winter months or longer, care should be taken that the last time the car is used water should be added to the cells (See Sec. L, Page 3), and that an "overcharge" (See Sec. L, Page 3), is given, taking care to add water before the "overcharge" so that it will be thoroughly mixed during the overcharge. At the end of the overcharge, the specific gravity of the electrolyte should be 1.275 to 1.300. With this condition, there will be no danger of freezing.

The overcharge should be repeated at intervals of one month during the out of service period, either by running the engine enough to give ten points oil the meter or by a charge from an outside source (see Sec. L, Page 5). If either of the above is not possible, and there is no garage equipped for charging batteries, to which the battery can be conveniently sent, the battery may be allowed to stand during the winter period without charging, provided the specific gravity of the electrolyte in the cells of the battery registers from 1.275 to 1.300 at the time the car is "laid up though much better results will be obtained by giving the periodic charges.

Putting Battery in Service Again. If the battery has been kept charged during the winter, put it on the car, being careful to get connections right. Use vaseline in putting them together (see Diagram No. 1, Sec. L, Page 5). Add water if necessary. Set meter back to "70" and then go ahead as usual.

If the battery has not been kept charged, add water if necessary. Set meter back to "70." As soon as it gets up to zero, set it back again. Do this for four or five times or once for each month the battery was idle then go to the regular two-weeks set-back. The best results will be obtained if the battery is "charged" from an outside source (See Sec. L, Page 5).

When connecting up the battery leads from the controller switch to the battery, be sure that the brass studs in the bolt connectors are free from corrosion. The greenish deposit can be removed from the studs and nuts by placing them in a solution of bicarbonate of soda (cooking soda) and water. After the deposit is removed, wash the bolt connectors in warm water, allow them to dry and then apply a light coat of vaseline to them.

When making the connections, be sure that the lead nuts are drawn up tight. When placing the battery in the battery box, be sure that it rests squarely oil the base, and that the holding down bolts are drawn up tight.

Hydrometer Test. The hydrometer syringe is nothing more or less than a pair of scales weighing the amount of sulfuric acid in the electrolyte. The specific gravity of pure sulfuric acid is 1.840. Of the solution in fully charged battery 1300 and in a discharged battery 1150. In taking a gravity reading, the electrolyte causes the hydrometer in the hydrometer syringe to float, that is, a portion of the stein of the hydrometer rises above the surface of the electrolyte. On the stem of the hydrometer is a graduated scale and specific gravity readings are taken at the surface of the electrolyte, As stated before, when a battery is discharged, the sulfuric acid goes into the active material of the plate, and as water is of less weight than sulfuric acid, the specific gravity of the cell decreases. On charge, the sulfuric acid is driven out of the plates into the electrolyte, and consequently the specific gravity rises. About the best instructions to give for the care of a storage battery is to intelligently let it alone, that is, keep the cells filled to the proper height with distilled water and set the ampere hour meter back 20 points every two weeks.

The two principal points in the care of the battery are:

I . To give the battery an overcharge once every two weeks (see Sec. L, Page 3).

2. To keep the level of the electrolyte at the proper height above the plates by adding distilled water (Sec. L, Page 3).

The Electric Storage Battery Company has distributors, who do battery repair work in all towns of any considerable size, and Exide Battery Depots in the following list of cities, where complete assembled batteries and repair parts are carried in stock. These depots are fully equipped to do any kind of battery work:

LIST OF EXIDE BATTERY DEPOTS:

New York City	Yellow Taxicab Co., 8th Ave. and 49th St.
Philadelphia, Pa.	Allegheny Avenue and 19th St.
Boston, Mass,	789 Tremont St.
Cleveland, Ohio	5121 Perkins Avenue.
Chicago, Ill.	333 W. 35th St.
Atlanta, Ga.	76 Marietta St.
San Francisco, Cal.	590 Howard St.
Denver, Colo.	1424 Wazee St.
St. Louis, Mo.	1415 Chestnut St.
Kansas City, Mo.	1329 Walnut St.

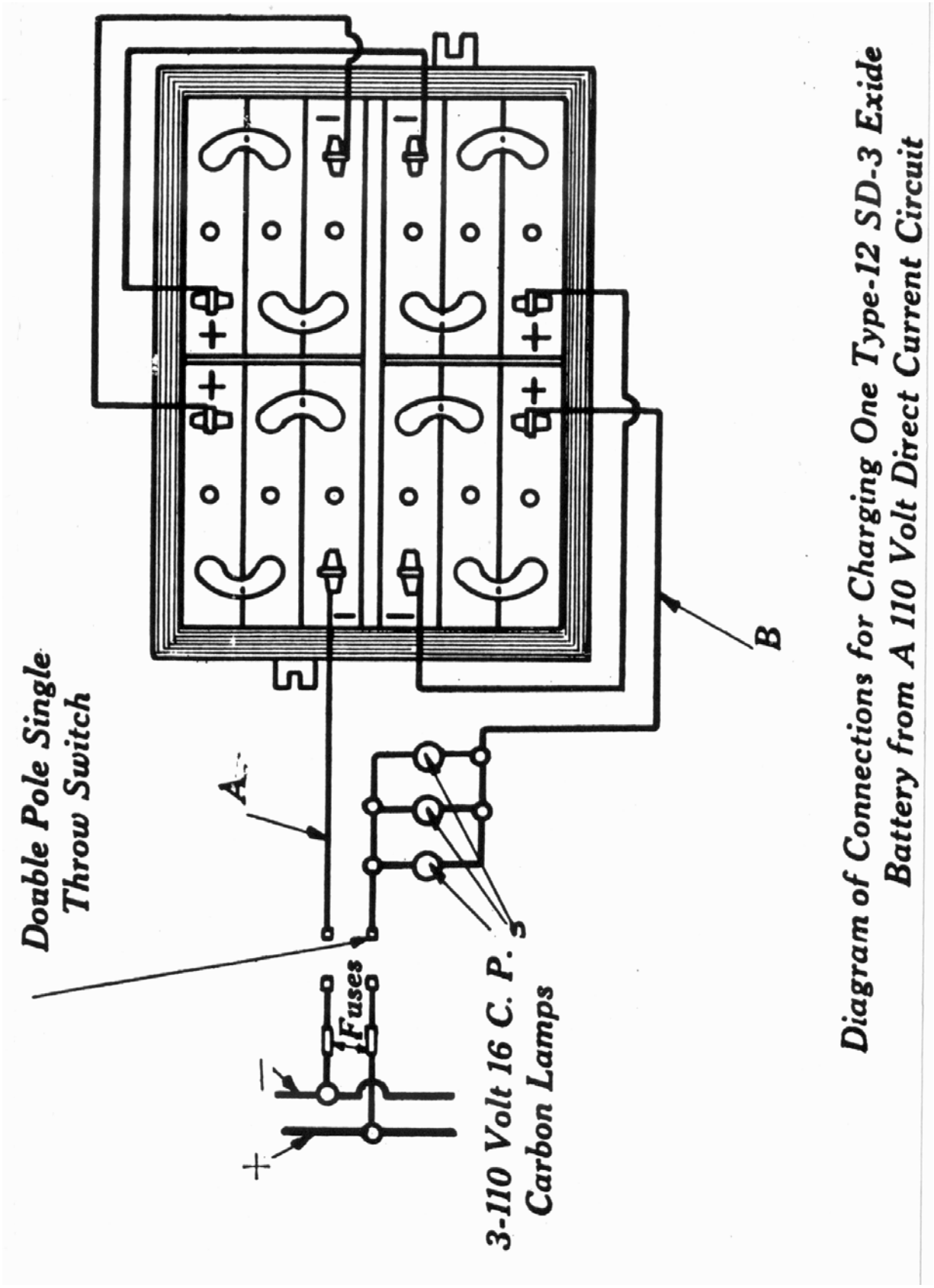


Diagram of Connections for Charging One Type-12 SD-3 Exide Battery from A 110 Volt Direct Current Circuit

Section "M"

1913 Models

DELCO SYSTEM
1913 MODELS
THE WIRING

The wiring on the 1913 car seems on first inspection to be complicated but this impression soon vanishes as one becomes a little more experienced. To make the subject clear we will take each circuit in turn and separate it from the whole system.

The motor-generator, and storage battery make up one system of lighting and ignition, really, a dual system, the storage battery simply supplies the necessary current when the generator is not doing so, as when it is running at too low a speed. If, for instance, the generator shaft is turning more than 300 R. P. M. the battery must supply the demand and when turning more than 300 R. P. M. the generator supplies in proportion to its speed until the maximum output is reached, which is at 1000 R. P. M. of the engine. At higher speeds this output increases very little. At ordinary driving speeds sufficient current is produced by the generator for all necessary demands of lighting and ignition and to keep battery fully charged.

There is also another circuit for ignition only supplied by the set of dry cells under the seat. (See Diagram No. 1

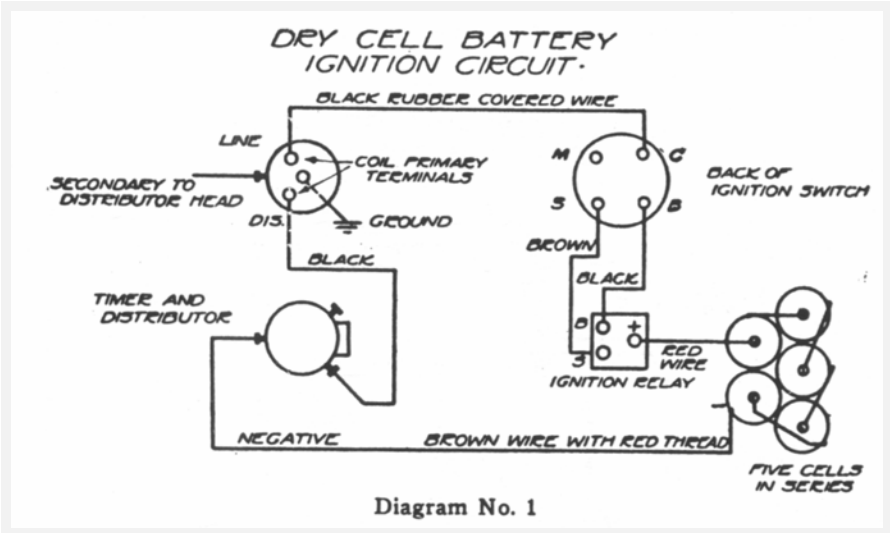


Diagram No. 1

These cells are for starting and emergency cases only. If the storage battery should be discharged, it is possible to start the engine by hand cranking, using the dry cells for ignition. The storage battery may in this way be charged without taking it from the car.

The dry cells are also convenient for starting engine in cold weather on account of the stream of sparks supplied to the plugs when the S button on switch is pressed in.

There are between generator and storage battery four main wires. (See Diagram No. 2.) Two of these run uninterrupted from generator to controller and battery and of the other two #3 is tapped for lights and ignition, and #4 for starting circuit. Standing in front of the car the four wires number from left to right on generator and also at controller end. Besides these four there are two additional wires #5 and #6 from controller and battery to supply starting circuit and lights and ignition respectively.

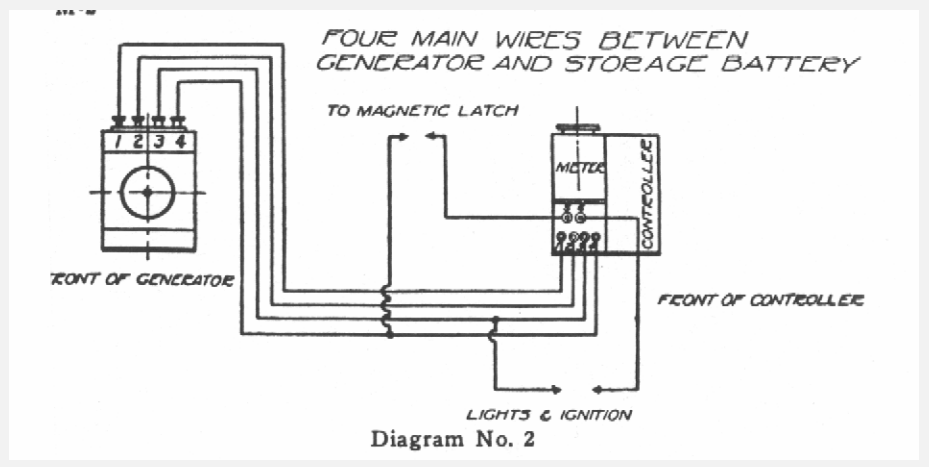


Diagram No. 2

Taking the wiring of the Ignition first (See Diagram No, 3), there are in the generator and storage battery primary circuit the switch, coil timer and resistance unit.

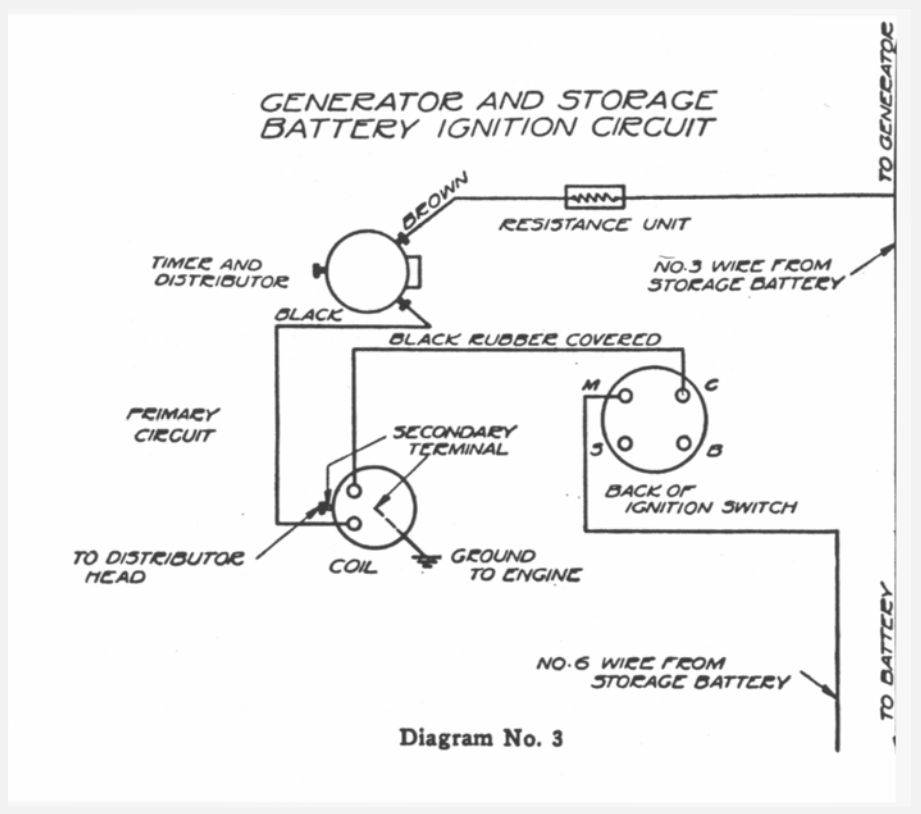


Diagram No. 3

The current being supplied by the storage battery on generator. To close this circuit press button M. The current comes from the wires #3 and #6; refer to Diagram (No. 3). No. 3 wire is tapped between generator and storage battery and No. 6 comes directly from the battery. When M button on the switch is pushed in the circuit is closed by connecting the common terminal C with M. Look at back of switch. The coil has two primary terminals, to one of which the common wire from C on switch is attached. To the other a common wire from the timer.

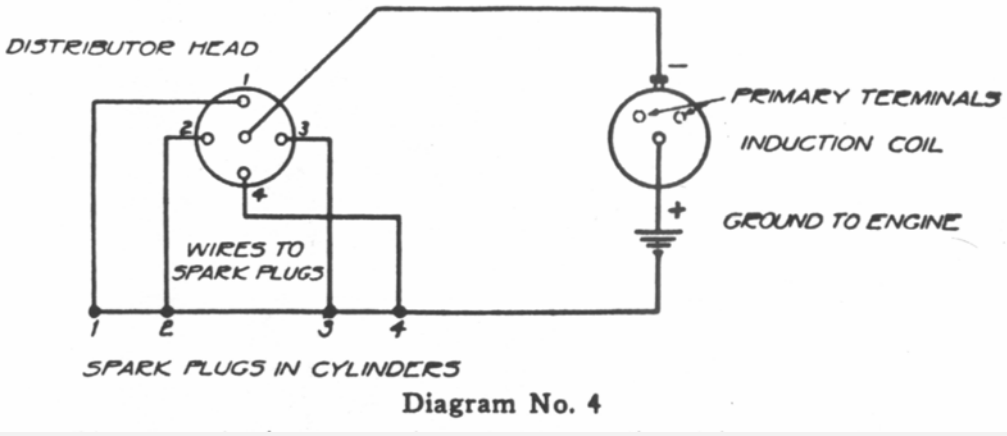
The timer has three terminals, the one next to the cylinder is common to both ignition circuits, the one on the outside next to the frame is t he magneto terminal and the one in front is the dry cell connection.

In the generator ignition circuit a wire from the magnetic terminal to a resistance unit and then to #3 wire. This unit controls the current in the circuit so that when running slowly and remaining on contact a longer time the small resistance wire in the circuit heats and increases the resistance to the flow of current, so that at all speeds the spark delivered to the plugs is the same.

The make and break mechanism is located in the timer, and in this circuit the spark occurs when the points separate.

The secondary winding in the coil (See Diagram No. 4), has a terminal on the front near the top, from which the heavy insulated wire leads to the center of distributor head

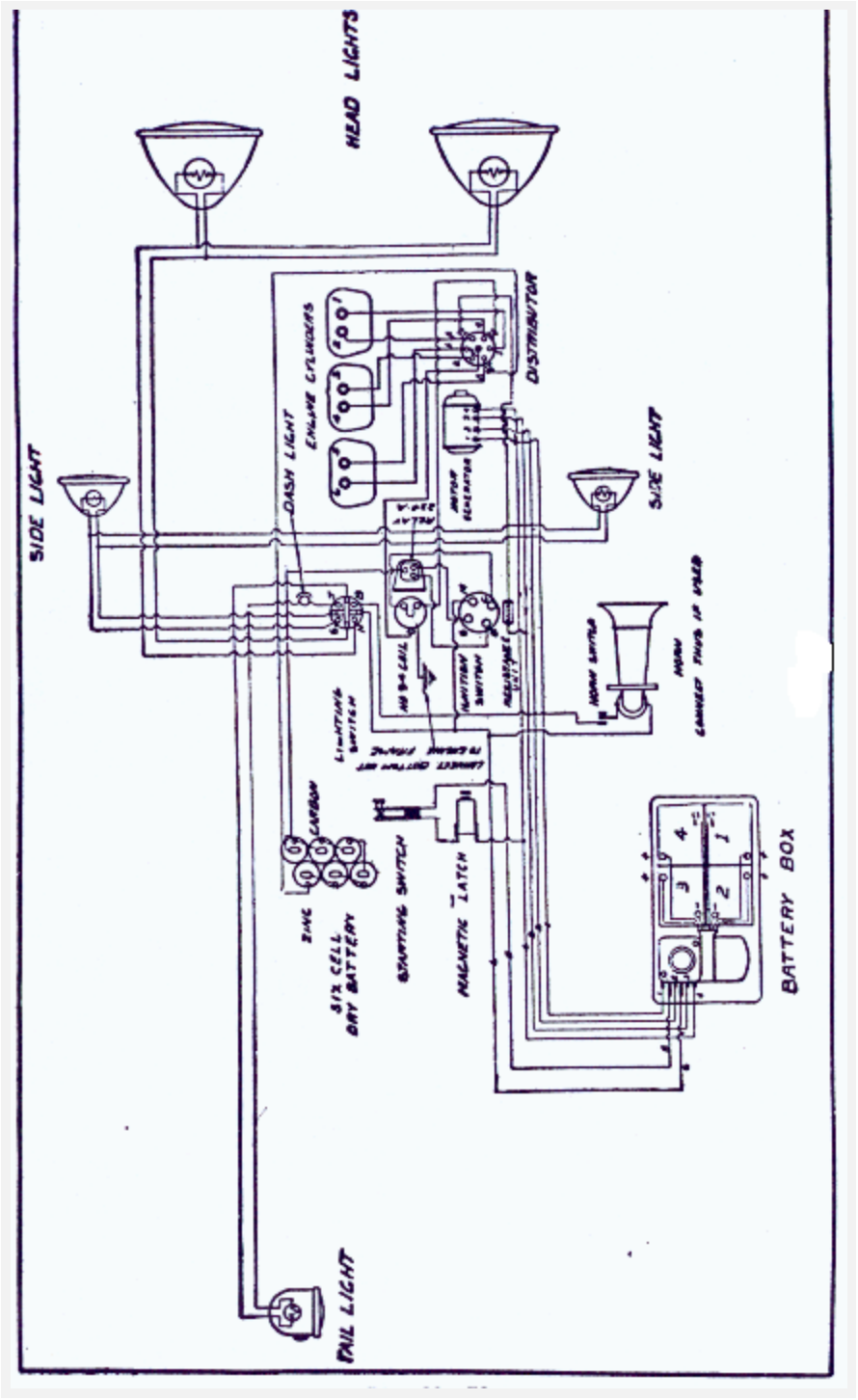
Secondary Ignition Circuit



The ground wire comes from base of coil and is attached to screw on top of generator and secondary circuit is completed through the engine to the spark plugs.

In testing for grounds or to trace a wire through the conduits, always remove the terminals from their binding posts at generator and battery, otherwise it is possible to get a circuit through the generator windings from one wire to another. It is convenient to know that #6 wire comes to the front of dash and is attached at M on back of switch and that #3 terminals at the resistance unit also on front of dash. These two are the main lines for ignition and lighting.

First learn the different circuits for ignition and what wires and controlling devices are common to both and what are peculiar to each one, so that if motor will run on one and not on the other half the problem is solved since some of the controlling devices are in one circuit only.


HEAD LIGHTS
SIDE LIGHT
DASH LIGHT
ENGINE CYLINDERS
DISTRIBUTOR
SIDE LIGHT
HORN SWITCH
HORN
CARBON
SIX CELL DRY BATTERY
STARTING SWITCH
MAGNETIC LATCH
BATTERY BOX
TAIL LIGHT

IGNITION

TO SET THE DISTRIBUTOR

The timing of the motor and ignition systems is indicated on the rim of the fly wheel in front and can be seen by raising the hood. To set the distributor, proceed as follows: Turn engine over until air begins to blow from the cup on No. 1 cylinder. Look at fly wheel and turn a little further until a point on the wheel marked "A" is opposite the indicator on the crank case. (This is the firing point, 5½ - 6" ahead of dead center.) Advance your spark lever to the extreme position and take off the distributor head and rotating brush holder and note position of generator breaker, the one nearest outside of car. The points in this breaker should be just opening, that is, the arm should just be falling off the corner of the cam, breaking the contact between the points.

When open these points should receive the .010 thickness gauge provided for the purpose; and when closed the flat spring should have about the same clearance from the end of the slot in which it moves.

The dry cell circuit brakes on the other side of the cam should be set with same opening.

When necessary to set the opening of the breaker point. Change position of hand lever or turn engine until points are closed being on top of the cam the flat spring holding one of the points should have clearance from end of slot of about one third the opening. Then turn cam to allow points to open fully back off the lock nut and turn screw out or in as demanded and when set in proper opening, lock in place. Use the small wrench supplied with car for this adjustment, using care not to turn the small screws too hard and break them. Note which direction the timer shaft is turning and take into consideration the back lash in timer, gears in setting breaking points.

If the proper setting of the timer cannot be made, that is, if the timing of your motor is too late or early, proceed in this way: One tooth on the pump gear in front will change the setting 4" on the flywheel. The difference of one tooth in the distributor gear under the timer will change 2" on the flywheel. If you cannot get correct setting by changing teeth, it will be necessary to take off the driven gear on timer shaft and drill new pin hole turning the cam to right position. It is advisable in this case to put in new shaft as an additional hole would greatly weaken the shaft.

The cylinder fires when points separate in generator breaker and when points come together on battery breaker.

SPARK LEVER POSITION ON WHEEL

The correct position for the spark lever on the steering wheel in relation to the sector is for starting a point two inches from bottom and for running on the generator ignition a 'Point 2 inches from the top.

In case of using the dry cells for ignition the spark can be advanced more on account of the greater lag in this circuit.

DRY CELLS

The dry cell has been developed to such a state of perfection that it is not a question as to whether they are suitable for ignition purposes. The only point is to select the proper size for any given ignition system. A battery improperly selected will not give long life or satisfaction. A set of dry cells in connection with a single spark ignition system, should give 2000 miles on the average car. If the drain on the dry cells is heavy, as is often the case in most battery ignition systems, the life of the battery will be very short. Where the current consumption is very little, and according to the speed of the car, as in the Delco system, the battery life is extremely long. One of the most important things in the operation of dry cells is to properly shield them from dampness or coming in contact with acid of any kind.

If storage battery is removed from a car and dry cells are to be installed instead for a temporary repair for lighting, the inside of the box should be thoroughly washed with a strong solution of bicarbonate of soda (cooking soda) and when dry, place a piece of pine board about 1/2" thick in the bottom of the box for the cells to rest upon.

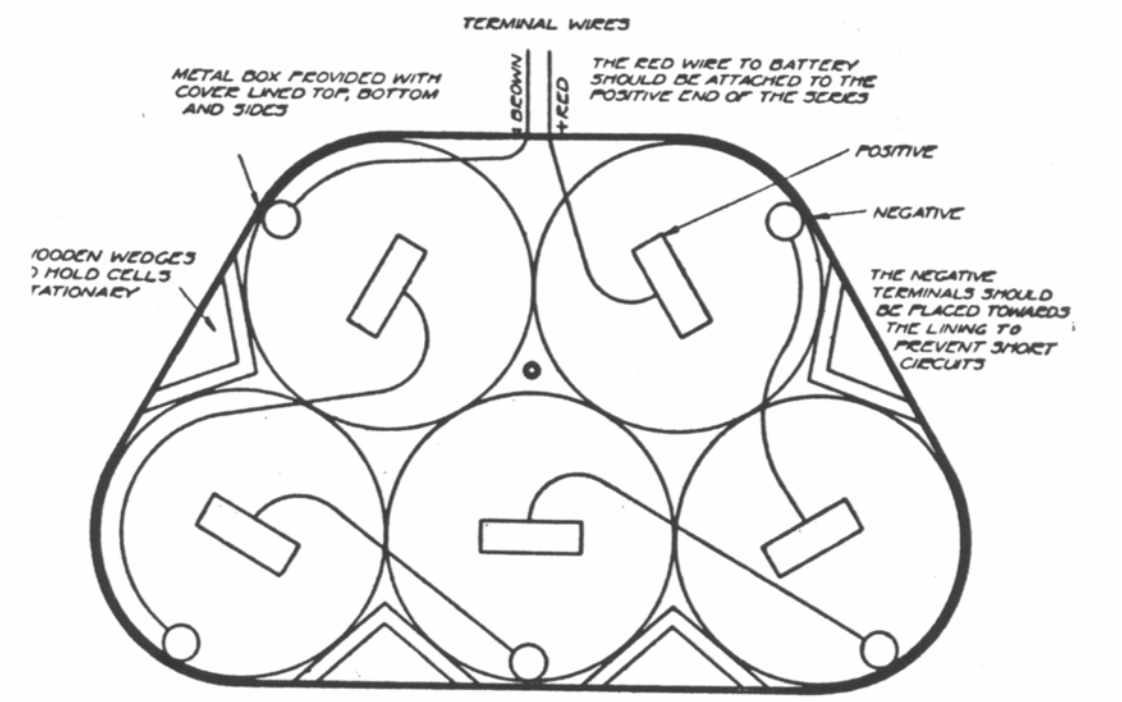
The terminals and side of the cells should not come in contact with metal parts of the battery box. A lining is supplied for this purpose. Care should be taken in connecting up a set of dry cells, as one is liable to connect a cell in the reverse direction or short circuit one or more cells. The cells should be connected in series-that is-positive to negative, using the first negative and last positive in the series for the terminal wires.

A set of dry cells in cold weather will not give as much capacity as in warm weather. Therefore, an ammeter test will not show the true condition of a cell unless temperature conditions are taken into consideration. The cold weather does not affect the life of the dry cell, as full capacity can be obtained if it is subjected to normal temperature.

BATTERY IGNITION (Dry Cells)

In this circuit are five dry cells in series (See Diagram No. 5), the switch, coil and timer which were also in the generator ignition circuit, and in addition the relay. The wire from the carbon terminal of dry cells is red and
can always be distinguished; this wire goes to the single post on the relay. The circuit continues from relay to switch then from the common post C to coil, and from coil to timer and return to dry cells.

The relay terminals are marked for the positive wire and the other two terminals B and S and are connected to the B and S on switch. The primary terminals on coil are marked DIS. and LINE and as the marking suggests these terminals are connected to those on distributor and switch.



THE PROPER ARRANGEMENT OF DRY CELLS IN BATTERY BOX. 5 CELLS IN SERIES GIVING 7½ VOLTS.

Diagram No. 5

IGNITION RELAY

The adjustment of the relay is only necessary when contact points wear which will not be often as there is no sparking and it should give satisfactory service without much attention. Occasionally there may be some trouble and the following cases will cover the subject:

1. If relay vibrates rapidly on button "B" the holding coil circuit that should allow only a single spark is open. Test out the circuit for this trouble looking for wires off or poor connections. Short circuit the two terminals on bottom of relay marked "B" and "S" and if trouble is outside of relay the vibrating will stop.

2. If the relay vibrates feebly with "B" button on switch in, this indicates weak cells or dirt between contact points of relay or distributor.

3. Misfiring on the dry cell circuit does not indicate relay trouble for if one cylinder fires the relay is not at fault.

The ignition relay is made up of a core with two windings, a condenser and some flat springs on which are the contact points.

On top of the coil is the pole piece which has an adjustment that regulates the opening between the contact points when vibrator is pulled down against it.

The vibrator is hinged on a small pin which is held in place by a spring. This pin should be free to move endways and should not be touched or removed as it is easily bent and if bent or stuck so as not to move the action of vibrator is seriously affected. The two windings in the relay coil are used as follows. The coarse winding is used when "S" button on the switch is in. Under this condition a stream of sparks are sent to the spark plug as long as contact is made in distributor. When the "B" button is pushed in the fine winding in the relay coil becomes active and holds the vibrator down on the pole piece allowing relay to deliver but a single spark for each cylinder.

To Adjust the Relay.

The distance between contact points when vibrator is held down by pole piece should be about .005". There is an adjustment on the pole piece which can be turned to vary this opening. Get the vibrator in action by getting a contact in distributor and with "S" button in, turn adjusting piece counterclock wise until relay stops vibrating then turn in opposite direction counting the notches beginning with one when vibrator starts buzzing and turn four or five notches but not over five under any condition.

The flat spring on the outside regulates by its tension the amount of magnetism at the pole piece necessary to pull down the vibrator and open the contact points.

To test this tension, put in the "B" button on the switch and then disconnect one wire to the dry cells, and if on contact in the distributor the relay will vibrate when three of the cells are used but will stop vibrating when four are connected in the series. In this way the amount of current that is necessary to hold down the vibrator is shown to be that of 4 good dry cells testing up to capacity, Dry cells that are run down would be of no value for this test. If spring tension is too weak less than four cells will draw vibrator down and hold it from vibrating or if too strong vibrator will continue to act on four cells.

To change the tension in this spring use only a pair of flat nose pliers that are thin enough to go between the springs and straighten or bend spring slightly to get required result.

The bottom spring should always hold against its rubber bumper and the middle spring be neutral without tension.

If it should be necessary to file down the contact points be sure that afterwards the bumper on the vibrator is not too high to prevent making contact. This should not be necessary in the life of a car unless you run on the "S" button as this is the only way to burn these points. The condenser for the dry cell circuit stands beside the relay coil and needs no attention. Trouble due to the condenser is rare.

IGNITION SWITCH

The switch has four buttons for the two circuits of ignition. The button marked "M" is for the generator and storage battery as the case may be depending on the speed the generator is turning. The generator does not supply any current below 300 R.P.M. the Storage battery takes care of this and also helps out above that speed if more current is being used than generator is supplying.

The Buttons "B" and "S" are for the dry cell circuit, and the top button to stop the motor by cutting off all of the ignition sources.

Either of these buttons will lock in but not any two at one time. In case the "M" button is in the "S" button can be held in to help start the motor in cold weather.

It is important to keep in mind not to allow motor to run with "S" button in. This is for starting only and if used for running the points in the relay will be burned. It is convenient to start on the "S" button and then change to the "M" button. This arrangement has the advantage of keeping the operator informed of the condition of the dry cells which might become useless if not watched and when needed would not be of service.

Always lock the switch to prevent discharging battery if button should be left in. If motor should become stalled or stopped by any other means than by shutting off the switch the battery would be discharged and to prevent this it is advisable to get the habit of locking the switch.

SPARK PLUGS

How To Take Care of Spark Plug Troubles.

Unfortunately, spark plugs are one of the features most essential to the proper working of the modern automobile motor.

First of all, do not remove the spark plugs every time the motor skips until reasonably convinced that the plugs are at fault. Their removal often cracks the insulation and breaks the well made joints with the cylinder head, so that when replaced there may be a chance for the compression to leak by the plug. Such a leak can be tested by squirting a few drops of either kerosene or lubricating oil around the plug after it has been replaced. Turning the engine over will then disclose the leak, if any, by bubbles appearing. If no gasket is provided on the plug (a copper-asbestos one being preferred,) a good joint can be made by the use of pipe joint compounds containing graphite (do not use white or red lead); a graphite joint is just as tight and the plug can be removed with ease at any time. Red or white lead becomes so hardened that it is almost impossible to take the plug out. After removing a hot plug for any reason, remember not to screw it into the engine as tight as possible with a fourteen inch wrench, as you may crack the hexagon shell, or, as the plug has probably cooled off and is contracted, while the engine is still hot and expanded, the contraction of the engine unto the plug may make it impossible to remove it at some future time.

The distance between the points of the spark plug should be about one-thirty second of an inch. Less distance clogs easily and is not as apt to produce a large spark, while if the batteries are weak a larger distance under the compression in the cylinder may cause sufficient resistance to entirely suppress the spark, although the same plug with the same gap may show a good spark when laid on the outside of the engine. Don't vary the distances between the points, as this will spoil the uniformity of the spark gap in the various cylinders, and bending the points back and forth may loosen or weaken them so that they will come out and may do damage in the cylinder.

Excessive lubrication of the motor should be avoided, as plugs will be covered with oil in which particles of carbon are carried, and this will eventually form a bridge across the gap, making a line of easy resistance for the current so that no spark will take place.

Do not get oil on the outside insulated portions of the plug, as dirty oil will in almost any case form a bridge for the current, which will ass from the top of the plug to some of its metal parts, forming a short circuit. Even a slight crack in the inside of the porcelain will allow the current to pass directly from the one electrode to the other thus short circuiting it. By grounding the plug on the engine and turning the engine over so as to make the proper contact, a spark should pass at the plug gap; and if no spark occurs and if everything

else up to the end of the secondary terminal has been tested, this shown the plug to be defective. If this spark is a weak one, under the increased compression in the cylinder, the same plug may fail to work when in place; try another plug. In cleaning a plug in which the insulation extends well toward the end of the central electrode, be sure that the carbon deposit is removed from this insulation, as this is more important than filing the actual ends of the electrodes Do not needlessly take the plug to pieces, as this usually results in spoiling the joint between the insulating material and the metal and will cause a leak. Plugs can be sufficiently cleaned by washing them in gasoline.

Do not use force in screwing on the thumb nut holding the terminal, as the very fine threads may either be stripped or the electrode twisted, causing defective insulation, a leak, or if its lower end is bent, too wide or too small a gap between the points.

When plugs which are apparently defective when used in a certain cylinder operate better in another cylinder, it is usually a sign that the trouble is not in the plug. Carry extra plugs, or at least one extra, as in cases of extremity it is sometimes possible to use parts of a defective plug in combination with parts of one of the other plugs.

Do not carry plugs loose in your tool box if you wish them to be in a condition for emergency.

When trouble occurs, test the various parts of the ignition apparatus systematically and do not at once jump at the conclusion that the spark plugs are fouled.

EMERGENCY REPAIRS FOR IGNITION AND LIGHTING

There will be occasions when it will be necessary to resort to repairs which would not be considered permanent. When such conditions arise a driver must often use his ingenuity to make temporary repairs and devise some means of getting to a point where parts can be had. In case of accident, the storage battery might be destroyed or broken away from the running board. If this should occur in the day time it would be a simple matter as the ignition can be taken care of by the dry cells. A set of new cells will give sufficient current for ignition for 1500 miles.

The generator also can be used independent of the storage battery for ignition if the controller switch is still in operation. In this case, however, be sure to tape all battery wire terminals to prevent grounds and keep motor speed down below 30 miles per hour. Starting will of course have to be taken care of by hand cranking on dry cell circuit.

It is possible to get lights for night driving by connecting two of the battery wires to a set of dry cells. It is not possible to make changes in the wiring so as to get light directly from the generator without the storage battery being also in the circuit. The reason for this in our system is, the battery acts as the control on the voltage and if taken away the generator would produce current with a voltage in proportion with the speed. Under such conditions the lamps would be burnt out as soon as the voltage exceeded 6 volts.

If at any time there is trouble with the sliding gears, the shaft on which they operate can be removed by taking off the locking clip and pulling shaft out. To take gears out first take off generator.

If fork that slides the gears should get loose on its rod, the rod can be turned up on the threads in the yoke and end peaned over if necessary.

The generator begins producing current at 300 R. P. M. and continues to do so in proportion to the speed up to 1000 R. P. M., above which speed there is no increase. This is accomplished by the fact that the shunt field is opposed by the series winding and higher speeds give a constant output. At a speed of fifteen miles per hour the generator is supplying more than sufficient for all demands unless the car is driven Drily at night at slow speeds and a large amount of light is used. The average driver will never experience a lack of current but in special cases we can supply a larger resistance wire for charging the battery. This wire is placed between the two terminals on left side of controller switch.

MOTOR WILL NOT STOP

Occasionally when wishing to shut off the ignition switch the motor will not stop. This is due to a short circuit in ignition switch and can be remedied by taking off the switch and adjusting the points of contact for the different buttons, In the meantime motor can be brought to a standstill by taking off wire at the timer.

LIGHTING CIRCUIT

The main feed wire for lights is No. 6. From battery this wire comes to the brass plate inside the terminal block under the floor and back of dash. To this plate is attached one end of each of the head, side and tail lamp circuits.

With No. 3 wire the lighting circuits are completed as this wire has a terminal at the lighting switch, so that when buttons are pulled out the circuit for each pair of lamps is closed.

The head and side lamps are so wired that one of a pair may be used if the other becomes broken.

The tail lamp and dash illuminating lamps are in series so that if tail lamp becomes extinguished the lamp on dash will also go out. This is so arranged to signal the driver that the rear lamp is out. In using trouble lamp supplied with car do not attach to either tail or dash lamp, always use side lamp or lead lamp connections.

In case of trouble with lighting wires the switch plate can be taken off at back of dash and wires pulled out enough to see if connections are good.

To do any work on lighting wires, take out the floor boards and the common terminal block is easily reached.

To attach electric horn, there are two terminals on side of the block under floor to which the horn wires can be attached.

The wires for head and tail lights being attached to the frame, it is necessary to connect the terminals of each circuit to the terminals on the block on the dash. When body is taken off or put on, the wires need not be disturbed, except disconnected at this place.

The head lamps are 6 volt-16 candle power.

The side lamps are 6 volt-4 candle power.

The tail and dash lamps are 3 volt-2 candle power.

THE SELF STARTER

The name Self Starter is a name much misunderstood and incorrectly applied. The electric cranking system used in this year's models should be called more correctly a Self Cranking instead of a Self Starting System.

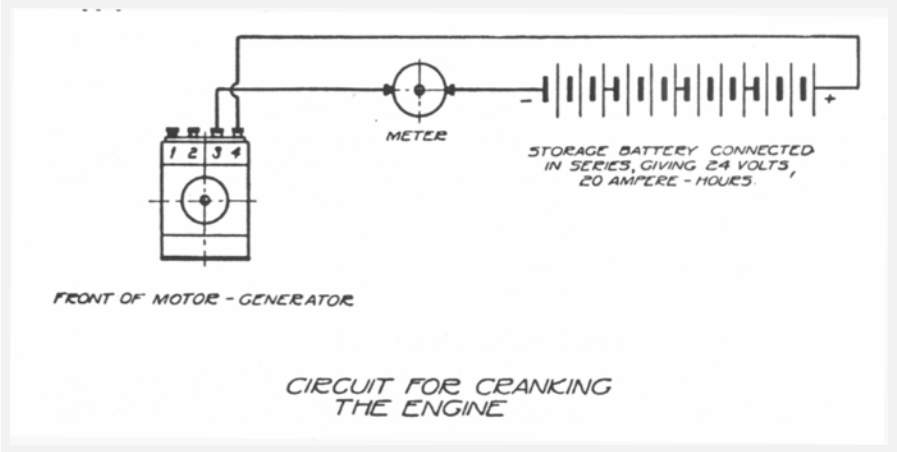
A storage battery in connection with the generator and controlling devices make up the system for cranking. The wiring connecting these parts is not complicated, regardless of what may be said to the contrary, and a brief outline of the wires and connections will convince anyone that nothing could be more simple.

The generator used as a motor for cranking the engine is supplied with current by the storage battery. This motor cranks the engine by means of gearing located in the rear housing and is only in gear with the fly wheel when cranking. The clutch pedal in connection with two rods under the floor slide the gears into the fly wheel teeth when operating the cranking system.

Besides the motor and battery the entire system for cranking consists of a controller switch and meter on the running board, the magnetic latch under the floor and a button on the seat. To crank the car first press the button on the seat, then press down the clutch pedal, which slides the gearing into fly wheel teeth, and also throws the controller switch over to the cranking side. The system is now in operation and if gasoline is supplied to the engine the starting is accomplished. In the cranking circuit, it may surprise you to know, there are only two wires from battery to motor; one of these being the positive carrying the current from the battery, the other the negative or return wire. At some point between battery and motor a meter is placed to

register the amount of current used. Nothing could be more simple, and there is nothing in this circuit that is not well known and used every day.

The usual failures for the cranking system to turn the motor over are due to lack of lubrication of the joints and rod bearings operated by the clutch pedal-improper adjustment of these rods so that clutch pedal does not come back far enough to engage the latch under the floor. If latch operates properly a clicking sound can be heard when button on seat is pressed. After this, if the battery is sufficiently charged there should be no difficulty in cranking the motor. The storage battery must have a certain amount of care, however, to keep it in proper working condition. This care consists of keeping the twelve cells supplied with distilled water and setting the meter hand
back twenty points twice a month. This is surely very little to do to get cranking, lighting and ignition. A car that is used through the day to any extent will keep the battery charged with plenty of current to spare. The generator will be running idle about half the time on the average car, showing that the Supply furnished by the system is ample for the needs of any driver.



CIRCUIT FOR CRANKING THE ENGINE

Under the floor boards on the frame is located a housing containing the latch for connecting the clutch pedal with controller. This latch consists of a magnet which draws an arm into position to engage with clutch pedal rod. When button on seat board is pressed a six volt current passes through this coil and attracts the arm towards the pole piece The rod from clutch pedal is attached to a lever in the housing, This lever has hook or pawl which engages the arm when in position. When pedal is pushed down the lever turns shaft in the housing which in turn operates the cross shaft, throwing the controller knife switch from one set of blades to the other. The lever also pulls the sliding gears back into mesh with fly wheel by means of a rod connecting lever end with sliding gears.

STARTING LATCH CIRCUIT

To magnetize the small coil in the controller latch current is supplied from #4 and #5 wires. This circuit (See Diagram No. 6), consists of these wires to hand switch and housing terminals and then to coil.

SOME FAILURES OF LATCH

If magnet will not draw arm, there is very likely an open circuit or no current. If arm becomes magnetized and will not release the trouble is in the hardness of the steel of which arm is made. On rare occasions we have had this condition and to remedy remove the arm and heat it enough to anneal it. Soft iron will not retain magnetism. If arm fails to pull into position and armature does not turn, examine brushes

on motor and clean commutator and brushes, also see if brushes are held down properly by the springs. Gears in generator housing will not mesh if armature shaft fails to turn, or if sliding gear strikes fly wheel before pinion on armature shaft is brought into mesh. This latter condition can be remedied by changing adjustment of rod that shifts gears on moving generator on its base.

THE CONTROLLER SWITCH

This device is used to change the battery connections so that for running, the voltage is 6 volts and when switch is thrown over to other set of blades towards rear of car the voltage is increased to 24 by connecting the cells of battery in series. (See Diagram). This part of the system will give little trouble.

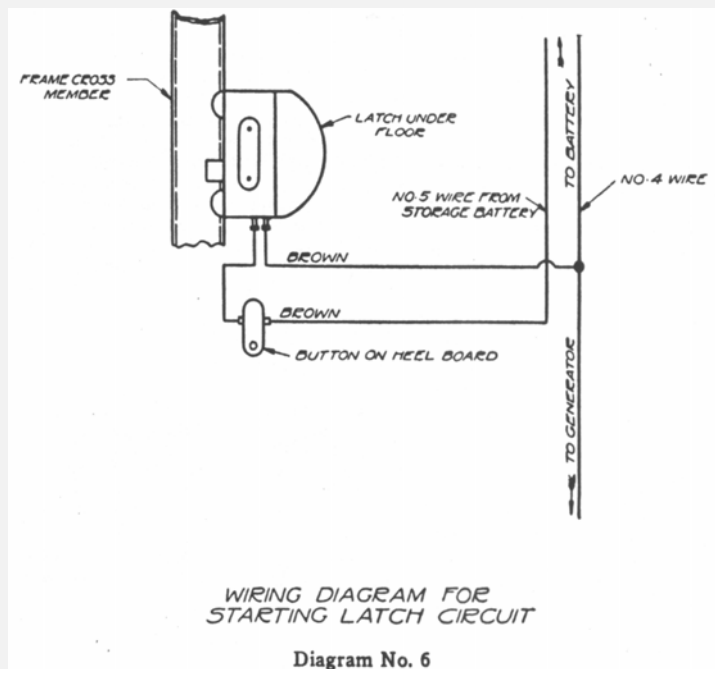


Diagram No. 6

Avoid lubricating the knife blades as this is unnecessary and in cold weather the water in the lubricant would freeze and prevent action of the switch.

See that rod across the car is adjusted to operate switch equally, getting full surface on blades both sides and that locking device is engaging each side in turn. Switch should not shift to 24 volt side until gears are meshed with flywheel and to prevent this a coil spring is placed so that it must be compressed first before lock is released in this way giving gears an opportunity to get into fly wheel.

If connections in switch become corroded from the gas of the battery they can be cleaned with a strong solution of cooking soda and water and then coated with vaseline.

THE CUT OUT RELAY

This controlling device is placed on top of controller switch and it is used to prevent the current of the battery from coming back to the generator when the voltage of generator falls below that of the battery.

The coil spring on the relay is so set as to open the contact points when the above condition occurs. If the relay fails to operate do not change this spring tension for the cause will be found elsewhere.

If relay fails to open when car is stopped the cause is a tight driving coupling at front of generator. If the leather in this coupling is so fitted between flange and roller clutch as to have no freedom end ways the end friction resulting prevents armature shaft turning and relay from opening resulting in discharging the battery. To remedy this condition take leather out and shave it down thinner.

AMPERE HOUR METER

A meter is supplied through which all current going into or coming from the battery must pass. The dial is so arranged with a large and small hand that the operator can tell whether a charging or discharging is taking place. The arrow indicates the direction of travel of the hand for charging. As hand reaches the top there are two contact points which can be opened by travel of the hand in charging, the first contact when opened inserts a resistance in the circuit cutting down the output of the generator and the second cuts out the generator entirely.

If the storage battery is fully charged the large hand on the meter will prevent over charging by stopping the flow of current into the battery by opening the contacts.

Section "N"

1913 Models

Generator

GENERATOR
1913 MODELS

The source of supply of current for starting, lighting and ignition is the motor generator used as a motor for cranking the engine, as a generator for light and ignition. In connection with the generator is the storage battery to keep in reserve sufficient current to supply the motor when cranking the car and for lights when generator is not running. The generator is driven by the pump shaft through a flexible coupling and has a roller type of clutch at the front end to allow it to run when engine is idle. As a generator this arrangement allows the motor to run at engine speed or when used as a motor twenty time engine speed.

At the rear of generator is a gear housing containing the gears for engaging with the teeth cut in flywheel rim to turn the engine, Another roller clutch located here allows the engine freedom to run at a higher speed than motor is turning it over for starting.

The generator is made up of an armature and shaft mounted on two large ball bearings and a series and shunt winding in the field. On the commutator are two carbon brushes mounted on arms which can easily be taken out. These brushes supply their own lubricant. On top of generator are the four terminals for the wires. (See wiring, Sec. M, Page 2, Diagram No. 2.)

To take out armature or bearings take off the roller clutch in front by removing headless set screw in center of shaft and drive out pin through hole in clutch shell. Then take off rear housing and armature is ready to come out.

The armature shaft is one inch in diameter on account of its size and rigidity allows the armature to revolve within .015" of the pole pieces, which greatly increases the efficiency.

In setting generator on the engine be particularly careful to get in line with pump shaft and use enough shims to level the base tip high enough to get shaft in line and see that gears mesh properly in flywheel. The leather in coupling allows a certain amount of misalignment but the leather should not he changed to overcome any trouble of that kind for if generator is set properly the limitation of the leather will be sufficient.

Always allow this leather a little side play between the flange on pump shaft and roller clutch for if it is set up tight the end friction will prevent armature revolving and keep cut out relay closed discharging the battery. The care of the generator consists of cleaning the commutator each month with a soft cloth into which a little vaseline has been worked. A few drops of oil for the ball bearings and oil for front roller clutch through the hole under the cover and a few turns of the grease cups at rear which supplies the rear clutch through the hollow shaft.

TO TAKE OUT THE GENERATOR

This may become necessary to replace a ball bearing on the armature shaft or failure of roller clutches or for some other reason. The generator is mounted on the engine base secured by three screws on the tinder side and is driven through a flexible coupling by the pump shaft of the engine. To take generator off, disconnect gear operating rod at rear and take out the three screws which fasten generator to engine base, then disconnect the fly wheel guard which is attached to gear housing and the wires. You may then do either of two things. Take off the ignition relay and coil cover or the water pump, One or the other is necessary to get generator clear and the amount of work is about equal. In either case the flange on pump end of driving coupling will need to be unpinned and driven off the key to permit leather in coupling to come out and allow generator to come forward or pump backward to free itself at distributor housing. The pump shaft is in two parts connected by a flange joint with three screws. This joint is recessed, and to get pump free it must move back after the two caps are taken off and the water connection unfastened.

To take off Ignition relay, take off the nuts which hold the bracket to dash. Take off the cover to coil housing and the housing itself which is fastened to dash with several bolts and screws. Generator can now be lifted up and brought forward away from dash to be lifted out.

To take off roller clutch in front, remove headless set screw in center of shaft and turn clutch body until hole in side shows pin. Drive out the pin which holds clutch on shaft. Remove back cover plate and armature can be removed and repairs done on bearings, field winding, brushes, etc.

The brushes are removable without taking off generator by removing covers in front and releasing tension on the spring which holds them in place. The lower brush is more difficult to get at, but it can be reached after the cover is removed. Sliding gears can be taken off by taking off screw in rear housing and locking washer which holds in the shaft. Pull shaft out and take out gears. This can be done only when generator is off the engine. This sliding gear shaft is drilled out to supply the clutch in the gears with lubrication. The roller clutches in front and rear allow the generator to run when engine is not in operation. The generator runs engine speed when the engine is driving it as a generator, but when acting as a motor the speed is 20 times engine speed. The roller clutches are positive in one direction of rotation but can run free when necessary so that when engine starts fly wheel can speed up and run faster than motor gear.

TO ASSEMBLE GENERATOR ON ENGINE

In placing generator on engine base for its support, considerable care should be used in getting the height from base to center line the same as to center of pump or driving shaft. It is necessary to use shims for this purpose and by using the forward roller clutch and the flange on pump shaft for guides the proper alignment can be secured, also watch the gears in rear to see that they mesh correctly with fly wheel. Spin gear over and try in several different places and get the clearance between the teeth sufficiently free. When generator is lined up, secure it with the three screws, the larger of which should be packed to prevent oil leaks as it asses through the crank case. If teeth mesh too deep gears will not Side into position easily and if they mesh too shallow, the teeth on fly wheel may be chipped off.

The leather in the coupling in front should be free between the flanges as any binding here will cause enough end friction in armature shaft to prevent the cut out relay from releasing when engine stops and in that way run down the storage battery. If leather is too thick it can be trimmed down. With the generator in place, connect up the rods for operating the sliding gears and the wiring

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Section "O"

1913 Models

Lubrication

LUBRICATION
1913 MODELS

(See Oiling Chart, Sec. O, Page 2.)

The Motor is supplied with oil from a reservoir in the bottom of the crank case. This reservoir is filled through the vent in front leg on left side. There is a cock in side of case to show the high oil level.

The oil is circulated by the action of a pump, of the plunger type, operated by a cam on the camshaft oil is pumped from the reservoir and through two leads to front and rear of case discharging into the front gear housing and on the rear bearing of the motor. From these two points the oil distributes towards the center and supplies the connecting rods. Pockets 'in the case are provided for rods to dip into; this dipping supplies also by the splashing, the cylinders and center bearings, they being amply taken care of by the mist of oil produced by this process. The excess oil returns to the reservoir through drains in the case at the proper level. The oil should be changed every 1000 miles at least, washing the case thoroughly with kerosene. Nothing but oil of good quality should be used in the motor.

The Clutch runs in an oil bath Light cylinder oil can be used diluted with kerosene, using equal parts; 1/4 pint of each is sufficient. In cold weather there will be some sticking of plates when car is cold. This will disappear as soon as oil warms. The oil should be renewed frequently and clutch kept clean.

The Transmission is filled to level of center of lower shaft with heavy steam engine oil and needs nothing more except to look for shortage if there should be a leak.

The Rear Axle housing should be filled with cup grease. This will take care of the rear axle for a long period or about 1000 miles running, if the grease cups on the spring saddles and for the bearings are filled and screwed down every day or so. Regularity in the matter of lubrication is most important as the grease hardens if neglected.

The Universal Joints are filled with Greedag No. 52. The four pins and slip Joint are supplied with cups to keep supply always sufficient.

The lower side of the **Controller Switch** is packed with grease and is provided with a generous cup to furnish ample lubrication to the vertical shaft.

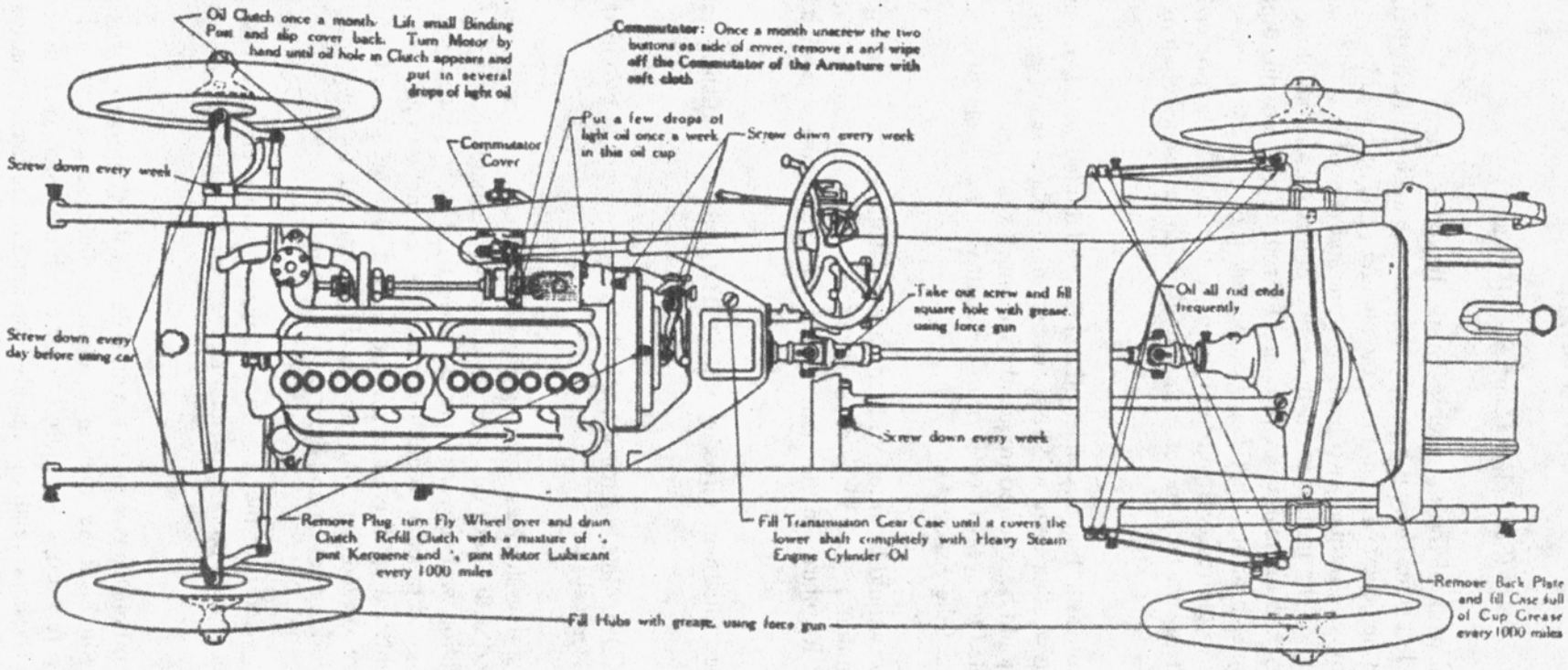
The Grease Cups on spring shackles, steering parts, torque arm hanger, universal joints, rear axle and water pump should be kept filled with a turn down on the caps often enough to make the lubricant actually ooze out all the time. Proper lubrication will prevent wear to a great extent in places where this is aggravated by exposure to road dirt. It is very good practice to get under a car occasionally to get used to how things look from that point and to keep things tightened up. It is interesting to know how a car looks from underneath and some of the parts that need lubrication are located there. Fill the wheel hubs through the plug holes provided, with a grease gun so that grease can be seen working out around the inside of the hub.

Watch the **Fan Bearings** and give the cups located there a turn every day, also the cups on the spindle bolts need daily attention. No oil is used on the distributor except a drop or so of light oil on the ball bearing Just under the can.

Put a few drops of light oil once a week into the oil holes for the **Generator Bearings**. Oil the front clutch on the generator once a month. Slip back the cover after releasing the binding screw and turn motor until oil hole can be reached and then put *in a few drops of light oil. Rear clutch on generator is in gear housing on generator and is supplied by a grease cup. The cars are all thoroughly lubricated in the factory, particular attention being paid to this feature of the manufacturing but this supply will only last a short time

Lubrication of Parts

Universal Joints, Wheels and all Grease Cups to be lubricated at least every 800 miles with good grade of cup grease or graphite grease. Don't be satisfied that screwing down the grease cup is getting you the necessary lubrication. See that the grease is oozing out from such parts all the time.



NOTE. Once a month drain all oil out of Motor, pour Kerosene in the Crank Case and let Motor run with the Electric Starter for two minutes. Stop Motor, drain Kerosene out and add fresh Motor Oil until same comes out of the Level Try Cock, and when this is closed, add a pint of Oil. Once a week when car is laid up for the night, and while Motor is still hot, pour in each Priming Cock about three teaspoonfuls of Kerosene, close them and let stay all night. In the morning, start Motor in the usual way.

and needs watching. After the chassis is assembled, it is lubricated by men who do nothing else and the cars do not go out on the road for test until inspected for lubrication. After a car is tested and washed it is again oiled and filled with grease before passing to the paint shop. After painting, the wheels are put on the wheel bearings being filled with grease and finished grease cups put on.

In the tuning department, after final assembling cars are looked over for lubrication and are then given final test. The cars now are washed and ready for shipment and on the shipping platform all the grease cups are refilled. Oil In engine, clutch and transmission is inspected. Motors that are shipped are always filled with oil except on foreign shipments but it is advisable before starting car to inspect oil level and pour about one-half pint of oil into the priming cups dividing the quantity equally and run the motor very slowly at first.

Oil should just run from the cock when motor is standing if it is filled to the right level. Excess of oil can, in this way, be determined There are openings in bottom of case to draw oil and also a plug to drain each one of the connecting rod basins when washing crank-case. The clutch can be drained by taking out the plug and turning motor over until hole in housing is on the bottom. To keep motor clean, it is a good practice to pour a little kerosene into the priming cups once a week or after a long ride and allow it to stand over night, putting it in when motor is still warm and starting as usual in the morning. This loosens up the dirt and soot which -,vill be blown out when motor is started. A drain plug is also placed in bottom of transmission to take out the oil.

The Steering Gear should be oiled through the small oiler on the spider of the wheel. The gear housing should be kept full of grease and all the small joints and pins in the throttle and spark control rods should have a drop or so of oil occasionally as these rods should always work freely. All the pins in the brake rod mechanism should have a little oil to keep the action free and you should take off the wheels at least once a month and oil the internal brakes, for in an emergency these brakes cannot be depended upon unless they are carefully watched and tested. It is customary to use the foot brake entirely, neglecting to try the emergency and the joints soon get rusted up when car is washed or in wet weather, so that when needed they will not work.

As a final word, too much oil and grease will seldom do harm except on the generator and distributor, so follow directions closely in all cases, Lack of oil in the motor will destroy it, the oil level should be inspected daily. If you have any doubt do not use the car until sure of the oil supply. If you are undecided as to what grade to use, our factory Service Department is ready to advise you.

OIL LEAKS

Leaks of oil or grease are very annoying and as a rule the result of lack of attention. Carrying the oil level too high in transmission and axle will usually account for these troubles.

There has been some complaint of oil leaking from front end of transmission. Do not carry oil level higher than center of lower shaft. See that there is a vent hole in top of case and that the felt washer retainers are properly fitted and fight on the shafts. Fit an oil deflecting plate in front end of main bearing to prevent oil following the shaft through. If grease in rear axle is no higher than center of housing the grease will not come out the front pinion bearing on the wheel hubs.

Section "P"

1913 Models

Brakes