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STRUCTION BOOK

THE Detroit ELECTRIC

1922

PLEASURE CARS

MODEL 90

THE DETROIT ELECTRIC CAR COMPANY

Detroit, Michigan, U. S. A.

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The Operation and Care of

DETROIT ELECTRIC

MODEL 90

OCTOBER 1, 1921

The Detroit Electric Car Company

Detroit, Michigan, U. S. A.

DETROIT ELECTRIC INSTRUCTION BOOK

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STANDARD WARRANTY

APPROVED BY

NATIONAL AUTOMOBILE CHAMBER OF COMMERCE, Inc.

ADOPTED BY

DETROIT ELECTRIC CAR CO., DETROIT, MICH.

This is to certify that each new Detroit Electric manufactured by us is warranted to be free from defects in material and workmanship under normal use and service, our obligation under this warranty being limited to making good at our factory any part, or parts, thereof which shall within 90 days after delivery of such vehicle to the original purchaser be returned to us with transportation charges prepaid and which our examination shall disclose to our satisfaction to have been thus defective; this warranty being expressly in lieu of all other warranties expressed or implied and of all other obligations or liabilities on our part, and we neither assume nor authorize any other person to assume for us any other liability in connection with the sale of our vehicles.

This warranty shall not apply to any vehicle which shall have been repaired or altered outside of our factory in any way so as, in our judgment, to affect its stability or reliability, nor which has been subject to misuse, negligence or accident.

We make no warranty whatsoever in respect to tires, voltmeters, ammeters, speedometers and horns, inasmuch as they are usually warranted expressly by their respective manufacturers. The battery in this vehicle is covered by a special agreement, on which adjustments are made based on a period of two years or eight thousand miles at our option.

The purchaser expressly agrees that our liability is limited to the above warranty and does not include damages to either property or person of self or others.

DETROIT ELECTRIC INSTRUCTION BOOK

PART ONE—OPERATION

1. FUNCTIONS OF CONTROL LEVER.

The upper and shorter lever at the side of car is the control lever. Moving the lever forward from this position operates the controller which makes the various electrical connections necessary to run the car at different speeds. Pulling this lever backward from a running position first cuts off the power and then applies a brake. There are five speed positions of the control lever in addition to the "neutral" and braking positions.

When not in use the control lever folds upward to a vertical position and a lock is provided to lock it so that the car cannot be operated.

The push button operating warning signal is located in the end of the control lever where it is convenient for the driver.

2. STEERING LEVER.

The lower and longer lever is the steering lever. Moving the lever forward from this position steers the car to the left, pulling this lever backward steers the car to the right.

When not in use this lever also folds upward to a vertical position.

3. FOOT BRAKES.

Of the two foot pedals the larger one operates the service brake on the rear wheels while the smaller pedal operates the cutout switch in the main power circuit, and also the brake ratchet to lock the brakes.

The large pedal operates independently of the small one; the latter however, always carries the large one with it.

4. TO OPERATE CAR.

Assume the driver's seat, unlock the control lever, and bring the control and steering levers to the horizontal position.

If you have not run a "Detroit Electric" before, first try the operation of the control lever with the car at a standstill and the brakes in locked position. This can be done by first pressing the cutout and ratchet pedal until the ratchet clicks and the pedals are held down. In this position the brakes are set and the power is cut off at the cutout switch so that the car will not move when the control lever is operated. (If the previous driver has done his duty the pedals will already have been set as described, as this is the proper way to leave them when leaving the car.)

Move the control lever forward and backward through the different speed positions, until you have become familiar with its operation. Note that you can feel a notch corresponding to each speed. The notches indicate the correct positions where the controller makes full electrical contact.

Learn to move the control lever with a sudden impulse from notch to notch, without hesitancy, pausing only at each point where the speed notch can be plainly felt. This will prevent burning of the controller contacts and thus save maintenance expense.

If the speed notches cannot be felt plainly the controller probably is in need of lubrication or the control system is in need of adjustment. The necessary attention should be given without delay. (See "Controller," pages 10 and 13.)

When you have become thoroughly familiar with the operation of the control lever, including the operation of Reversing as described below, release the foot brakes by applying slight pressure to the small pedal while holding the control lever in the extreme backward (braking) position. The car will now run when the control lever is moved into the speed positions.

Use first speed for brief intervals of running only, such as in starting and slow running in traffic. Any of the other four speeds can be used continuously for as long intervals as desired. The highest speed (5th) is the most efficient and satisfactory for hill climbing or heavy running such as in sand or new snow. The 3rd and 4th speeds are most efficient for ordinary level running.

The beginner should not attempt to drive faster than 2nd or 3rd speed until a fair degree of confidence is acquired.

5. TO STOP.

For the ordinary slowing down in traffic the hand brake will be found very serviceable and handy. To apply this brake, simply pull the control lever back toward the body as far as it will go. This operates a mechanical brake acting directly on the armature shaft of the motor. The harder the handle is pulled back the more effective the brake becomes.

For controlling the speed of the car on hills, use the foot brakes and the hand brake in addition if desired.

To stop quickly in an emergency use both brakes.

If for any reason the controller becomes inoperative while the car is running, the power may be cut off and car stopped by pressing the cutout pedal. This is one of the important safety devices of the Detroit Electric.

Never apply the foot brakes with the control lever in a speed position except when absolutely necessary in emergencies. When it is necessary, for any reason, to apply the foot brakes before bringing the control lever to the "neutral" position be sure to press the cutout pedal so that the power will be cut off at the cutout switch.

Before vacating the car press the cutout pedal to set the brakes. Next make sure the control lever is in "neutral" position, raise it to the vertical position and lock it in this position, taking the key with you.

It is impossible to remove the key from the control lock except when the control lever is in the neutral position and the key has been turned to lock the control.

We cannot impress upon you too strongly the importance of forming the habit of setting the foot brakes and locking the control lever in neutral position every time you leave the car. This will make operation or theft of the car impossible and will prevent meddling. Accidental releasing of the brakes by anyone moving about the car will also be prevented, which is an important point especially when the car is left on a hill.

Doors may be locked from the outside if desired by using the locks provided in door handle.

6. TO REVERSE.

With the control lever in neutral, press the foot lever on the heel board down to the floor with the heel of the left foot.

Then advance the control lever into the speed positions in the same manner as when driving forward. This will run the car backward, the five speeds being the same as in running forward.

It is not necessary to keep the heel on the reverse pedal after the control lever has been advanced into first speed.

To stop from reverse speed pull the control lever back to "neutral" and apply the brakes. At the neutral point the reverse lever will automatically come up to position for driving forward.

7. METERS.

The voltmeter and ammeter indicate the voltage, or pressure and amperage, or flow of the battery current.

When running on first, second and third speeds the battery is connected as two separate batteries working "in parallel." On these speeds the voltage shown by the meter will be approximately one-half what it reads on fourth and fifth speeds where the battery is connected as a single unit "in series."

On any speed the voltage will become lower as the battery discharges. The following table shows the approximate voltage limits on different speeds when the car is running freely on a level street having a clean hard pavement:

Car Running on	Battery Fully Charged	Battery Fully Discharged
2nd speed	42 volts	36 volts
3rd speed	42 volts	36 volts
4th speed	84 volts	72 volts
5th speed	82 volts	70 volts

These figures apply only to cars equipped with the standard 42 cells of lead battery and not cars from which cells have been removed or to which cells have been added.

From the habit of observing the voltage occasionally as you come to level stretches of pavement and try to keep from discharging the battery below the above low limits of voltage. It is preferable to recharge a little before the fully discharged point is reached.

If you should happen to run the battery clear down to a point where the car speed is very slow, make sure that the battery is put on charge without delay and that a very complete overcharge is given before the car is used again. (See Part 4, Battery Instructions.)

The amperage, or flow of current, varies considerably for different speeds and for different road and weather conditions. Under normal conditions and with the car running freely on a level, clean, hard pavement, the amperage or current draft should be about as follows:

Car Running on	Current Draft
2nd speed	20 to 25 amperes
3rd speed	35 to 40 amperes
4th speed	30 to 35 amperes
5th speed	40 to 45 amperes

Should the current draft exceed these figures appreciably it is probably an indication that the car is not running freely and needs adjustment, lubrication or replacement of worn parts. The use of gas car tires or underinflation of tires will also cause an increased current draft.

The Voltmeter and Ammeter also serve to indicate voltage and amperage during charge and no other meters are required with the charging set.

8. LIGHTS.

Two switches, (Nos. 1 and 2) are used for the headlights. Pull out both of these to burn headlights at full brilliancy, while to dim them push in switch No. 1. and leave switch No. 2 out.

When the car has just come off charge and is standing, the lights burn with extreme brilliancy which is likely to shorten their life. In such a case it is best not to switch them on until just before you are ready to run the car.

Never switch on lights while the battery is charging, as the high charging voltage is liable to destroy the bulbs.

The lights are connected to one-half of the battery only. In order to change the lights from one-half to the other: First, disconnect the battery leads; second, loosen the screws on the controller which connect to fingers 16 and 18 (see Diagram No. 49215 in back of book) and change the light connections to fingers 15 and 17. Be sure to replace and tighten all screws after making this change. This should be done monthly if the lights are burned a great deal.

9. A FEW THINGS A CAREFUL OPERATOR WILL NOT DO

1. A careful operator will not remove the charging plug until the switch on the charging set has been opened. He will make sure the charging plug is removed before starting the car.

2. He will not release the foot brakes until he is ready to start the car.

3. He will not, under any circumstances, get out of his car without first setting his brakes, raising control lever to upright position, locking it in place and removing the key.

4. He will not, under any circumstances, reverse his car when runn'ng forward without first coming to a complete stop.

5. He will not attempt to reverse without first seeing that the control lever is in neutral position.

6. He will not attempt to run the car forward after reversing without bringing the car to a complete stop.

7. He will not drive up to a stopping place at the rate of 20 miles an hour and then suddenly apply the brakes. He will shut off the current at a reasonable distance from the stopping place and coast, applying the brakes softly and easily at the proper time. He has in mind eliminating a waste of current, unnecessary wear on brake shoes and general strain throughout the car.

8. He wiil not use current on a down grade where the grade is sufficient to keep the car under fair headway.

9. He will not coast down a grade and wait until the car nearly stops before applying the power. He will strive to maintain a as nearly as possible, a uniform speed.

10. He will not try to obtain 20 miles an hour suddenly from a standing start. He has in mind preventing strain on the gears and parts generally. He will, in starting, take the speeds one at a time, pausing a short time in each to allow the car to accelerate gradually.

11. He will not turn corners at a high rate of speed as he knows this strains the car, wears out the tires and is dangerous.

12. He will not attempt to turn the front wheels with the steering lever when the car is standing. He will take hold of the wheel itself to do this.

10. A FEW THINGS A CAREFUL OPERATOR WILL DO.

1. A careful operator will keep his tires well inflated at all times.

2. He will keep his car well and properly lubricated.

3. He will study and strive to follow the manufacturers' instructions.

4. He will make as few starts and stops as possible.

5. He will study his car, and ask advice from the manufacturers' representative on points that are not clear.

6. He will have his car thoroughly overhauled and inspected at least once each year, as he knows that in so doing the car will give better results and longer life.

7. He will have his car refinished every six or eight months. Paint will not last forever. He will not expect the paint on his car to last as long if his car stands in front of his home from early morning to late at night as it does on his neighbor's car, which is run under shelter, out of sun and bad weather, when not in use.

11. GENERAL.

See Plate 1.

An automobile is a machine and, like all machinery, it must be regularly and properly lubricated to give efficient service and to protect parts from damage. We cannot too strongly impress this fact upon you.

The lubrication chart, Plate 1, makes clear the proper lubrication of the parts.

In addition to the lubrication called for in the chart there are a few rod connections and other moving parts which require a few drops of oil occasionally. Also the instructions below should be given careful attention. Refill grease cups as often as they become empty.

About once a year the car should be given a thorough overhauling, including cleaning, repacking and adjusting of bearings and other moving parts and renewal of worn parts. For instructions regarding the taking down of the different parts see Part Three, Adjustments and Repairs.

12. KINDS OF LUBRICANT.

Where grease is mentioned in the lubrication chart (Plate 1), any good light grease, free from acid, can be used. It is, however, preferable to use a grease the character of which is changed as little as possible by changes of temperature. Some greases become extremely hard and lose their lubricating properties in very cold weather. These should be avoided. Do not use graphite grease except to repack the spring leaves. Where oil is specified use a high grade light engine oil.

Use nothing but the special kinds of lubricant called for on the controller contact plates and in the rear axle. We recommend that lubricating grease for axle and universal joint be obtained from the Detroit Electric Car Company. This special grease may be obtained in 5 and 10-pound cans.

13. CONTROLLER.

The controller contact plates should be wiped clean once a month. The oil pad provided for lubrication of the contact plates is saturated with oil which should last one month. Renew the supply by pouring on the pad as much good sperm oil or "Three-in-One" oil as will be readily absorbed.

Give the star wheel roller and the hinge of the roller arm a few drops of oil every month.

Put a little grease on the controller pinion and sector every month.

Examine the controller fingers every month to see that they are making full and proper contact with the contact plates.

The cutout switch which is assembled in a unit with the controller, has a hole through its contact. This hole should be filled with grease every month.

14. MOTOR.

The motor runs on two annular ball bearings, one at each end. Clean and repack these once a year. For instructions on how to do this and how to take care of commutator see Page 16.

15. UNIVERSAL JOINT.

The universal joint housing is packed with grease for lubrication of the universal joint.

During the yearly overhaul, clean out the housing and repack with grease while the propeller shaft is disconnected.

16. REAR AXLE.

As sent from the factory the axle contains six pounds of special grease, which is sufficient to run for at least six months. Every six months remove the rear cover. If gears do not appear well lubricated add one pound of special grease.

Every year the cover should be removed from the rear axle and the old grease washed out, taking care to clean bearings in the pinion housing. This can all be done without moving any of the gear adjustments in any way. The axle should then be refilled with six pounds of new grease and the back cover replaced.

A permanent oil-tight joint is made on the front of the axle housing by means of a Vellumoid gasket with a coat of shellac on each side. Should this joint leak, one or more coats of thick shellac painted around the edge of the casting will invariably cure the trouble.

An oil-tight joint at the rear of the housing is maintained by a one-sixteenth inch thick cork gasket, shellaced to the face of the cover only, leaving the cover free to be removed for inspection purposes. Should the gasket become torn or broken a new one should be ordered from the Detroit Electric Car Co.

17. WHEELS.

Remove the wheel bearings, clean in gasoline and repack with grease during the yearly overhaul.

18. SPRINGS.

The eyes of the springs are lined with self-lubricating bushings. Should the spring links squeak, drop a very little oil in the grooves in the face of the links which will carry the oil between the squeaking surfaces.

Repack between the spring leaves with natural graphite grease during the yearly overhaul.

19. STEERING AND CONTROL RODS.

The ball and socket joints of the steering and control rods are packed with grease and covered with leather boots. Remove the boots, clean out the old grease and repack with fresh grease every two months.

The upper and lower steering and control mast bearings should be cleaned and repacked with grease during the yearly overhaul.

20. BRAKE RODS.

Give each clevis end on the ends of all brake rods a few drops of oil once a week.

21. HORN.

Clean and lubricate the horn once a month in the following manner:

Take out the screw which holds the back shell to the horn and remove this shell.

Take a dry cloth and wipe the commutator clean.

Once a month a few drops of light machine oil should be dropped into the two oil wells inside the back shell.

Every three or four months a little non-fluid oil or vaseline should be applied to the toothed wheel next to the diaphragm.

22. SPEEDOMETER.

The speedometer swivel at the head of the motor is provided with a grease cup. This should be given a full turn every two weeks.

23. PNEUMATIC TIRES.

The tires used on Detroit Electric Cars are Cord tires. In replacing tires, Cord tires only should be used. The Detroit Electric Car Company does not guarantee its car, battery or mileage when other tires are used.

Do not ride a pneumatic tire flat. Running deflated is apt to injure the tire so that repair is impossible.

Keep the air pressure to 70 pounds for the 4″ tire. A higher inflation is not detrimental, but causes less comfort in riding. A lower inflation sacrifices efficiency and is detrimental.

If your tire is cut, bruised or injured so the repairs are necessary, have the work done at once.

Do not allow the car to stand in oil or grease, as this is detrimental to rubber.

When out of use for considerable periods, keep the weight of the car off the tires and store in a dark, cool room.

24. CARE OF BODY.

The finish of a body is the result of many weeks of extremely careful work in the paint shop and its lustre depends on its elasticity. Even the finest dust will scratch the surface of the varnish and paint if wiped off with a cloth. The only proper way to remove dust and mud is by washing.

Great care should be taken not to use too great a force of water, but flow plenty of water over the parts from an open hose.

On the body proper no soap or preparation of any kind should be used except by a washer of experience. It is advisable to have two sets of sponges and chamois, keeping one set for the body and upper surface of the fenders, the other for the running gear and under parts. Flow water liberally over the body until the dirt is loosened, then sop it off with a sponge, afterwards drying the body with a chamois.

On the running gear and the under parts of the fenders a high grade carriage soap may be used.

When the original baked enamel finish of fenders becomes dull the lustre may be restored as follows:

Prepare a solution consisting of one part ammonia water, three parts water and small quantity of linseed oil. Rub this over the fender surface with a woolen cloth, and rub dry with a clean cloth of wool or any soft material.

Do not use this preparation on the body or on a fender that has been varnished, as it will injure the varnish.

PART THREE—ADJUSTMENTS AND REPAIRS

25. SAFETY FIRST.

Never get under a car or work on the controller, reverse switch, cutout switch, charging receptacle, or wiring without first disconnecting one main battery cable from the front battery and one from the rear battery. By so doing you will avoid any possibility of the car starting and all danger of short-circuiting the battery.

Referring to Diagram No. 49215 in the back of the book, the front battery main cables are those numbered 17 and 15, the rear battery main cables are those numbered 16 and 18.

26. ELECTRIC WIRING.

See Diagram No. 49215, in back of the book.

Each car shipped from the factory has correct wiring diagrams for its particular equipment pasted on the bottom of the removable seat board underneath the rear cushion.

Underneath the rear seat the fuse board is located.

In case one or more of the lights do not light or the horn does not blow (other lights being O. K.) the trouble is due to the burning out of either a fuse or a light bulb. Individual light and horn fuses are 5 ampere capacity, battery fuses 15 ampere. The fuses from left to right are as follows. Battery, Horn, Headlights, Side Lights, Inside Light and Tail Light. (See Diagram No. 49215).

By disconnecting the tail light connection as shown at the round dots in the wiring diagram and the battery connection at C and T the body can be removed without unsoldering or cutting a wire.

27. CONTROLLER.

See power circuit diagram 49215.

The controller is located in the controller compartment under the rear seat.

The controller is protected fom dust and dirt by a metal cover held on by two spring clamps which fasten underneath the screw heads at the top.

To remove the cover simply push back these two clamps and lift it off.

The controller is fitted with a spring-operated roller, which drops into notches in a sector, to indicate the proper speed point where full electrical contact is made. If the driver properly manipulates controller handle, this sector device will prevent arcing at controller which causes roughening of both the contact fingers and contact plates.

In case contact fingers or plates become rough, smooth out the contact finger and plate without delay. To do this, first be sure to disconnect the main battery cables, front and rear (see "Safety First" page 13). Then loosen the screw which holds the contact finger to the terminal block and remove the finger. Smooth this up with a piece of sandpaper or a fine file, being careful to leave a smooth, even surface which will bear its full width on the contact plate. Smooth up the contact plate in the same way, if necessary. If the parts are badly damaged it will be necessary to replace them.

In inspecting or adjusting the controller, make sure that all fingers make good contact. If a finger is making good contact it will rise about one-sixteenth inch when it engages with the contact plate and will bear with its full width so that a thin piece of paper cannot be inserted beneath either side, at the point of contact. If any finger does not meet these requirements adjust it by bending. Care must be taken not to bend a finger down too far, however, as it might, if bent too far, catch on the edge of the contact plate instead of riding over it. Also there is a possibility of short circuiting if a finger is bent crudely and too much.

In case the car will not run on any speed with the battery properly connected and the cutout switch closed, the trouble may be due to one or more of the controller fingers not making contact as above.

In case the car will run on 1st, 2nd and 3rd speeds, but not on 4th or 5th, the trouble may be due to poor contact of fingers No. 16 or 17.

In case the speed notches are not distinct at the control lever, make sure that all the ball and socket joints, the controller idler, upper and lower control mast bearings, the controller bearings and shaft are properly lubricated, and that the contact plate oil-pad is lubricating the plates properly. Also make sure that the roller arm spring is not broken or out of adjustment.

28. REVERSE SWITCH.

The reverse switch is assembled in the controller housing and interlocks with it. The controller cannot be operated unless the reverse switch is in the proper position and the reverse switch cannot be operated unless the controller is in the neutral position. If this is disconnected for any reason, the rods must be replaced so that the switch travels far enough in each direction to clear the locking device and allow the controller to be operated.

29. CONTROL MAST.

The control mast has two bearings; one near the top in the upper bracket, and one at the bottom. Both of these are ball bearings.

The upper bearing is adjusted by means of a threaded collar, which screws into the bottom of the upper bracket. Screwing this farther in tightens the bearing. This collar is locked by means of a cap screw with a large washer and lock washer, which screws into the bracket. The large washer presses against the threaded collar and prevents it from turning.

The lower bearing is kept in adjustment by means of a heavy spring, which rests against the lower lever and pulls the control mast down on the bearing.

The adjusting nut in the lower bearing adjusts the height of the control mast, but does not affect the bearing in any way.

30. STEERING GEAR.

As the steering gear wears it may develop rattles in the ball joint connections of the different rods. To overcome this, remove cotter pins from the rod ends and screw up the plug with a heavy screwdriver, using a wrench on the screwdriver, if necessary, until all lost motion is eliminated. Then replace cotter pin and repack the ball joint with new grease.

The upper and lower steering mast bearings are similar to those of the control mast and are adjusted in the same manner. The spring at lower end of mast is provided with a differential washer at its upper end.

31. HAND BRAKE.

The hand brake is of the contracting shoe type and is operated by pulling the controller handle back. This, through the rods and idlers, operates the cam shafts and causes the shoes to come into contact with the brake pulley. As the lining wears, it may be necessary to adjust the brake. This should only be done by adjusting the brake adjusting rod between the idler on the right side of the frame and the operating lever on the motor and at no other point. All other adjustments are for initial use at the factory and should need no attention after they have once been set.

32. FOOT BRAKES.

The brake system is connected to the right foot pedal.

The brakes should be adjusted for wear only by the brake adjusting rods, between the brake equalizers and the camshaft levers on the rear axle. To make the adjustment, have the pedals released and loosen the lock nuts next to the yoke ends which connect to the camshaft levers on the axle. The other end of the brake adjusting rod is provided with a square end for turning the rod with pliers or a wrench. If the pedals are too slack, screw the rod further into the yoke end. Always adjust the two corresponding rods the same amount.

The brakes should be adjusted so that the brake shoes are as close to the drum as possible without, however, actually touching the drum. Be sure to leave enough clearance between brake shoes and drum so brakes will not drag and consume current when released.

A convenient and good way to test for dragging brakes is to jack up both rear wheels and run the motor on 2nd speed. If the axle grease is cold, let the motor run for at least two minutes to warm the grease, then read the ampere draft on the meter in the car. This reading should not be more than one or two amperes higher than a similar reading taken before commencing to adjust, and should be less than 10 amperes.

If such a test indicates that the brake shoes are dragging, the brake adjusting rods should be unscrewed until the current draft falls to the proper point. The lock nuts next to the yoke ends should then be tightened securely.

Should it be found that one-half only of a shoe is working, the other half of the shoe can be brought into action by loosening the loose face clamp bolt, and inserting one or more shims between the back of the loose face and its bracket on the brake shoe and again tighten the clamp screw.

When the lining on the brake shoes has worn, then it should be removed by cutting the rivets which hold it, and a new piece of lining substituted, using the old rivet holes so that the shoe is not weakened by drilling a large number of holes.

Cut the brake lining to length and rivet the two ends to the shoe first, so that when the lining is drawn down into the depressions it is tight on the shoe all around.

33. CUTOUT SWITCH.

The cut-out switch is assembled in the controller frame. The switch can be inspected by removing the rear seat cushion and taking off the top cover of the controller.

See that the hole in the contact arm inside the box is filled with clean grease.

34. MOTOR.

The motor commutator in normal use quickly assumes a glossy, bluish tint. The motor should be inspected once a month and, if the commutator is found to be black, it should be cleaned with No. 00 sandpaper. This is best done by jacking up one rear wheel and turning it while the sandpaper is held lightly against the commutator.

If the commutator is found to be rough or badly grooved by the brushes, the armature should be taken out and a light cut taken over the commutator in a lathe, to smoothe it up and true it.

Never use emery paper or extremely coarse sandpaper on the commutator.

To remove the armature: 1st, take out the propellor shaft (see rear axle). 2nd, remove the nut on the end of the armature shaft and pull off the motor brake pulley. 3rd, loosen the clamping shaft to the motor and remove the brake shoe support. bolt on the under side of the ratchet housing and slip the pedal to the left until it is free from the motor. 4th, loosen the clamps which hold the wires together and remove the motor wires from the controller. 5th, loosen the set screw which holds the speedometer swivel and pull the swivel out from the head of the motor. 6th, block up under the motor and remove the bolts which hold the motor to the frame, lower and remove the motor. 7th, remove the cap screws which hold the motor brake shoe support. 8th, remove the front end plate from the motor. 9th, remove the nut from the front end of the armature shaft. 10th, with a piece of string tie up the brushes to the ribs of the frame around the commutator so that all brushes are clear of the commutator. The

armature, with its rear bearing pedestal, can then be drawn out of the rear of the motor, taking great care not to drag the armature across the pole pieces of the motor or damage the insulation in any way.

After turning down the commutator it is advisable to shape the brushes to a good bearing by wrapping a piece of No. 00 sandpaper around the commutator, with its sand side toward the brushes, and working the sandpaper gently back and forth, with the brushes bearing upon it, until the brushes are a good fit to the curvature of the commutator.

To remove or grease the front motor bearing: 1st, block up under the front part of the motor. 2nd, loosen the set screw which holds the speedometer swivel and pull the swivel out from the front of the motor. 3rd, remove the U-shaped bolt which fastens the front end of the motor to the frame. 4th, unloosen the cap screws which hold the front end plate of the motor and remove this end plate. 5th, remove the screw which keeps the bearing retainer from turning, and unscrew the bearing retainer. The bearing can now be easily greased. If it is desired to remove the bearing, remove the cotter pin and unscrew the nut on the end of the armature shaft and the bearing can be removed.

To remove or grease the rear armature shaft bearing, remove the propeller shaft and brake pulley as previously described. Then remove screw and bearing retainer as described under front motor bearing, and the bearing can readily be greased or removed.

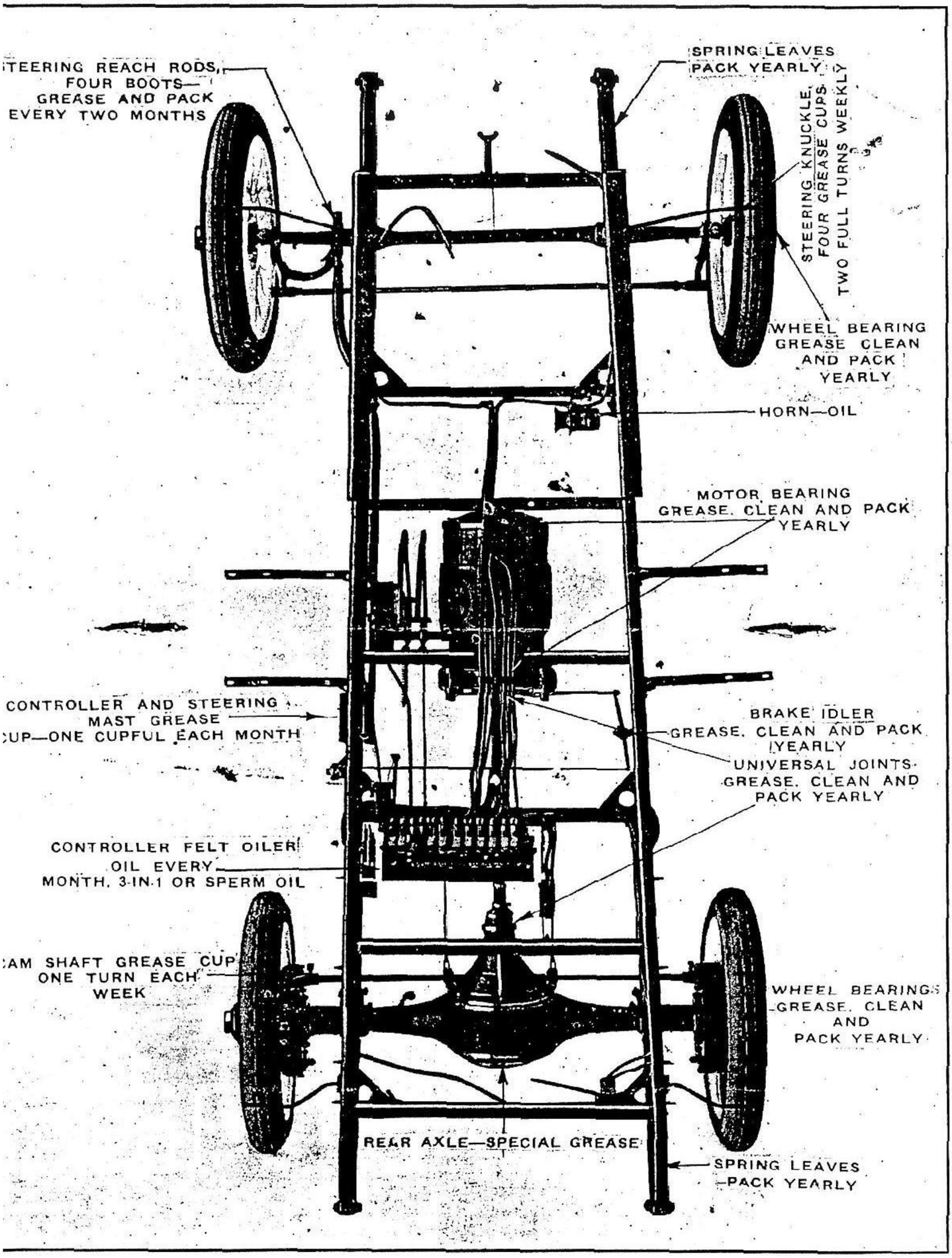
35. FRONT AXLE.

The front wheels should have from ¼" to ⅜" gather. This means that the front wheels, when in proper adjustment, should measure ¼" to ⅜" less from rim to rim at the front than at the back, measuring at the height of the wheel center in each case. If a knuckle arm or the knuckle tie rod has become bent in any way the gather will be changed, thus causing hard steering, increased current draft and excessive wear of the front tires.

If there is not sufficient adjustment on the knuckle tie rod to bring the wheels back to the proper gather, the bent part should be replaced or straightened, without heating. This adjustment is important and should be checked from time to time.

The front axle is designed to be mounted with the knuckle pins tilting backward from 1 to 1½ degrees. If the angle of the knuckle pins is more than 1½ degrees or less than 1 degree, steering trouble will result. This angle can be adjusted by the use of wedge-shaped shims (which we can supply) between the spring and the spring pad.

The front axle is also designed in such a way as to give the wheels a camber or pitch in at the bottom so that the wheels measure 1¼" less from rim to rim at the bottom than at the top. This camber is not adjustable, however, and will not change except in case of accident in which case it must be re-adjusted to the original position.


STEERING REACH RODS, FOUR BOOTS—GREASE AND PACK EVERY TWO MONTHS
SPRING LEAVES PACK YEARLY
STEERING KNUCKLE, FOUR GREASE CUPS, TWO FULL TURNS WEEKLY
WHEEL BEARING GREASE CLEAN AND PACK YEARLY
HORN—OIL
MOTOR BEARING GREASE. CLEAN AND PACK YEARLY
CONTROLLER AND STEERING MAST GREASE CUP—ONE CUPFUL EACH MONTH
BRAKE IDLER GREASE. CLEAN AND PACK YEARLY
UNIVERSAL JOINTS GREASE. CLEAN AND PACK YEARLY
CONTROLLER FELT OILER OIL EVERY MONTH. 3-IN-1 OR SPERM OIL
CAM SHAFT GREASE CUP ONE TURN EACH WEEK
WHEEL BEARINGS GREASE. CLEAN AND PACK YEARLY
REAR AXLE—SPECIAL GREASE
SPRING LEAVES PACK YEARLY

36. REAR AXLE.

A slight noise in coasting sometimes develops without there being any real trouble in the gears and should give no cause for worry. Such a coasting noise may pass away in time.

Be sure to correctly locate a noise before doing anything to the axle.

To remove the driving gears: 1st, remove the wheels (in case car has wire wheels also remove inner hub and brake drum). 2nd, remove the clamping bolt from end of housing and take out the locking plate. The bolt passes through a hole in the plate and the plate fits into a slot cut in the bearing sleeve and prevents the sleeve from turning. 3rd, unscrew the bearing sleeve and the shaft can be withdrawn.

(In replacing the drive shafts, both shaft bearing sleeves should be screwed in an equal amount until both shafts touch without any lost motion in the bearings. Do not screw them too tight as this would cause the car to run hard).

After the driving shafts have been taken out remove the axle housing cover, taking care not to damage the cork gasket; take off the lock plate which locates the differential adjusting nut. If the same gear is to be put back into the axle, mark the particular notch of the adjusting nut into which the lock plate is fastened. Then remove the cotter pins and nuts which hold on the main bearing caps and remove the caps. The gear wheel, complete with differential assembly, can then be easily taken out through the opening in the rear of the axle.

To remove the pinion. 1st, disconnect the propellor shaft from the pinion driving flange and remove the propellor shaft. 2nd, remove cotter pin which holds down sleeve lock. 3rd, press down on the back end of the sleeve lock plate, so that this is lifted out of the slot in the pinion sleeve. 4th, with the flange still on, unscrew the pinion sleeve and pinion from the housing. This screws out towards the front of the car.

If the same pinion is going to be put back into the axle again, mark the slot in the pinion sleeve into which the lock plate was fastened and measure the distance from the small end of the pinion to the joint face of the differential pedestal (this dimension should be approximately 4″) so that the gears can be returned to their original setting.

When replacing the large ring gear on the differential after it has been removed for any purpose, take care that no one bolt is screwed down tight before the others, but travel around tightening each nut a half turn at a time until all the nuts are tightened. Unless this is carefully done the gear may be distorted slightly and it will be impossible to obtain an absolutely quite axle.

The pinion may be assembled into its sleeve on the bench, taking care that the thrust bearing nut is tightned properly and securely fastened; the sleeve can then be screwed into the axle until the rear end of the pinion is (4″) ahead of the joint face of the differential pedestal.

The bearing mounted in the adjusting sleeve at the right hand side of the differential must also be very carefully tightened so that there is no lost motion in either direction, and the nuts locked by the spring rings. The bearing on the left hand side of the differential should be pushed on and the nut tightened and securely fastened by the spring locking ring. The whole differential can then be put into position and the bearing caps put on to the studs and the nuts put on loosely. (Never attempt to alter the adjustment of the gear without first loosening the nuts of the bearing caps two full turns and lightly tapping the caps sideways to ensure that the bearings are free to slide.) The ring gear should be adjusted so that from .004″ to .005″ backlash can be felt between the teeth of the gear and pinion and then the bearing caps tightened.

If the pinion has been properly located to the above dimensions the gears, when run, will probably be found to be reasonably quiet and comparative silence can be obtained by adjusting the pinion one or two notches backward; but if quiet running cannot be obtained within this range of four notches, the ring gear is probably distorted and should be dismounted from the differential, given a partial revolution and again carefully mounted.

Should it, however, be found necessary to adjust the ring gear out of mesh even but a few thousandths of an inch, the bearing caps must be loosened, as previously described, and the adjusting nut turned until the gear has moved outward about one-sixteenth inch then screw up the adjusting nut to bring the gear into the required position. It is impossible to satisfactorily adjust the gear outward unless done in this manner.

After the pinion has been properly adjusted replace the sleeve lock and fasten with cotter pin.

Never try gears for silent running unless the differential bearing caps are all tightened.

After any pair of gears have been run together for any length of time their respective adjustments should never be altered for any reason whatever; and, if taken apart for cleaning or other reasons, the locking notches of both gear and pinion should be marked before moving, so that they may be replaced in exactly the same relation.

37. WHEELS.

Wood wheels. To remove the rear wheels and bearings: Unscrew the hub cap; remove the hub bolt cover which is held in place by the hub cap. Remove the nut on the end of the drive shaft and pull wheel off drive shaft.

Wood front wheels and bearings are removed in the same way.

WHEELS. (WIRE).

The inner hubs for Houk Quick Change Wire Wheels are made with right and left hand threads. The hubs for the right hand side of the car have left hand threads; while the hubs for

the left hand side of the car have right hand threads. Before leaving the factory all hubs are plainly stamped. "Right Side" and "Left Side." By right hand side of the car we mean the side to the right of the driver as he sits in the car. The hub caps are marked "Right Side" or "Left Side" with arrows indicating the direction the cap revolves in screwing on or tightening. The wheels themselves are held in place on the inner hubs by their respective hub caps.

In order to prevent squeaks and to insure the easy removal of the wheels after a long period of undisturbed service, a light application of grease is given to the inner hub and the hub cap. The threads of the hub caps are also greased.

It is observed in some instances when the wheels are first put on and run a few miles that one or more of the hub caps can be tightened a few degrees. No actual unscrewing of the cap has taken place, but the apparent looseness is due simply to the elasticity and final accommondations of the parts toeach other. It is better after the first few miles of driving to go over the caps again with a wrench and take up this initial slack. At the time this tightening is done the weight of the car should be lifted from the wheels.

It is good practice after having pulled the hub caps to place with a wrench by hand to fix the wrench on the caps at a convenient angle and give it a few light taps with a hammer. If the hubs are mounted and surfaces given a slight film of grease, no further attention need be given them, and when it is necessary to remove the wheel, it can be done with a minimum amount of labor.

Caution:

1.—Remove wheels every 1,500 miles and wiping clean apply new grease to surface of inner hub.

2.—In applying hub caps always screw them on by hand, being careful that threads are not crossed.

3.—In removing hub cap always turn towards front of the car.

4.—Wheels must be drawn up tightly against surface of inner hubs—(to do this see that hub caps are drawn absolutely tight).

5.—For washing provide a good stiff brush which can be purchased at any accessory house.

6—Do not remove or replace hub caps with weight on wheel. First jack up car.

7.—When new spokes are inserted, do not draw too tightly. Be careful not to pull the wheel out of alignment. They should ring true with spokes of same length.

In case of wire wheel spoke breakage, new spokes should be put in at once. In replacing the wire wheel spokes, the following precautions are necessary:

Contact surfaces of the spoke ends should be free from paint and provided with a little graphite lubricant. The spoke is always entered from the hub end and the nipple from the rim. Then in tightening, care must be taken to see that the spoke has

the proper tension, neither too great nor too small. This is determined by noticing the sound produced by tapping on the spoke which should be tightened until it gives off a sound of medium pitch, the same as the other spokes.

To remove the rear wire wheel hubs, first remove the wheels, as previously explained. Then remove inner hub and brake drum as described under wood wheels.

Before replacing hubs always take care that the bearings are filled with clean grease. For proper adjustment of bearings see section on Timken Roller Bearings.

38. TIMKEN ROLLER BEARINGS.

Every time a wheel hub is removed the cup of the bearing is removed with it and consequently the bearings must be properly readjusted when the wheel is replaced.

The best method is to adjust the bearing tight, then revolve the wheel a few times by hand. This will overcome any tendency to backlash. Then back off the adjusting nut very slightly so that by grasping two opposite spokes a barely perceptible amount of shake can be felt. If the bearings have been adjusted properly the wheel should spin easily and coast freely.

39. SPRINGS.

All spring clip nuts must be tightened at regular intervals. On a new car this should be done after the first month of service and thereafter about every three months. This is very important for protection of the springs.

All spring shackle bolts should be examined occasionally and tightened as required, taking care not to tighten enough to bind the spring and prevent good spring action. A loose shackle bolt may cause a very bad rattle on rough roads.

In removing a spring, put a clamp or wire around the spring leaves near the center, before loosening the spring clips, to hold the leaves together.

40. BODY BOLTS.

The body is held to the frame by six bolts, three on each side As a rule a new car requires two or three months of service before these bolts find a firm seat in the wood. In order to avoid annoying squeaks these bolts should be tightened every month for the first three months and once every six months thereafter.

41. HOODS.

Beneath each hood hinge is a piece of soft rubber sheet so mounted as to prevent any rain or wash water getting through the hinge into the batteries. Should this rubber become torn or detached it must be replaced.

The lower front edge of the front hood is fitted with rubber bumpers to prevent rattling. These rubber bumpers will have to be renewed occasionally.

42. FENDERS.

The fenders are mounted on the chassis in such a way that they can be removed without disturbing the body.

All the nuts which fasten the fenders are provided with lock washers. When replacing any of these nuts care should be taken that the lock washer is securely in place. Annoying noises will thus be prevented.

43. LAMPS.

If a lamp will not light examine both the fuses (see Electric Wiring, page 13) and the light bulbs.

All light bulbs have the Ediswan base. To remove a bulb from its socket push it in and give it a slight turn counter clock wise. This will free the bulb and it will spring loose.

The glass of the inside lamp is held by a spring plunger and can be removed by pushing the plunger at the front of the lamp in and then pulling down on the cover.

To open the tail lamp remove the spring lock wire which holds the ruby glass.

44. HORN.

In case of trouble with the "Klaxet" horn take up the matter direct with the nearest Klaxon agency.

For lubrication and care of the horn see page 12.

45. CHARGING PLUG AND RECEPTACLE.

When connecting the plug to the charging source, be sure to connect the positive wire to the terminal of the plug marked + and the negative wire to the terminal of the plug marked —. Should the receptacle have been disconnected for any purpose connect the positive battery wire to receptacle terminal marked + and negative battery wire to the receptacle terminal marked —.

After the wires have been connected to the receptacle the recesses into which the wires are fastened must be filed up with insulating compound to prevent short circuiting by water.

46. VOLTMETER AND AMMETER.

In case of trouble with these instruments remove from the car and return to the instrument manufacturer. The small resistance on the back of the instrument board should accompany the voltmeter and the meter shunt and leads from the shunt to the ammeter should accompany the ammeter.

47. SPEEDOMETER.

In case of trouble with the speedometer, it is absolutely essential that it be returned intact as the speedometer people will not guarantee the same if it has been tampered with.

Trouble with this instrument should be taken up with the nearest Stewart-Warner Service Station.

48. TO REMOVE BODY.

Disconnect the heavy wires at the meter shunt underneath the car; also voltmeter leads at the controller.

Disconnect wires from the fuse board under the rear seat as follows: Disconnect the wire T, and C, also the tail light wires as shown at the black dots—see wiring diagram No. 49215. Remove the control mast lower lever.

Remove the lever from the bottom of the steering mast.

Disconnect the reverse foot lever.

Remove the plate around the pedals and loosen up the floor boards so pedals can pass through and depress pedals as much as possible.

Remove the six bolts which hold the body to the side rails of the frame and the body is ready to be lifted off.

49. TO REPLACE BROKEN GLASS.

In case of broken window glass in the front quarter or the sides proceed as follows: Remove the aluminum moulding on the outside of the glass and take out the old glass carefully without breaking the rubber channel into which the glass is set. Coat the edges of the new glass with varnish and then replace this rubber channel on the new glass, then set the new glass into the body with putty, then replace the aluminum moulding, fastening it so that it presses the rubber channel against the glass. Touch up all bare and marred places with black color varnish.

50. TO REMOVE DOOR GLASS.

First, remove the outside lower door moulding and rubber, also inside lower moulding.

Second, raise up the glass with the lever as far as it will go and it can then be lifted up above the door opening.

Third. Raise the glass and channel up through the top of the door.

Fourth, clean out the channel, shellac the inside of the bottom channel, also the bottom of the new glass and press these together with a piece of felt between.

Fifth, lower the glass and channel into place through the top of the door. Hold the loose washer on the regulator stud back towards the chain, with a screw driver, and press the channel slot onto the stud between this washer and the end of the stud.

Sixth, replace the mouldings and rubber removed first and the repair is completed.

51. TO REMOVE A BATTERY.

Disconnect all battery cables and the jumpers which connect the trays to one another. Unscrew the wing nuts on the battery hold-down irons underneath the frame and remove battery hold-downs. There are two hold-downs at the front end of the front battery and one at the rear end of the front battery. There are three hold-downs at each end of the rear battery. After these are removed the batteries can be easily lifted out.

In putting the batteries back make sure to place and connect all trays in the exact position shown in the power circuit wiring diagram. (See diagram 49215).

PART FOUR—BATTERY INSTRUCTIONS

52. GENERAL—CARE OF BATTERY.

Lead battery terminals should be kept clean and covered with a thin coating of vaseline to protect them from corrosion by the acid. The tops of the battery cells should be kept free from dust and dirt at all times.

Always raise the hoods for ventilation while battery is being charged.

The standard equipments of M. 90, 1922 models is 42 cells of 13 thin plate lead battery.

The following instructions apply to the standard lead battery equipment only and are intended particularly for the owner who keeps and charges his car at home.

53. UNPACKING AND INSPECTION FOR BROKEN JARS.

Most batteries are shipped installed. In case the battery is boxed separately the following instructions should be followed.

Take off the top and one side of the box, in order to slide out the battery trays, as a short drop may break a jar or the acid may be spilled. Clean off the tops of the jars and trays. Examine all connections. They should be clean and bright. Take out the vent plugs and see that the acid covers the plates. If the level of the acid is low, add distilled water only to bring the solution just above the plate tops. Do not fill to the normal height of ½" above the plate tops as the solution level will rise considerably during the first charge after standing.

If the level of the acid is much lower in some cells than others examine them carefully for leaks; the jars may have been broken in transit. In case a leaking jar is found, cut the connecters and pull out the whole cell. If plates are still wet place the element in another jar and cover immediately with electrolyte of the same specific gravity as the other cells. If they have become partially dry fill with 1.220 electrolyte. If the plates have dried in the least the cell should be charged at 8 amperes until the voltage and specific gravity of the acid have reached their maximum and have stopped rising for at least four hours. The specific gravity should then be adjusted to 1.270 and the cell replaced in the battery. If no jars are available use a clean crock, glass jar or other acid-proof receptacle until a jar is obtained, covering at once with electrolyte as directed above. If no electrolyte is available, cover the elements with distilled water. As soon as possible, replace the element in a good jar and charge as above.

The battery is shipped fully charged, but before using, it is important to give a freshening charge at 8 amperes until the voltage and specific gravity are at a maximum, otherwise full mileage may not be obtained on the first few discharges.

54. FREQUENCY OF CHARGING.

The best results are obtained by keeping the battery fairly well charged all the time. "Get enough current into the battery and get it in with a minimum of gassing." The rate of charge is immaterial as long as the gassing and temperature are watched as outlined on page 27.

When a battery is charged the water of the solution is decomposed by the electric current into gases. These gases unite with the active material of the plates during the early part of the charge, but as the charge proceeds a point is reached known as the gassing point where more gas is formed than the active material of the plates can take care of and bubbles rise to the surface of the cell. The temperature of the cell also commences to rise at this point. At first the bubbles rise slowly just as a kettle of water being boiled commences to simmer, but if the rate of charge is high they will soon commence to rise quite violently the same as the kettle boils violently and the temperature will rapidly reach the danger point (105 degrees F.) The greatest wear on the positive plate takes place during this gassing period, therefore the longest life of the battery can be obtained by keeping this to a minimum. On the other hand the greatest harm occurs to the negative plate when it is allowed to stand over two-thirds discharged. A complete discharge once in a while does the battery no harm, provided the battery is not allowed to stand after it is two-thirds discharged and it is always better to follow this with a full charge.

From the above it will be seen that the best results are obtained by keeping the battery fairly well charged all the time.

55. CHARGING APPARATUS.

Where it is desired to charge one's own car the market affords the following apparatus:

Where 110 volt Direct Current is available a rheostat should be used. These are obtainable in any capacity desired with prices varying in proportion to their capacity.

Where 200 volt Alternating Current is available a mercury arc rectifier or a motor generator set should be used. Mercury arc rectifiers are obtainable in 30, 40, 50 ampere sizes with prices varying in proportion to the size.

Rotary generator sets, which can be used on both 220 or 110 volt Alternating Current are available in sizes of any capacity desired with prices varying in proportion to the size.

56. CHARGING.

Always make sure the control lever is locked in neutral position and see that both hoods are raised for ventilation before commencing to charge.

Turn out vehicle lights while charging to prevent burning out the bulbs.

The following is the usual method of charging which has been governed more or less by the capacity and prices of the charging apparatus available.

The charge can be started at any rate, provided care is taken to see that the finishing rate when the specific gravity and voltage are up does not exceed 8 amperes. The great secret of obtaining long life from a battery is to finish each charge at such a low rate that strong gassing and overheating are prevented. 8 amperes

is the maximum permissible finishing rate; 5 to 7 amperes is better.

Charging at a rate higher than 8 amperes after cells have commenced to gas freely must not be permitted.

The following table shows the approximate battery voltage, during charge, at which strong gassing will commence and at which the current rate must be reduced to between 6 and 10 amperes. The table also shows the approximate final voltage at the end of a charge to the point of maximum specific gravity.

	Volts Per Cell	Voltages of 42 Cells
Voltage gassing point	2.35	99
Voltage at finish of charge	2.55	107

Charging voltage readings vary with temperature and age of the battery; the higher the temperature and the older the battery, the lower the voltage will be. Take voltage readings only when the battery is charging or dicharging. Readings taken when the car is standing idle are of no value.

The density or specific gravity of the acid changes during charge and discharge and specific gravity readings taken by means of a hydrometer syringe give the most reliable indication of the state of charge. The specific gravity will read about 1.140 to 1.170 after a total discharge. It will rise during charge and at the end of a full charge should read 1.270 to 1.280.

The hydrometer syringe is a convenient and inexpensive little instrument which it will pay you to obtain and use if you are charging your car at home. This instrument is used universally in the best electric garages.

Hydrometer readings are not dependable unless any added water is thoroughly mixed with the acid by subsequent charging. Hydrometer readings are not comparative unless the acid levels are one-half inch over the plates in all cases.

Hydrometer readings depend on temperature to some extent. For every 10 degrees F. rise in temperature the specific gravity readings will drop three points (.003) and vice versa. At ordinary temperatures this variation is negligible.

If at any time the battery temperature tends to rise above 105 degrees F. reduce the charging rate or stop the charge altogether until battery cools.

57. UNATTENDED CHARGING.

For overnight charging, without attendance, start at such a current rate that, as the rate falls due to rise of battery voltage, it will reach a minimum of 6 to 8 amperes when the charge is complete. The proper starting rate varies, depending on the type of charging apparatus used, and will have to be determined by trial. With mercury arc rectifier sets or a direct current line the proper starting rate will ordinarily be from 15 to 17 amperes. With some types of small rotary chargers, however, the proper starting rate will be as high as 30 to 50 amperes.

In starting on overnight charge, unattended, the charging apparatus should be set at a point which previous experience has shown will make the finishing rate not over 6 to 8 amperes.

58. HURRYING THE CHARGE.

If it is desired to charge in a short time use the maximum capacity of the charging apparatus until the gassing point is reached. (See table, page 28.) The charging rate must then be reduced in successive steps down to the normal finishing rate, keep in mind that the gassing point voltage must not be exceeded at a current rate higher than 8 amperes.

59. PERIODICAL OVERCHARGE.

Once a month follow the regular charge with an overcharge at the finishing rate until the specific gravity in every cell has stopped rising. During the overcharge take the specific gravity of each cell once every hour. When four successive readings of every cell are alike, showing that the specific gravity has risen to its maximum point the overcharge may be stopped.

The maximum specific gravity should be between 1.270 and 1.280, with the acid level not more than one-half inch over the plate tops. If higher than 1.280 reduce it by withdrawing some acid and replacing with distilled water. If lower than 1.270, do not add acid, but proceed as directed below under Addition of Acid. To properly carry out the above instructions will mean that the overcharge must be continued at least four hours after the end of the regular charge. In case the battery has become sulphated, due to insufficient charging, it may be necessary to continue the overcharge for ten to fifteen hours or longer.

60. ADDITION OF ACID.

Never add acid to the battery under ordinary operating conditions. The capacity and life of batteries are too often reduced by the unnecessary addition of acid. Under normal conditions the battery will need no addition of acid during its whole life. The acid in a battery cannot evaporate only the water evaporates. Therefore, if no acid has leaked or splashed out, and the specific gravity is low, the acid must be in the plates in the form of sulphate, and the specific gravity must be restored to the proper point by an overcharge at the finishing rate.

If the specific gravity in a few cells is lower than the average, it is due to some abnormal condition in these cells, such as a leaky jar, sloppage, impurities, in the acid or a short circuit. THE FIRST THING TO DO IS TO REMOVE THE ABNORMAL CONDITION. This done, the cells must be given an overcharge at the finishing rate until the specific gravity has reached a maximum and has entirely stopped rising for eight or ten hours. If, at the end of such an overcharge, the specific gravity is below 1.270 some 1.300 acid may be added. DO NOT ADD ACID AT ANY OTHER TIME, AND NEVER USE STRONG ACID OR VITRIOL.

61. ADDITION OF WATER.

During the charge, water is evaporated, causing a decrease in the amount of electrolyte and an increase in the specific gravity. As the electrolyte should cover the plates by one-half inch, it is necessary to replace this loss with distilled water; never by the addition of acid. It is advisable to replace this evaporation before charging, so that the added water will mix thoroughly with the acid before hydrometer readings are taken. The frequency with which the battery must be filled or "flushed", depends on the temperature and the amount of water evaporated in gassing. The acid must never be allowed to fall below the tops of the separators.

62. CAPACITY.

The capacity of the batteries used in Model 90 is 25½ amperes for six hours, or 153 ampere hours. The capacity will, however, vary considerably under different conditions.

It is less when the battery is discharged at very high rates. It varies with the age of the battery. The battery as shipped out has the rated capacity but when used under ordinary conditions this will increase gradually during the first few months. It will hold this increased rate for quite a long period and then the capacity will slowly drop until the useful life of the battery has expired.

The capacity of a battery is also affected by cold. In extremely cold weather, especially if the car is kept in a cold garage (below freezing) full capacity should not be expected. **By giving the car a warming charge (that is, charging until the battery feels warm to the hand. A charge of fifteen to twenty minutes will usual y accomplish this.) Much greater capacity can be obtained in the cold weather.**

It is always well to remember that temperature figures refer to the battery temperature and not to the weather. The battery compartments in the Detroit Electric cars are designed in such a manner that the batteries retain their heat for a long time.

It is for this reason that cars kept in warm garages and taken off charge just before being used have given very great satisfaction under such severe weather conditions as a protracted period of 40° below zero. If the battery itself had been allowed to reach this temperature, very little mileage could have been obtained.

63. LITTLE USED BATTERIES.

Where electric pleasure cars are operated under conditions calling for a small daily mileage, the batteries must be handled in a somewhat different manner than in service where full mileage is used every day or two.

Many owners average only 5 to 10 miles per day and if a battery is capable of giving 80 miles on one continuous run, these owners find it hard to understand why 80 miles are not obtained on a discharge extending over ten days to two weeks, and why it is harder to obtain full mileage in winter than in summer.

There are two factors which greatly affect the mileage of a battery. These are internal discharge and temperature.

Internal discharge goes on whether a battery is working or not. Although proceeding very slowly, it will ultimately cause even an idle battery to become completely discharged, unless it is compensated for by charging.

Very generally speaking, internal discharge reduces the available mileage per charge by one mile per day. If full mileage is used every two or three days, the reduction in mileage, due to internal discharge, is negligible. On the other hand, if but little mileage is used per day, and the battery is charged every ten days or two weeks, the reduction in the available miles, due to internal discharge, is large enough to be a considerable factor.

Cold weather also reduces the mileage of a battery. If the capacity of a moderately warm battery (70 to 100°) is 80 miles, the available capacity of the same battery at 32° will be only about 60 miles. The loss is only temporary. It is a loss not of actual capacity but of available capacity. An increase of temperature to 70 to 100° will automatically restore the battery to its full capacity.

The following is representative of what may happen in service: Following a full charge a battery is moderately warm (70 to 100°). However, only 20 miles are used in the first three days. Should it be winter time and the car is kept on the street or in an unheated garage, the temperature of the battery gradually falls to the air temperature. Its available capacity is, therefore, reduced to 60 to 65 miles. The capacity is also reduced one mile per day by internal discharge. After delivering the first 20 miles the car averages one to five miles per day, finally at the end of ten days, fifty miles have been obtained. The battery now shows signs of being completely discharged.

Mileage obtained	50 miles
Mileage lost by low temperature	20 miles
Mileage lost by internal discharge.....	10 miles
Total	80 miles

The figures are only comparative and they will vary with the age of the battery, condition of the roads, etc. The principals, however, are correct.

How can these conditions be corrected? Maximum mileage will be obtained if the discharge is taken within two or three days after the previous charge. Should the discharge extend over a a week, neglecting temperature, the available mileage will be less. Beyond the period of a week, the internal discharge still further reduces the total mileage. Therefore, under normal weather conditions, charge at least once a week if normal mileage is to be expected. When the weather is cold, it may be necessary to modify the above.

A battery when taken off charge is moderately warm (70 to 100°), as much internal heat is generated on the charge. If it is used at once, it keeps warm because some internal heat is gener-

ated even on discharge. Therefore, a battery used immediately following a charge does not have a chance to fall to the air temperature and the mileage is not much reduced. However, if a battery is kept idle overnight in an unheated garage, it may cool down almost to air temperature. If forty miles have been used the first day, the battery will be one-half discharged and will be capable of delivering 40 miles more at 85°. If it cools down to 32° this remaining capacity is automatically reduced from 40 miles to 20 miles. It is therefore desirable in winter to take some steps to insure that a battery is kept moderately warm. Heating the garage will help a great deal. In addition to this or under very severe weather, it is necessary to charge more often. The charging serves two purposes. It keeps the plates charged so that available mileage is always high and by preventing a battery from becoming chilled it prevents temporary loss of mileage which accompanies low temperature.

It is not uneconomical especially when a battery is charged in a private garage—the current instead of being used a great deal at one time as when charging every week or two, is used a little at a time, a number of times during this period, and the total current used over the period is the same.

It is not advisable to allow a battery which is more than two-thirds discharged to stand over night in that condition. It is more economical to current to charge as soon as possible after two-thirds of the capacity has been used, unless the remaining one-third is to be used at once.

It is not advisable to attempt to discharge a battery completely, unless the last third of the charge is to be taken out at one time. If an attempt is made to take out the last third over a period extending over several days, there is danger that the effect of internal discharge or low temperature will reduce the available mileage below the figures expected and that the car will run out of power on the road.

It is necessary to add water occasionally to compensate for the loss of water by evaporation and often enough to prevent the solution level from falling below the tops of the plates.

It is only the portion of the plates covered by solution that give the electrical energy and allowing the solution to fall below the tops of the plates also reduces mileage, besides injuring the plates themselves.

It is also important that overcharging should not be omitted. If a little used battery will be given an overcharge at low current rate every two weeks, it will keep the plates from becoming sulphated. And when not removed the sulphate formed by internal discharge becomes greater the longer the internal discharge is allowed to proceed without interruption. This is due to the fact that the sulphate formed becomes denser and harder to remove by charging the longer it is allowed to remain in the plates.

It is more economical to current to overcharge once every two weeks even when the car is used very little than it is to overcharge once a month, and it is much more economical to overcharge once a month than once in every two or three months.

The following simple rules as to when to charge will serve to keep a little used battery in the best operating condition.

First.—If a battery is not used at all, give it a good freshening charge once a month.

Second.—If a battery is used with a small daily mileage, charge once a week; if full mileage per charge is desired, and even if full mileage per charge is not insisted upon, charge at least once every two weeks.

Third.—In winter, charge more often so as to keep the battery moderately warm. This is to prevent undue reduction of its available capacity by low temperature.

64. IDLE BATTERIES.

If a battery is to be idle for a long period, the following procedure should be followed:

Give battery a regular overcharge before the period of idleness.

After this charge flush cells right up to the covers, to allow for evaporation and absorption of the acid by the plates.

Give battery a freshening charge at the finishing rate once every month.

Give battery a discharge followed by a regular overcharge before putting into regular service again.

After putting into service the capacity may not reach its maximum again unt l after several charges and discharges.

65. WASHING.

The batteries used in 1922 Detroit Electrics have high rib jars and do not require washing during their entire life.

66. CAUTION.

Keep all metals and other impurities out of the battery. Impurities in the electrolyte, even in minute quantities, are very detrimental to the life and capacity of the battery.

Do not use iron buckets for water or acid.

Keep the battery clean—jars, covers, straps, terminals and connectors. It will prevent trouble from leakage and short circuits..

Keep the tray terminals greased with vaseline or oil to protect them from acid.

Keep naked flames away from the battery when charging.

Investigate and repair troubles at once.

67. VEHICLE BATTERY TERMS.

Positive Plate.

Distinguished by dark brown color.

Negative Plate.

Distinguished by gray color.

Straps.

Moulded lead to which the plates are burned to form groups.

Positive Group.

A number of positive plates held together by a strap.

Negative Group.

A number of negative plates held together by a strap.

Wood Separator.

A thin, flat, specially treated piece of wood, sightly larger than the plates, and grooved on one side. The smooth side is placed against the negative plate.

Rubber Separator.

A thin, perforated sheet of hard rubber, which is placed between the positive plate and the grooved side of the wood separator.

Separator Hold-Down.

A rectangular block of wood, placed between the strap and the tops of the separators to prevent the separators from floating and exposing the bottom of the plates.

Element.

A positive and negative group, assembled with separators and hold-downs.

Jar.

Made of hard rubber, and having ribs in the bottom to support the element.

Electrolyte.

A mixture of distilled water and pure sulphuric acid.

Complete Cell.

A jar containing element and electrolyte, and with cover and vent.

Connectors.

Moulded lead strips for connecting the cells

Tray.

Hardwood box or crate with handles, and tray terminals, intc which a number of complete cells are placed.

Connecting terminal.

Metal castings for connecting one tray of cells to another.

Battery.

The total number of complete cells, which, assembled in trays and properly connected, are necessary for propelling a vehicle,

Polarity.

A cross (+) or P indicates Positive; a dash (—) or N indicates Negative.

Gassing.

The bubbling which takes place toward the end of charge due to gases rising through the electrolyte.

68. General.

Do not change adjustments or disarrange parts until you are sure they are at fault. Study the symptoms, and if the fault cannot be located consult the nearest Detroit Electric dealer or write the factory.

The following is intended simply as a key to aid in locating trouble. For further information, see Parts Three and Four.

96. Car Will Not Run at ALL; Voltmeter Needle Drops to Zero.

(a) The trouble is in the battery or battery wiring.

(b) See that the battery is properly connected and all connections clean and tight.

(c) Examine solution level in all battery cells. Fill, if necessary. Look for cracked or leaky jars where solution is found very low.

(d) Take a pair of pliers and shake each lead battery connector to locate a loose connection or broken pillar post.

70. Car Will Not Run at All; Voltmeter Reads Normally, Ammeter Reads Zero.

(a) Jack up rear wheels.

(b) The trouble is in the controller, cut-out switch, reverse switch, motor or wiring.

(c) See that brakes are released and the cut-out or small pedal all the way back.

(d) Examine all controller fingers to see that they are making good contact.

(e) Examine cut-out switch to see that its fingers are making proper contact.

(f) Examine reverse switch to see that it is making proper contact.

(g) Examine motor to see that the brushes are working freely and making proper contact with the commutator.

(h) Examine the car wiring for breaks or loose connections.

71. Car Will Not Run at All; Ammeter Reading Very High.

(a) Examine breaks to see that they have released properly.

(b) Jack up one rear wheel to see if it can be turned. If it cannot, and the brakes are free, remove the propellor shaft and examine the universal joint, gears and bearings.

72. Car Will Run on First Three Speeds Only.

(a) Look for bad contact at controller finger No. 2 or 3.

(b) Examine battery. See No. 69 (a), (b), (c) and (d).

73. Speed and Mileage Low; Current Draft High.

(a) See that the brakes release properly and do not drag.

(b) Examine the tires to see if they are properly inflated. Make sure they are high efficiency cord tires as distinguished from regular gas car tires.

(c) Make sure the front wheels are properly lined up.

(d) Examine the rear axle and make sure it is filled to the proper height with the correct kind of oil.

(e) Examine all bearings in the driving system and wheels for improper adjustment, wear and lack of lubrication.

(f) This complaint may be due simply to unusual road or weather conditions.

74. Speed and Mileage Low; Current Normal.

(a) Examine solution level in all battery cells. Fill, if necessary. Look for cracked or leaky jars where solution is found very low.

(b) Make sure that all battery trays are properly connected according to the wiring diagram.

(c) Examine the motor commutator to see that it is smooth and clean. See that all the brushes have sufficient tension, are working freely and are not worn too short.

(d) This complaint may be due simply to lack of charge or to a worn-out battery.

75. Car Will Run Forward, But Will Not Reverse.

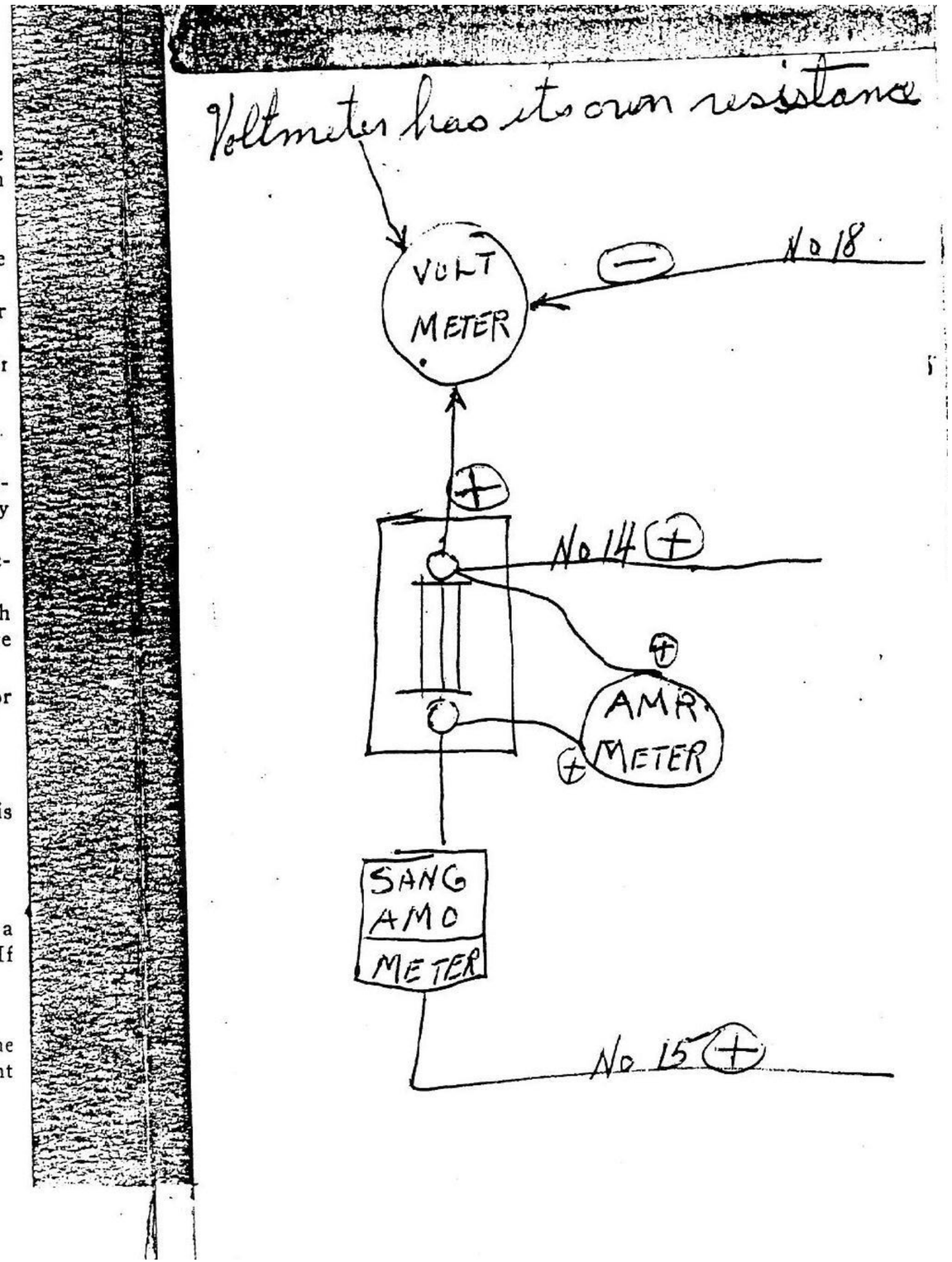
Make sure foot reverse pedal is pushed all the way down and is not held up by the carpet or foreign material.

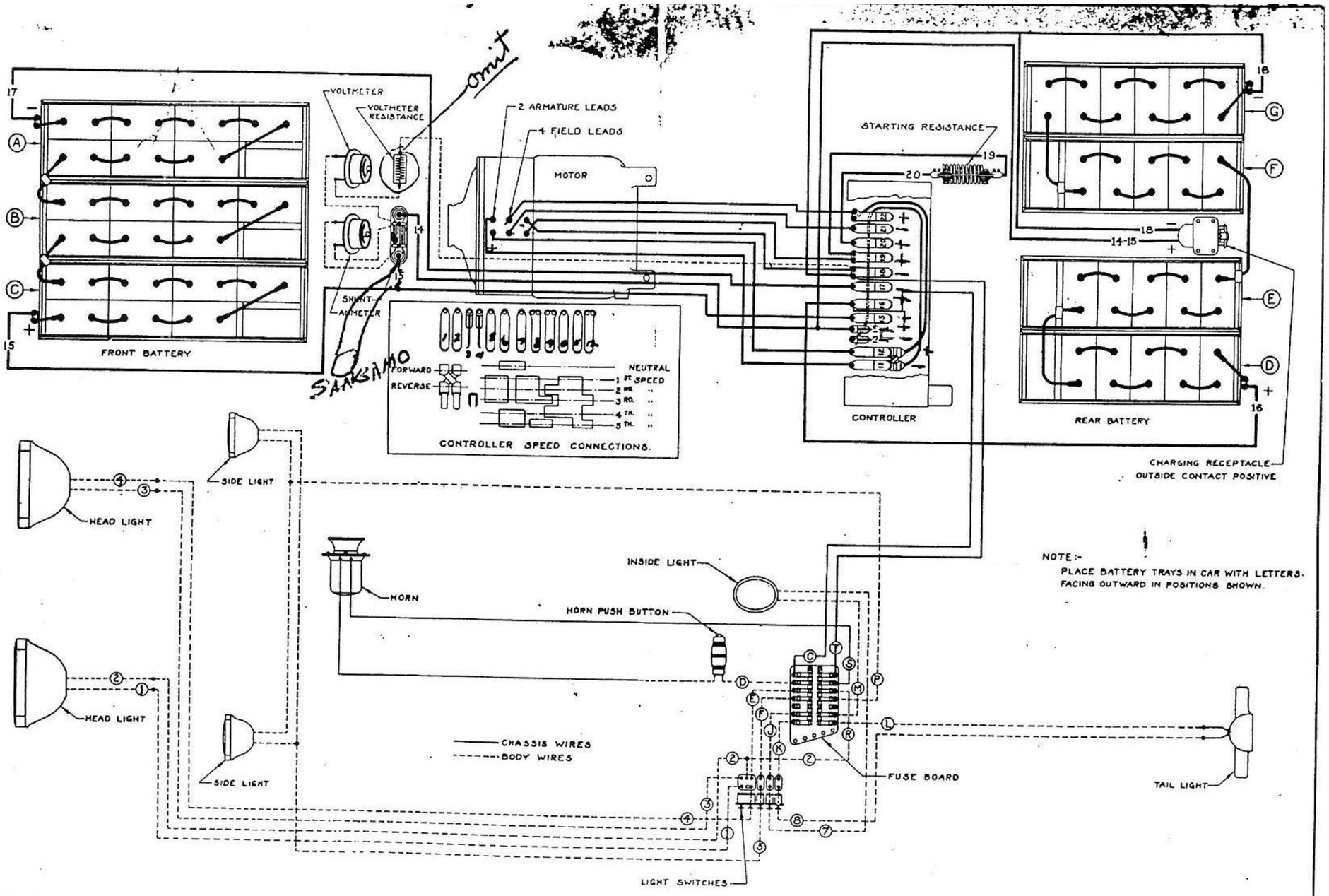
76. Squeaks.

If springs squeak, lubricate between the leaves by means of a spreading tool. If squeak is at the shackle bolt, use oil can. If necessary, remove shackle bolt and clean it.

If body squeaks on the frame, tighten up body-bolts.

If hoods squeak or rattle, oil the hood hold-downs and the springs back of them. Renew the rubber bumpers on the front hood.





WIRING DIAGRAM---POWER AND LIGHTING CIRCUITS
MODEL 90
42 CELLS, 13 PLATE LEAD BATTERY EQUIPMENT
DETROIT ELECTRIC CAR CO., DETROIT, MICHIGAN

THE Detroit ELECTRIC

49215