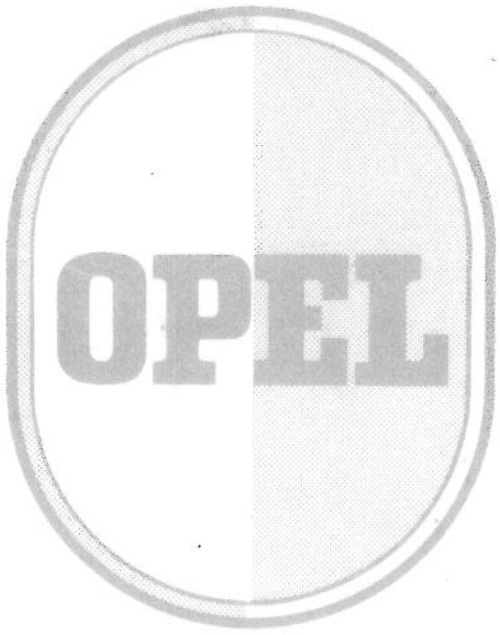

OPEL

ELECTRICAL

OPEL TRAINING MANUAL

STP-70-02

OBJECTIVE — The objective of this manual is to acquaint you with the Opel Electrical System and to set-up testing procedures.

REFERENCE — 1970 Opel Kadett and GT Service Manual and Opel Service Bulletins.

TABLE OF CONTENTS

EQUIPMENT NEEDED –

1 – Voltmeter
1 – Ammeter
1 – Ohmmeter
1 – Test Light
1 – Continuity Light
1 – Opel Kadett

Electrical Training Manuals

Work should be done on the car.

SECTION I

INTRODUCTION

A. BASIC PRINCIPLES OF ELECTRICITY

1. Matter consists of atoms. Atoms are made up of positive charges – protons – and negative charges – electrons.

2. In some materials – called "conductors" – the electrons are "free" to move from one atom to another when electrical pressure – voltage is applied. Voltage is measured in volts.

3. The movement of electrons through a conductor resulting from the application of a voltage is called an electric current. The greater the voltage, the more electrons flow, and the greater is the current. Current is measured in amperes.

4. For simplicity the direction of flow of an electric current is usually considered to be from the positive terminal of battery or generator, through the circuit, and back to the negative terminal.

5. All conductors resist the flow of current to some extent, some more than others. This resistance is measured in ohms. The resistance of a conductor depends on:

   a. Material. Some materials have greater resistance than others (copper, silver, aluminum, iron are good conductors.)

   b. Length of conductor. The longer the conductor, the greater the resistance.

   c. Size (cross section) of conductor. The smaller the cross section, the greater the resistance.

   d. Temperature of conductor. An increase in temperature usually increases resistance.

6. The voltage drop across any circuit element is directly proportional to its resistance and the current flowing through it. Ohm's Law explains the interaction of voltage (E), current (I), and resistance (R), in any closed electrical circuit.

   Volts = Current times resistance $E = IR$

   Knowing any two values, it is possible to figure the third item.

$$\text{Ohms} = \frac{\text{VOLTS}}{\text{AMPS}} \qquad R = \frac{E}{I}$$

$$\text{Amps} = \frac{\text{VOLTS}}{\text{AMPS}} \qquad I = \frac{E}{R}$$

7. Magnetic fields have a north pole and a south pole. The unlike poles of magnets attract each other. Like poles repel each other.

8. A current flowing through a wire or a coil of wire creates an electro-magnetic field around the wire or coil.

ELECTRICAL TERMS AND SYMBOLS

The volt is a unit of measurement of electrical pressure. The higher the voltage, the higher the pressure and the more work that can be done by this voltage. Automobile battery voltage is either 6 or 12 volts. All single cell batteries, such as flashlight batteries are 1-1/2 volts. These are sometimes connected end to end, in series to obtain higher voltages.

The ampere is a measurement of electrical quantity. When electricity is used to perform work such as running a motor of lighting a bulb, there is a flow of current which is measured in amps. A heater motor may use as much as 30 amps., a small light bulb may only use 3 amps.

The ohm is a unit of measurement of electrical resistance. All conductors of electricity offer some resistance to the pressure of voltage in a circuit. Carbon offers more resistance than copper and glass has so much resistance that it is considered an insulator, not a conductor.

SYMBOL

The amount of resistance in a circuit is measured with an Ohmmeter.

The condenser, also called a capacitor, is used in the ignition circuit. It is connected across the contact points to reduce arcing at the points by providing a storage place for electricity as the points open.

A coil is made up of a number of turns of wire in a spiral form used for electro-magnetic effect such as in relays or solenoid or used for magnetic induction such as in the ignition coil.

SHORTS, GROUNDS, OPENS

These three terms are as confusing among mechanics as any terms in the automotive service industry.

SHORTS

A short in an electrical circuit means that a part of a circuit is bypassed or wires of separate circuits have become connected due to a lack of insulation between the circuits. For instance, if a switch is defective so that the circuit is completed through it all the time, we would say the switch is shorted. The switch has no effect on the circuit, regardless of how we move it, so it is bypassed. It is also possible for us to have a short in a unit and yet the unit will still operate to some degree. Suppose 50 turns are shorted out in an ignition coil. This means that the insulation is gone on these 50 turns so they are actually acting like one turn. This will cause the coil to draw more current since the total resistance of the coil is now less. This could result in damage to other components of the ignition system due to the extra current they are now being required to carry because of the shorted coil. If we have two circuits shorted together, it would mean that the operation of one circuit could cause another circuit to operate.

GROUNDS

A ground exists in a circuit any time the wire in a circuit comes in contact with the frame, body, or other metal parts of the car. An example of this would be if the feed wire for the courtesy lamps were making contact with the roof panel at the dome lamp. This would cause the dome and courtesy lamp fuse to blow.

OPENS

An open in a circuit is a break in continuity. This can be caused by a broken wire, burned out lamp filament, disconnected wire or blown fuse. Anything that breaks the current flow is an open. When we operate a switch to turn off lamps in a circuit, we are creating an open in the circuit.

GENERAL PROCEDURE – CIRCUIT DIAGNOSIS

When a circuit failure is encountered, a systematic approach to the problem should eliminate unnecessary time loss. Listed below is a general pattern which will apply to most conditions even though the sequence may vary.

LOCATING OPEN CIRCUITS

1. Turn on ignition switch as well as switch that operates the unit.

2. If it is a fused circuit, check the fuse with a test lamp from ground to fuse clip (fuse installed). No voltage (on feed side) indicates an open circuit in the feed wire to the fuse. If there is no voltage in the load side (with voltage on feed side) the fuse is burned out. Naturally, if a new fuse burns out, there is a short or ground in the circuit which must be corrected.

3. If the feed wire to the inoperative unit is accessible, use a test lamp to determine if the open circuit is toward the unit or toward the fuse.

4. Refer to circuit diagram and determine what other units in the same circuit do not operate.

5. From the circuit diagram you can localize the open circuit. The two body harness plugs provide a convenient spot for checking voltage supplied to many units.

LOCATING SHORTED OR GROUNDED CIRCUITS

1. In locating a short or grounded circuit some method of limiting current flow must be used, such as, a circuit breaker connected across the fuse block so that current flow will be low enough to prevent burning of wires.

2. Circuit Check J-8681 provides an excellent means of locating a shorted circuit.

3. To use J-8681 remove fuse from defective circuit and attach lead wires from J-8681 to fuse terminals.

4. Close all switches in circuit.

5. Intermittent clicking in the J-8681 case indicates a complete, grounded circuit. Open circuits cannot be traced with J-8681.

6. Move meter from fuse block along the path of the defective circuit. At each click of circuit breaker J-8681, the meter will deflect substantially. Following the circuit, when the meter deflection stops or reduces, you have passed the ground. Note: Keep meter as close to circuit as possible because deflection decreases as distance from the circuit increases.

7. Frame or body metal to which the circuit is grounded will carry current in varying directions often cuasing slight meter action but it will always be less than that in the circuit ahead of the ground.

LOCATING SHORTED GROUND CIRCUITS

This type of short circuit results in the lamps staying on because the switch wire (ground wire) is shorted to ground on the unit side of switch.

1. First study the circuit and determine which of the switches could be shorted. Then check each one by removing each wire to the switch. If the light goes out, the short is in the switch. If light remains on, proceed with following steps.

2. Remove the proper wire (dome or courtesy lights) from one of the switches and connect it to J-8681 Circuit Check lead.

3. Make sure the other switches in the circuit are not on. This will prevent possible damage to the switch.

4. Connect the other lead of the Circuit Check to a hot terminal.

5. Use the meter to localize the short.

B. BASIC TOOLS

VOLTMETER

When in use, the voltmeter is placed in parallel with the circuit load. Therefore, it is necessary that we use an extremely high resistance so that the current draw of the circuit will not be increased. In this manner, the current draw of the circuit is not appreciably changed, and the voltage reflected on the metal dial is the true voltage in the circuit. For these reasons, it is important that the voltmeter always be connected in parallel with the circuit load. Otherwise, because of the high resistance valve of the meter, there will be no current flow and, therefore, no voltage indicated in the circuit.

AMMETER

Since the ammeter has a very low resistance, it must always be connected in series with the circuit. The ammeter must never be connected in parallel with the circuit or directly across a source. If this is done, the ammeter will be subjected to extremely high currents and be destroyed. Because the resistance of the ammeter is so low, placing it into a circuit does not introduce any appreciable change in current; allowing an accurate measurement of the current.

OHMMETER

The ohmmeter is used to measure resistance. When the ohmmeter is connected to a resistance, the current flowing through the coil is directly relative to the value of the resistance. The meter scale is calibrated so that it shows the actual resistance of the device in ohms. Because of the construction of the ohmmeter, it is imperative that an ohmmeter never be connected to an external voltage source. This could seriously damage or permanently ruin the meter movement.

CONTINUITY LIGHT

A continuity light is used to check for grounds, opens, and shorts. It can also be used to check for excessive resistance. A continuity light has its own power source. This light must never be used with power running in the circuit.

To use a continuity light connect the lead wires across the desired circuit. If the light lites, the circuit is good. If the light does not light there is a ground, open, or a short in the circuit. If the light glows dimly, there is excessive resistance in the circuit.

TEST LIGHT

A test light can be used to check for grounds, opens, or shorts. It operates by power through the circuit. To use a test light, connect one lead to ground and connect the other lead to the desired circuit being tested. If the light lites, power is present in the circuit. If the light does not lite, no power is present.

SECTION II

STARTING SYSTEM

A. COMPONENTS

There are four (4) major components in the starting system. They are:

1) Ignition switch
2) Battery
3) Starting solenoid
4) Starter motor

The starter is a brush type series wound electric motor equipped with an over-running clutch and operated by a solenoid. The field frame is enclosed by the commutator end frame and the drive housing and carries the pole shoes and the field coils. The armature has a spline on the drive end which carries the over-running clutch and pinion assembly. The armature shaft is supported in sintered bronze bushings in the commutator end frame and the drive end housing. These bushings are packed with lubricant during initial assembly and require no additional lubrication between overhaul periods.

As the starter is operated by turning the ignition switch on the instrument panel, the shift lever is moved against spring tension. By means of the guide ring, the shift lever moves the pinion into mesh with the flywheel ring gear.

After the pinion meshes with the flywheel ring gear teeth, the solenoid contact disc closes the circuit and the engine is cranked. When the engine starts, the speed of the rotating flywheel causes the pinion to over-run the clutch and armature. The pinion continues to be engaged as long as the shift lever is kept in the cranking position.

The lead-acid storage battery used on automotive applications is an electrochemical device for converting chemical energy into electrical energy. It is not a storage tank for electricity as is often thought but actually stores energy in chemical form. The replacement battery for Opel is the Delco Y-55 battery.

Active materials within the battery react chemically to produce a flow of direct current whenever lights, radio, cranking motor, or other current consuming devices are connected to the battery terminal posts. The current is produced by chemical reaction between the active materials of the plates and the sulfuric acid of the electrolyte.

The battery performs three functions in automotive applications. First, it supplies electrical energy for the cranking motor and for the ignition system as the engine is started. Second, it intermittently supplies current for the lights, radio, heater, and other accessories when the electrical demands of these devices exceed the output of the generator. Third, the battery acts as a voltage stabilizer in the electrical system. Satisfactory operation of the vehicle is impossible unless the battery performs each of these functions.

B. TESTING

BATTERY TESTING

Check outside of battery for damage or signs of serious abuse such as broken case or covers. Check electrolyte level. If electrolyte level is low, bring it up to the split ring by adding distilled water. If battery shows signs of serious damage or abuse, it should be replaced.

421 BATTERY TEST

The 421 Battery Test uses an open circuit battery terminal voltage to determine battery condition. Open circuit voltage is the measurable battery characteristic least affected by temperature, ampere hour capacity or state of charge. The test can be made even though the electrolyte level is below the top of the plates. This test is based on a comparison of two voltage readings. The first reading is taken 5 seconds after the energizer has been discharged at a 50 ampere rate for 15 seconds. The second reading is taken 15 seconds after the energizer has been charged at a 15 ampere rate for 45 seconds. The tester compares the two readings and indicates whether or not the energizer is good.

Instructions on test procedures are printed on your particular make of 421 battery or energizer tester. Many 421 testers incorporate a medium rate (15-20 ampere) battery charger. This feature is beneficial when the test reveals that an energizer is good but needs charging, since all that is required is to flip a switch or turn a knob.

HYDROMETER

The hydrometer measures the percentage of sulphuric acid in the battery electrolyte in terms of specific gravity. As a battery drops from a charged to a discharged condition, the acid leaves the

solution and enters the plates, causing a decrease in specific gravity of electrolyte. With a hydrometer, an indication of the concentration of the electrolyte is obtained.

The specific gravity of the electrolyte varies not only with the percentage of acid in the liquid, it also varies with temperature. As temperature increases, the electrolyte expands so that the specific gravity is reduced. As temperature drops, the electrolyte contracts so that the specific gravity increases. Unless these variations in specific gravity are taken into account, the specific gravity obtained by the hydrometer may not give a true indication of the concentration of acid in the electrolyte.

Correction can be made for temperature by adding .004, usually referred to as 4 "points of gravity", to the hydrometer reading for every 10°F. that the electrolyte is above 80°F. or subtracting .004 for every 10°F. that electrolyte is below 80°F.

When using a hydrometer, observe the following points:

1. Hydrometer must be clean, inside and out, to insure an accurate reading.

2. Hydrometer readings must never be taken immediately after water has been added. The water must be thoroughly mixed with the electrolyte by charging for at least 30 minutes before hydrometer values are reliable.

3. If hydrometer has built-in thermometer, draw liquid into it several times to insure correct temperature before taking a reading.

4. Hold hydrometer vertically and draw in just enough liquid from battery cell so that float is free floating, and with bulb fully released. Hold hydrometer at eye level so that float is vertical and free of outer tube, then take reading at surface of liquid. Disregard the curvation where the liquid rises against float stem due to surface tension.

5. Avoid dropping liquid on car or clothing as it is extremely corrosive. Any liquid that drops should be washed off immediately with soda solution.

NOTHING HAPPENS WHEN START ATTEMPT IS MADE

1. If engine starts in any selector position other than "neutral" or "park", neutral start switch is not properly positioned and adjustment of the switch is required. If nothing happens, proceed to next step.

2. Turn on headlights or blow horn. Feel battery cable clamps at battery posts immediately after a starting attempt.

   If lights are bright or horn blows normally, or no heat is felt at cable clamp after starting attempt, proceed to Step 5.

3. If lights are dim or do not light or if car horn does not blow with usual loudness and either of the battery post-to-cable clamp connections is hot, a bad connection is indicated. Make sure that battery posts and cable connectors are clean and the connectors fit tightly with metal-to-metal contact at the battery posts.

NOTE: A high resistance connection at the battery posts could have made battery charging extremely difficult, therefore the battery state of charge should be checked and battery recharged, if necessary.

4. If the lights are dim or do not light or if the horn does not blow with usual loudness and battery post-to-cable clamp connections are clean, tight and not over heated, check the battery to see if it is worn out, defective, or discharged.

   NOTE: A discharged battery may indicate a charging circuit problem.

5. Check voltage at starter solenoid "start" (S) terminal. Voltmeter should be connected between this terminal and the starter frame with the key in "start" position.

   CAUTION: Pedal on Manual Gear-Shift Cars Must Be Fully Depressed Or The Shift Lever In "Neutral" Or "Park" Position On Automatic Transmissions.

   If voltage is "zero", check circuit for wiring continuity or faulty switches – (Ignition, neutral start, or clutch start switch).

6. If voltage is less than 7 volts (and battery is good and in a healthy state-of-charge), check complete starter and solenoid circuit for loose connections. This includes the starter frame-to-engine connection and engine block-to-ground strap connection.

7. If voltage is 7 volts or more, remove and repair starter.

SOLENOID SWITCH CLICKS BUT STARTER DOES NOT TURN

1. Check the voltage between solenoid "motor" terminal and starter frame with key in "start" position.

2. If voltage is 9 volts or more, remove and repair starter.

3. If the reading is less than 9 volts, check battery and its state of charge. Recharge if necessary.

4. If the reading is less than 9 volts and battery is O.K., check for loose or corroded connections between the battery post and the starter solenoid. Check ground cable to see that it is clean and tight.

5. If the reading is less than 9 volts and the battery is O.K. and all wiring and connections are proper, remove and repair starter.

SOLENOID SWITCH PUMPS IN AND OUT

1. Connect a voltmeter between solenoid start ("S") terminal and the starter frame with key in "start" position.

2. Voltmeter needle will oscilate. If the lowest reading is below 7 volts, check condition of battery and its state of charge. Replace or recharge, if necessary.

3. If lowest reading is below 7 volts and battery is O.K., check for clean and tight wiring connections between battery and solenoid. Also, engine ground strap connection should be checked.

4. If lowest reading is 7 volts or more, remove and repair starter.

STARTER KEEPS RUNNING AFTER KEY IS RELEASED FROM "START" TO "RUN" POSITION

1. Turn key "off".
2. If starter stops, replace ignition switch (key lock, linkage, or ignition switch on column-mounted units).
3. If starter continues to run, remove battery cable. Then remove and repair starter.

STARTER SPINS AND/OR MAKES LOUD GRINDING NOISE BUT DOES NOT TURN ENGINE

1. Remove and repair starter. Examine ring gear for damage.

SLOW SLUGGISH CRANKING

Check for:

1. Loose or corroded cables and corroded battery posts.
2. Discharged battery.
3. Old, worn out, low capacity battery.
4. Correct capacity of battery.
5. Battery cables of proper size.
6. Engine oil of improperly high viscosity, particularly in cold weather.
7. Defective starter.