GROUP 1

ELECTRICAL

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BATTERY AND CABLES

ALL MODELS

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DESCRIPTION AND OPERATION

GENERAL BATTERY INFORMATION

Registration of Battery

United-Delco Battery dealers and distributors are prepared to carry **out** terms of the manufacturer's warranty on Delco-General batteries. In order that Opel owners shall have the protection and benefit of this warranty, it is necessary for the dealer or car owner to register his battery with the local United-Delco **Battery** dealer or distributor on all new car deliveries, and on all deliveries of new replacement Delco batteries. The Battery Owner's Certificate is located in the Owner's Protection Plan Booklet..

Care of Wet Batteries in Storage

Batteries in stored new cars, as well as batteries, in stock, must be given regular attention to prevent sulphation of plates that may result from inactivity and self-discharge. All automotive wet batteries will slowly discharge on standing idle, whether in stored vehicles or in stock, and will self-discharge much faster when warm than when cold. *Batteries in stock should be rotated and the older ones used first.*

To minimize the extent of self-discharge always store batteries fully charged and in a cool place where the temperature does not go below freezing. Every 30 days check the level of electrolyte, add water as required and charge the batteries at a 5 ampere rate until fully charged.

Batteries used for display purposes or standing in cars in storage must be treated in the same manner as batteries in stock.

When a new car, or a new replacement battery is delivered, make certain that it is fully charged and the electrolyte is at proper level. This is extremely important because the delivery of a partially discharged battery may not only lead to its **return** for charging but may also result in shortened life of battery.

Importance of Maintaining Electrolyte at PROPER Level

Water is the only component of the battery which is

lost as the result of charging and discharging, and it must be replaced before the electrolyte level falls to the tops of the separators. If the water is not replaced and the plates become exposed, they may become permanently sulphated, which would impair the performance of the plates. Also, the plates cannot take full part in the battery action unless they are completely covered by the electrolyte.

Importance of Keeping Battery Properly Charged

The battery has three major functions: (1) It provides a source of energy for cranking the engine. (2) It acts as a stabilizer to the voltage in the electrical system. (3) It can for a limited time furnish energy when the demand: of the electrical units in operation exceed the output of the generator.

In order for the battery to continue to function, it is necessary that current withdrawal from the battery be balanced by current input from the generator so that the battery is maintained in a properly charged condition. If the outgo exceeds the input, the battery will become discharged so that it cannot supply sufficient energy.

The state of charge of the battery as well as the temperature of the electrolyte has an important bearing on its capacity for supplying energy. Battery efficiency is greatly reduced by decreased electrolyte temperature as it has a decided numbing effect on its electrochemical action. Under high discharge such as cranking, battery voltage drops to lower values in cold temperatures than in warm temperatures.

In extremely cold climates it is important to keep batteries in a nearly full charged condition to avoid the possibility of freezing, which will damage any battery!

The following table shows the temperatures at which freezing will occur in electrolytes of *different densities, with specific gravity corrected to 80 degrees F.*

Specific Gravity	Freezing Point
1.220	-35 degrees F.
1.200	-35 degrees F.
1.160	0 degrees F.

Care of Dry Batteries in Storage

A "dry charge" battery contains fully charged positive and negative plates but no electrolyte.

Dry charged batteries should be stored in a dry place away from excessive heat. A dry charged battery should be kept in its original carton until ready to be put into service. This type of battery will retain its "charged" condition indefinitely if protected from moisture. Dry batteries may be stacked in vertical columns provided they are not stacked more than four high.

Preparing Dry Charged Batteries For Service

To prepare "dry charge" batteries for service use approved battery-grade acid electrolyte (1.265 sp. gr. at 80 degrees F). Care should be exercised in its use to prevent bodily injury or damage to clothing or other material resulting from actual contact with the electrolyte.

Electrolyte should be added to dry charged batteries in an area where water is readily available for flushing in case the electrolyte comes into contact with the body. Refer to instructions on side of electrolyte container for antidotes to use if electrolyte comes into contact with the body.

It is strongly recommended that a person filling batteries with electrolyte wear glasses (preferably safety glasses) to prevent possible damage to the eyes should any spattering of the electrolyte occur.

1. Remove dry charged battery from its original carton.

2. Remove the vent plugs.

3. Using a glass or acid-proof plastic funnel, fill each battery cell with electrolyte. ***Do not use a metal funnel for filling the battery.*** The cell is properly tilled when the electrolyte level rises to the split ring at the bottom of the vent well. Do not overfill or underfill. Overfilling will cause acid corrosion in the battery area; underfilling will cause early battery failure.

4. After tilling cells, wait five to ten minutes and add additional electrolyte, if necessary, to bring the electrolyte to the proper level.

5. Never finish tilling a dry charge battery with water. If electrolyte is spilled, more electrolyte must be obtained.

Test After Batteries are Prepared For Service

The Delco Dry Charge Battery may be put into service immediately after activation. However, to insure good battery performance, the following activation tests are recommended:

1. After adding electrolyte,, check the open circuit voltage. Less than 10 volts indicates a reverse cell or an open circuit and the battery should be replaced.

2. Check the specific gravity of all cells. If the specific

gravity corrected to 80 degrees F.' shows more than a thirty point (.030) drop from the initial tilling with electrolyte, or if one or more cells gas violently after addition of electrolyte, the batteiy should be fully charged before use.

3. For best performance in cold weather (32 degrees F. or less), or if the battery and the electrolyte are not at 60 degrees F., or above at time of activation, warm the battery by boost charging.

TROUBLE DIAGNOSIS

BATTERY AND CABLES. TROUBLE DIAGNOSIS

Quick Check of Battery and Cables

Whenever electrical **trouble developes,** it is desirable to make a quick check of the battery and cables to make certain that this source of current is in good condition, securely connected, and is functioning properly. This check will also give a good check on the cranking system.

1. Turn on the lights. They should burn steadily and with normal brilliance.

2. With lights burnings, operate the cranking motor. Either have the headlights shining on a wall so their brilliance can be noted, or have someone watching the headlights.

3. When cranking motor solenoid switch is closed, one of the following conditions will occur; (1) Lights will stay bright or will dim slightly if temperature is cold, and engine will be cranked at normal speed; (2) Lights will go out; (3) Lights will dim considerably; (4) Lights will stay bright but no cranking action will take place. The first named condition indicates that nothing is wrong with the battery, cables, and cranking system. The other conditions indicate trouble as follows:

4. If *lights go out* as cranking motor solenoid switch is closed, it indicates a poor connection in the circuit between battery and cranking motor. Check battery cables and clean and tighten loose or corroded terminals.

5. If lights dim considerably as cranking motor solenoid switch is closed, it indicates that the battery is run down, or there is a condition in cranking motor or engine which causes an excessive current drain on the battery. A **low battery** will be indicated by ,a clattering noise in cranking motor solenoid because the battery cannot sustain the voltage required to hold solenoid plunger "in" after switch contacts close and the "pull in" winding is shorted out.

Test battery with a 421 Battery Test. If battery is found to be in good condition check cranking motor.

6. If lights stay bright but no cranking action occurs when cranking motor solenoid switch is closed, it indicates an open circuit in cranking motor, switch, or control circuit.

Testing Resistance of Cables and Terminal Connections

Battery **cables** and terminal connections may be tested with equipment comprising of a voltmeter (5 volts maximum), ammeter of 300 or more amperes capacity, and carbonpile rheostat having a minimum capacity of 300 amperes connected in series with the ammeter.

1. Adjust rheostat to provide maximum resistance ("OFF" position).

2. Connect ammeter positive lead to post on starting motor. Connect ammeter negative lead to one side of rheostat and connect other side of rheostat to ground on engine, preferably at point where battery ground strap is attached. In the instrument shown in Figure 1A-1, the ammeter and rheostat are connected in series inside the case.

3. Connect voltmeter negative lead to post on starting motor. Use prod with voltmeter lead, if necessary, to insure direct contact with the terminal stud. ***Do not connect to the ammeter lead clip.*** Attach a prod to voltmeter position lead and apply the prod to center of battery positive post (Figure 1A-1.) Make sure that clips of voltmeter leads have clean metal contact with prods.

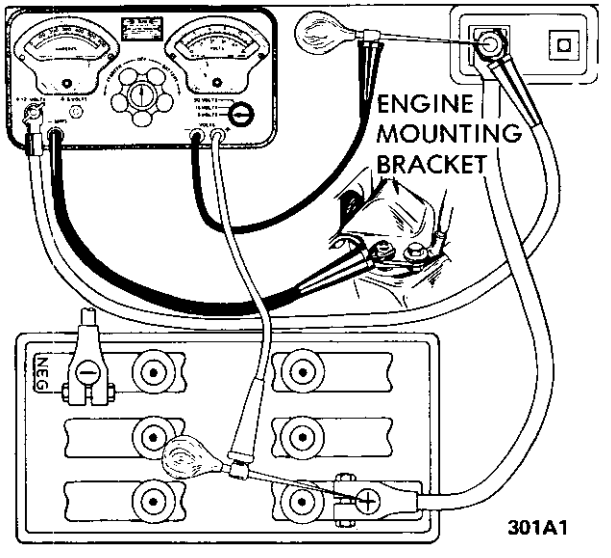

Figure 1A-1 Battery Cable Test Connections

4. Adjust rheostat until ammeter reads 200 amperes, immediately read voltmeter, then turn rheostat to starting ("OFF") position to avoid excessive drain on **battery.** Voltage drop across battery positive cable

and terminal connections should not exceed 2/10 volt.

5. Connect voltmeter positive lead to ground on engine. Attach prod to voltmeter negative lead and apply prod to *center* of battery negative post. Voltage drop across the battery ground cable and terminal connections should not exceed 2/10 volt at 200 amps.

6. A reading in excess of 2/10 volt when testing either battery cable indicates excessive resistance in cable or connections. Clean and tighten cable or connections. Clean and tighten cable terminals (subpara. c, below) and recheck for voltage drop. If voltage drop still exceeds 2/10 volt, replace cable with a genuine Buick-Opel cable to insure ample capacity.

Undercharge Failure of Battery

The most frequent trouble experienced with storage batteries is failure to maintain a state of charge sufficient to crank the engine and also furnish current to the ignition system, lights and accessories. Failure to maintain a proper state of charge may be due to one or more of the following conditions:

1. *Operating Conditions.* When determining cause of premature failure of a battery, consideration must be given /to the conditions under which the car is operated.,

In very low temperatures the capacity of a storage battery is considerably reduced and the energy required for cranking the. engine is considerably increased.

Frequent starting, particularly in cold weather, accompanied by short runs may take more energy from the battery for cranking than the generator can replace in the limited running time. This condition is aggravated by night driving when lights are turned on, or by operation of an air conditioner in heavy traffic.

When the car is operated under these conditions, adjusting the voltage regulator to the high limit may allow enough increase to keep the battery at a safe state of charge. If the high limit setting does not maintain a safe state of charge, an occasional booster charge should be given to the battery.

2. *Low* charging *Rate.* In case of premature battery failure, tbe charging rate of alternator should always be checked and adjusted if below specifications.

3. Internal Condition The internal condition of the battery niay be such that it cannot hold a charge satisfactorily. Check electrolyte level and test the **battery** using the 421 Battery Test.

Overcharge Failure of Battery

A common cause of battery failure is overcharging, that is, continued input of excessive charging current after the battery has reached a fully charged condition.

One evidence that battery is being overcharged is the need for frequent addition of water to the battery in order to maintain the electrolyte level above the tops of the battery separators, since overcharging causes rapid water loss. When this becomes evident, the charging rate of alternator should be immediately checked, as well as the voltage regulator, and adjusted to avoid internal damage to battery.

ADJUSTMENTS AND MINOR SERVICE

PERIODIC BATTERY INSPECTION AND SERVICE

The battery requires very little attention, but periodic inspection is essential to secure the maximum efficiency and life. The following services are essential to maintain the battery at maximum efficiency.

WARNING: ***Never expose battery to open flame or electric spark - battery action generates hydrogen gas which is flammable and explosive. Do not allow battery fluid to contact skin, eyes, fabrics or painted surfaces - fluid is a sulfuric acid solution which could cause serious personal injury or property damage. Wear eye protection when working with battery.***

Maintain Electrolyte Level

Add distilled water as required to maintain the electrolyte level at the split ring at bottom of tiller well. See Figure IA-2.

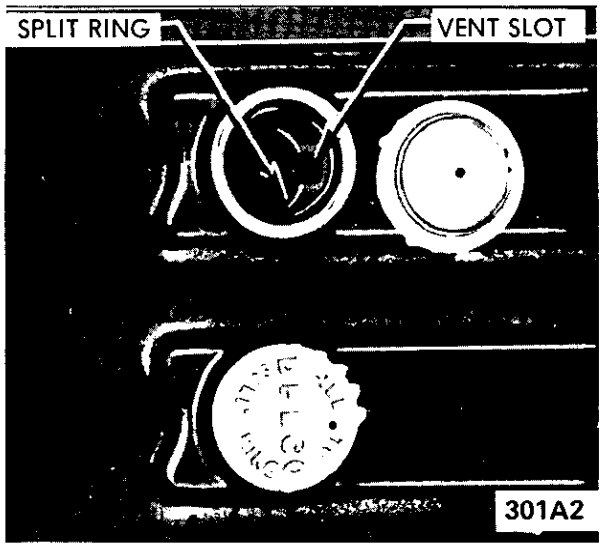

Figure 1A-2 Battery Filler Well

Do not overfill, as electrolyte may be sprayed out by gassing or may overflow due to heat expansion during charging.

If distilled water is not available, it is better to add clean, mineral-free tap water than to allow the electrolyte level to remain below the top of the plates.

In freezing weather the water should be added just before using the car or otherwise charging the battery so that the water will be mixed with the acid before it is allowed to stand in freezing temperatures.

If it is found necessary to add water to the battery more frequently than about every 1,000 miles and the quantity of water added per cell is' excessive, check setting of voltage regulator and adjust, if necessary: Abnormal water loss is an indication that the battery is being overcharged.

Inspect Battery, Mounting and Cables

Check outside of battery for damage or signs of serious abuse such as broken case or broken covers: Check inside of battery by removing the vent caps and inspecting for signs of abuse such as electrolyte level too low to see, or bad or unusual odors. If battery shows signs of serious damage or abuse, it should be replaced.

Check the battery hold down bolts to make certain that battery is securely held in place. The nut should be drawn up to 20 lbs. in.; *excessive tightening* may ***distort or crack the battery case.***

If the top of battery is dirty or the hold down strap is corroded, clean thoroughly with a brush dipped in ammonia or soda solution. Care must be used to prevent any solution from getting into battery cells. After the foaming of solution stops, flush off with clean water and dry thoroughly. If hold down strap is corroded it should be painted with acid-resisting paint after cleaning.

Check battery cables to make certain they are tight at bracket and junction block. If a connection is found loose it should be cleaned before being tight; ened as arcing and corrosion may have taken place in the loose connection. Check condition of cables and replace if badly corroded or frayed.

Special attention must be given to the battery positive cable position to eliminate the possibility of contact with the exhaust manifold on the 1.1 liter engine. The cable clamp must be rotated clockwise as necessary for the cable to run at a 45 degree angle toward the right wheelhouse panel.

Cleaning Cable Terminals

If loose connections are found by inspection, or high resistance is found by voltage test, disconnect the cable for thorough cleaning of terminals. When removing a corroded cable terminal from battery post, do not pry against battery case or hammer on terminal to break it loose, since either practice will result in broken cell covers. Use a screw-type terminal puller if terminal cannot be loosened by hand.

Thoroughly clean all corrosion from disconnected battery cable terminals and terminal posts, using suitable wire brushes. If wire brushes are not available, corroded terminals may be cleaned by brushing with a strong soda solution, using care not to get solution into battery cells.

If cable strands are broken, corroded, or loose in terminals, the cable should be replaced with the correct cable to insure ample capacity.

To prevent corrosion of battery terminals and connections, apply a coating of petroleum jelly over the battery post and cable terminals after cables have been installed on terminals.

421 BATTERY TEST

421 Battery Testers, manufactured and sold by a number of companies, are the only battery testers approved by Delco-Remy Division for testing one-piece cover batteries. They are also used by United Motors Service to determine whether or not a battery is defective.

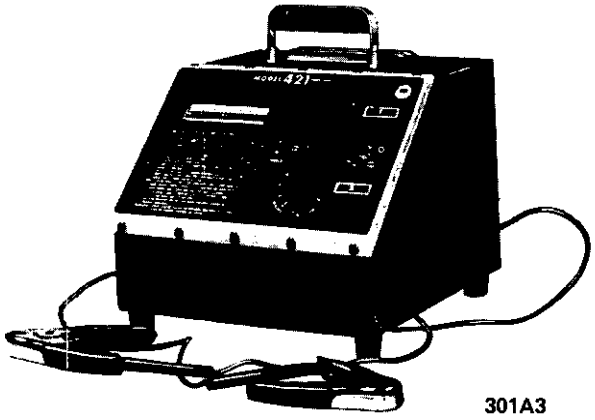

Figure 1A-3 421 Battery Tester-Charger

The 421 Battery Tester shows, in a few minutes, the state-of-charge of the battery and whether it is good or bad. The tester can be used with any 12 volt battery, in or out of the car. The test can be made regardless of the state of charge of the battery; it can also be made when the electrolyte level is low • even below the top of the plates.

421 Test Procedure

1. Visual Inspection - The first step in testing the Energizer or 12-Volt Battery should be a visual inspection which very often will save time, labor and expense in determining the condition.

(a) Check for broken or cracked case or cover.

(b) Check for loose terminal posts.

(c) Check for defective or mutilated sealing compound.

(d) Check for other visible signs of physical damage.

Obvious damage as a result of conditions described above indicates the need for Energizer or battery replacement.

2. The "421" Test is a programmed test procedure consisting of a series of timed discharge and charge events, requiring approximately 2 to 3 minutes, that will determine the condition of the Energizer or battery with a high degree of accuracy when used in conjunction with this entire test procedure. "421" Testers are produced by a number of different manufacturers and their directions for tester operation should be carefully followed. General comments on overall "42 1" Tester operation follow:

(a) Energizers or batteries ***should not be charged*** prior ***to making this test.*** Defects within the unit can be hidden by the charging and erroneous test results will be obtained.

(b) Erratic, or extremely low, initial meter readings may indicate poor connections at the tester terminals. ***Obtain clean and tight connections before performing the 421 Test.***

(c) All meter readings should be made ***immediately*** after the meter indicator light comes on even if the meter needle is still moving.

(d) If additional discharges are required after the initial discharge, set meter indicator following the *last* discharge cycle.

(e) Batteries designated as "bad" by the tester should be replaced.

(f) Batteries designated as "good" with no owner's complaint or indication of poor performance, should be left in service. Posts, cable clamps, and top should be cleaned, water should be added and recharging should be performed, if required. For dependable and reliable battery service, the battery should be in at least a 75 per cent state-of-charge.

(g) Batteries designated as "good" that are suspected of being questionable because of owner complaint, or age of the battery, should be further tested by the Hydrometer Test.

HYDROMETER TEST OF BATTERY

The 421 Battery Test as described in the previous paragraph is the fastest and most accurate means of determining the serviceability of a one-piece cover battery. However, if a 421 Battery Tester is not available, a hydrometer test may be used on a battery that has failed to give proper service.

Hydrometer Test

1. Fully charge battery.

2. Measure specific gravity of each cell as described in sub-paragraph below.

Decide battery serviceability as follows:

(a) If all cells read between 1.230 and 1.310, the battery is okay. All it needed was a full charge.

(b) After fully charging battery, if any cell reads less than 1.230, the battery is defective and should be replaced.

Use of 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 degrees F. that the electrolyte is above 80 degrees F. or subtracting .004 for every 10 degrees F. that electrolyte is below 80 degrees F. Figure IA-4 shows the exact correction figure to use for any temperature above or below 80 degrees F., the three steps used in obtaining the corrected or true specific gravity, and two examples showing how it is figured.

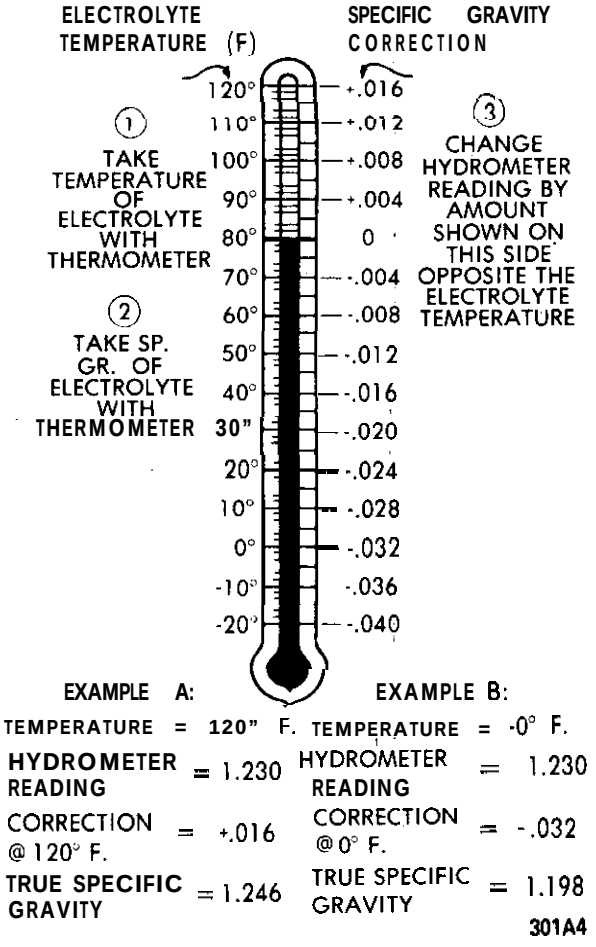

Figure 1A-4 Specific Gravity Temperature Correction Scale

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.

FUSIBLE LINKS

All 1973 Opel Models have fusible links located between the starting motor post and the generator regulator. These links are the weakest point in the electrical supply system for the complete car, and, as such, will act like a fuse for every wiring harness in the car. Every electrical accessory is still protected by a fuse or circuit breaker, of course, but fusible links protect the wiring harnesses ***before*** the fuses.

A fusible link consists of soldering a smaller gauge wire to a heavier gauge wire end to end. In the event of a circuit overload where the heavier gauge becomes short circuited, the fusible link or smaller gauge wire will burn out first, thus, protecting its circuit from major damage. These fusible links are located in the engine compartment in such a manner that if overheated, the possibility of a fire is very remote.

The attachment of the fusible links and the circuits they protect are as follows: See Figure 1A-5.

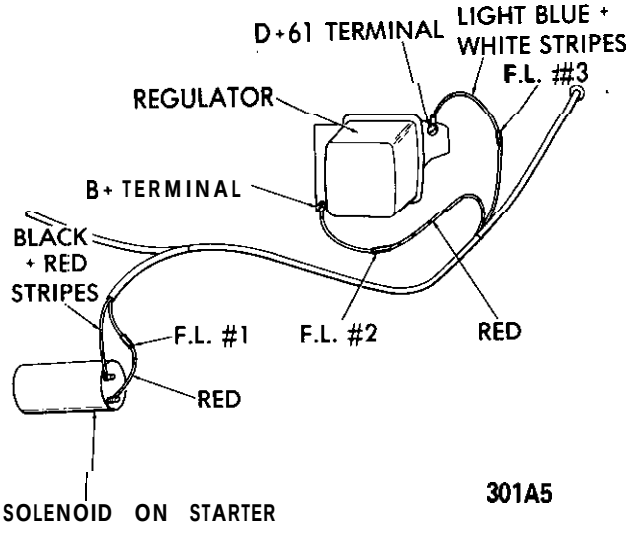

Figure 1A-5 Fusible Links

Fusible link (1) is connected to the starter solenoid at the battery cable terminal, on one end and to the red and white stripped main feed wire at the other end.

Fusible link (2) is connected between the red wire and the terminal of the voltage regulator and protects against a situation where the battery will not accept a charge and the generator is charging to handle various electrical loads. Fusible link (3) is connected between the light blue with white stripes wire and D

plus 61 terminal of the voltage regulator and protects the circuit to the generator telltale light.

BATTERY RECHARGING

There are two separate methods of recharging batteries which differ basically in the rate of charge. In the slow-charge method, the battery is supplied a relatively small amount of current for an extended period of time. In the quick-charge method, the battery is supplied with a high current for a short period of time.

Slow-Charging

Slow charging is the best and only method of completely charging a battery. The slow-charge method, properly applied, may be safely used under all possible conditions of the battery, provided electrolyte is at proper level in all cells. The battery may be fully charged by this method, unless the battery is not capable of taking a full charge. The normal slow charging rate for the 12-volt battery is 5 amperes.

Full charge of battery is indicated when all cell specific gravities do not increase when checked at three intervals of one hour and all cells are gassing freely.

Due to the low rate during slow charging, plenty of time must be allowed. Charge periods of 24 hours or more are often required.

Quick-Charging

Since time is often of most importance to the battery owner, quick-charging must sometimes be used to partially charge the battery so that the engine will start and the owner can be on his way.

Charge at 50 amperes for 20 minutes (50 times 20 equals 1000 ampere minutes). If charger will not give this rate, charge for an equal number of ampere minutes at the best rate available. Too high a current during quick-charging will damage battery plates.

A battery cannot be brought up to a fully charged condition by the quick-charge method. The battery can be substantially recharged or boosted, but in order to bring the battery to a fully charged condition, the charging cycle must be finished by charging at a low or normal rate. Some quick-chargers have a provision for finishing the charging cycle at a low rate so that the battery can be brought up to a fully charged condition.

Used with care, and employing all safeguards provided by the manufacturer, a quick-charger will not damage a battery ***which is in good condition.***

BATTERY REMOVAL AND INSTALLATION

Removal

1. Disconnect battery cables (remove negative cable first to prevent possible shorting).
2. Remove battery hold down bracket.
3. Remove battery.

Installation

1. Place battery back in hold down position.
2. Tighten hold down bracket bolts.
3. Connect battery cables (connect positive cable first to prevent possible shorting).

FUSIBLE LINK REMOVAL AND INSTALLATION

Replace a burned out fusible link as follows:

1. Disconnect battery.
2. Disconnect connector eye on end of fusible link.
3. Cut off other end of burned out link, along with solder joint.
4. Strip insulation from end of new fusible link and from end of wiring harness so that each will slide into soldering sleeve.
5. Crimp new link in soldering sleeve and solder carefully.
6. Cover new connection tightly with electrical tape.
7. Install new link connector eye on other end of fusible link.

A burned out fusible link connected to the starter solenoid would be indicated by:

1. All electrical accessories dead.
2. Starter dead - will not even click. Even with a nearly dead battery, the starter solenoid will generally engage; therefore, no click means no solenoid action, possibly due to a burned out fusible link.

SPECIFICATIONS

BATTERY SPECIFICATIONS

Delco-General 12 volt-44 amp hour storage battery is installed as original equipment. Replace with a Delco Energizer Y55.

STARTING SYSTEM
ALL MODELS

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DESCRIPTION AND OPERATION

STARTING SYSTEM DESCRIPTION

The new Delco Remy starter for 1973 is a brush-type series wound electric motor equipped with an overrunning 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.

TROUBLE DIAGNOSIS

STARTING SYSTEM DIAGNOSIS

In case of cranking motor breakdown, it should be kept in mind that the relevant cause(s) for the trouble may not only lie in the cranking motor itself

but also in the condition of related units, such as battery, switches, electrical **wiring and wiring connections.**

Condition	Possible Cause	Correction
When ignition switch is on, cranking motor locks up or drags.	1. Battery discharged.	1. Charge battery.
	2. Battery defective. Battery terminals loose, corroded or improperly grounded.	1. Test and replace as required. Retighten terminals, clean battery posts and terminals **and** coat them with acid-proof grease.
	3. Cranking motor or brush terminals grounded.	1. Eliminate grounds.
	4. Cranking motor brushes do not rest on commutator, or arc jammed in their guides, worn out, oily or clogged.	1. Check brushes - clean or replace as required. Clean guides on brush-holders.
	5. Ignition switch damaged (loose parts preventing switch from closing or burnt parts).	1. Replace ignition switch.
	6. Solenoid switch damaged.	1. Repair or replace as required.
	7. Excessive voltage drop in wiring switches damaged, connections loose.	1. Check wiring and connections. Repair or replace switches.
The armature revolves but the **drive** pinion does not come into; mesh.	1. Drive pinion clogged.	1. Clean drive pinion.
	2. Drive pinion or ring gear teeth **flattened** or burred.	1. Replace ring gear and overrunning clutch.
	3. Poor condition of shaft splines.	1. Replace **armature** and overrunning clutch.
	4. Voltage drop.	1. Replace shift lever.
When ignition switch is on, armature revolves until drive pinion engages and then stops.	1. Battery discharged.	1. Charge battery.
	2. Brush spring tension too weak.	1. Check brushes - clean or replace as required.
	3. Cranking motor solenoid or switch defective.	1. Replace or repair solenoid or switch.

Condition	Possible Cause	Correction
	4. Voltage drop.	1. Check wiring and wiring connections.
	5. Overrun&g clutch slips.	1. Replace overrunning clutch.
The cranking motor keeps on rotating after ignition switch is off.	1. Ignition switch does not cut off or solenoid switch sticks.	1. Immediately disconnect cranking motor cable from battery. Inspect and/or replace or repair ignition and solenoid switches as required.
The drive pinion does not demesh after engine has been cranked.	1. Drive pinion or ring gear teeth clogged or flattened. Return spring slack or broken.	1. Clean components as specified. Replace as required.

MAINTENANCE AND ADJUSTMENT

STARTING SYSTEM CHECKS

Voltage Loss Checks

When the starter cranks too slowly, check the battery state of charge and all electrical connections between the battery and starter.

1. Turn on headlights and operate starter. If headlights dim considerably when starter is engaged, the battery may be discharged or be defective. Check the battery.

2. If the headlights stay bright but the starter does not turn over, the starter cables may be faulty or the starter defective.

(a) Test battery voltage while cranking engine (9 volts minimum).

(b) Check voltage from starter terminal of solenoid to starter frame while cranking engine.

3. The difference in readings taken in Operations 2a and 2b above represents the voltage drop through the cables and solenoid switch. Voltage drop should not exceed .5 volt.

4. Locate excessive resistance as follows:

(a) Turn voltmeter to scale above 12 volts and connect voltmeter leads across connection or switch: to be checked.

(b) With starter switch closed, turn voltmeter switch to lowest scale and take reading as quickly as possible, then turn switch back to higher scale and stop cranking engine.

(c) Voltmeter must not read more than .2 volt across any connection. If voltmeter reads more than .2 volt, the defect must be corrected.

Starter Current Draw - Lock Test

1. Make sure battery is fully charged and in good condition.

2. Connect a volt ampere starter tester according to manufacturer's instructions.

3. Pull parking brake on securely, shift transmission into 4th (direct) gear and actuate starter. (Starter will not turn engine because engine is locked through transmission.)

4. While starter is actuated, read voltage and current. Refer to Specification Chart.

(a) Voltage low - poor battery or a voltage loss in the starter circuit.

(b) Current high - short circuit in starter. Overhaul starter.

(c) Current low - commutator dirty, brushes worn, solenoid switch contacts defective or open circuit in starter. Overhaul starter.

Starter Current Draw - On Car

1. Bring engine to normal operating temperature.

2. Stop engine and disconnect coil wire from distributor.

3. Ground coil wire to prevent excessive coil voltage build up.

4. Connect test equipment and, with transmission in neutral, turn engine over until voltage stabilizes. Note readings.

5. Current draw should be between 90-130 amperes.

MAJOR REPAIR

STARTER OVERHAUL

Starter Removal

1. Disconnect starter wiring.

2. Remove starter support bracket.

3. Remove two starter bolts, one nut and lockwashers.

4. Remove starter.

Starter Disassembly

1. Hold starter in a vise, as shown in Figure 1B- 3. Mark end' frame and field frame to ensure correct installation of parts on reassembly.

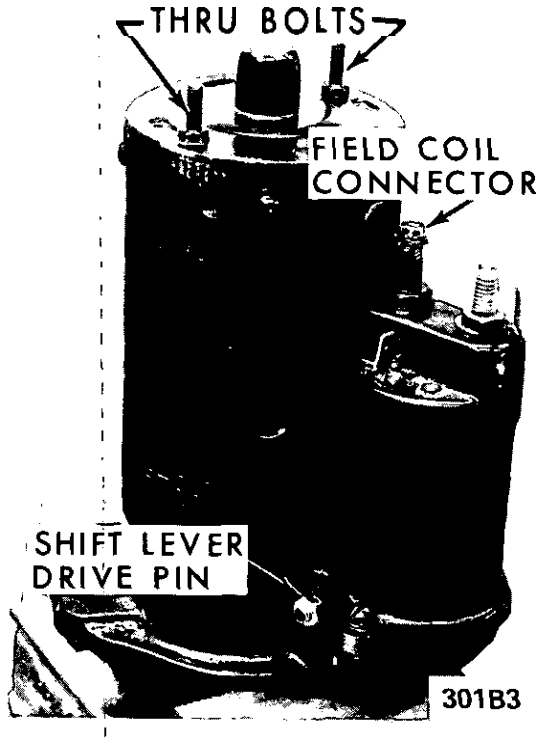

Figure 1 B-3 Cranking Motor in Vise

2. Remove both starter through bolts and field coil end from solenoid switch lower threaded bolt. See Figure 1B-3.

3. Remove end frame from field frame and pull both insulating tubes out of field frame.

4. To prevent brushes from coming out when removing the field frame, place a 29 millimeter socket over commutator while lifting up on the field frame. The brushes will be held in place by the socket. See Figure 1B-4.

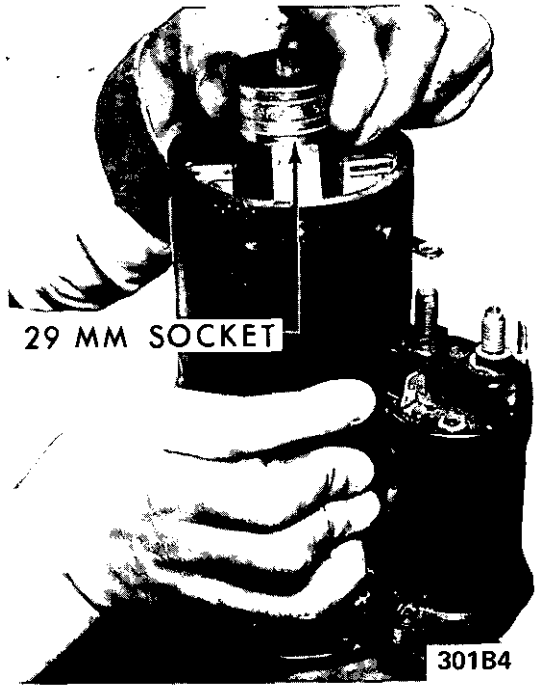

Figure 1B-4 Removing Field Frame

5. Remove the two (2) solenoid attaching screws and remove solenoid and spring.

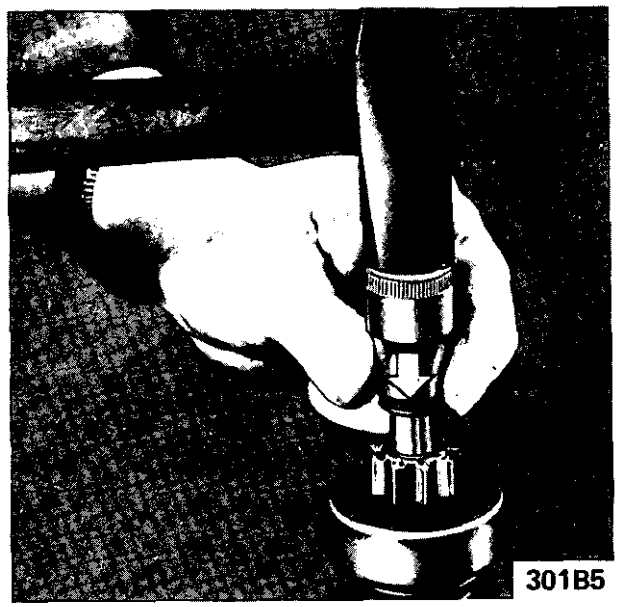

Figure 1B-5 Driving Retaining Ring Back

6. Remove shift lever shaft and lift armature and shift lever assembly.

7. Drive back retaining ring on armature shaft. See Figure 1B-5.

8. Take the lock ring, retaining ring, and overrunning clutch and pinion off armature shaft. Check groove in shaft for burrs and remove with a soft tile.

Cleaning and Inspecting Parts

1. Clean and check all parts. Replace defective parts.

2. Turn down worn or burnt commutator on a good precision lathe. Use a spindle speed between 2,000 and 3,000 RPM. See Figure 1B-6. When turning down commutator, adjust cutting depth of tool so that no more pits exist after this operation. Do not remove any more material than necessary, however, because if commutator diameter is less than 1 15/32 inches, armature must be replaced.

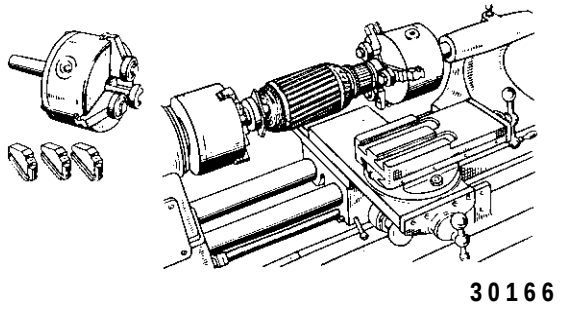

Figure 1B-6 Turning Down Commutator

3. Undercut mica approximately .020 below commutator surface. Finish and thoroughly clean commutator.

4. Check armature for short circuit on a growler.

5. With a test lamp, check armature for ground. Test lamp must not light up. See Figure 1B-7.

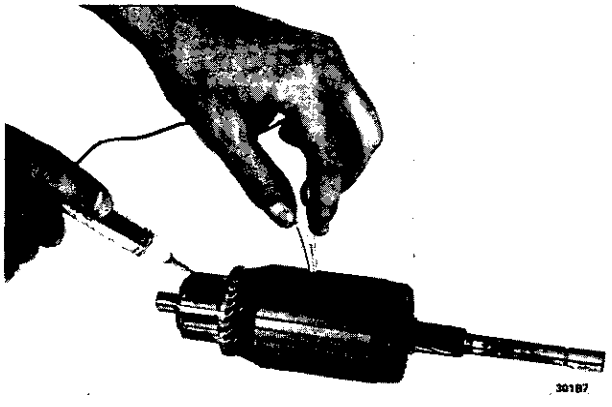

Figure 1B-7 Testing Armature for Grounds

6. Check armature for an open circuit on a growler. Considerable variation in readings between individual commutator bars would indicate an open circuit.

7. Visually check field coils. Replace burnt or scorched field coils.

8. With a test lamp, check field coils for ground. See Figure 1B-8. Test lamp must not light up. Replace grounded field coil.

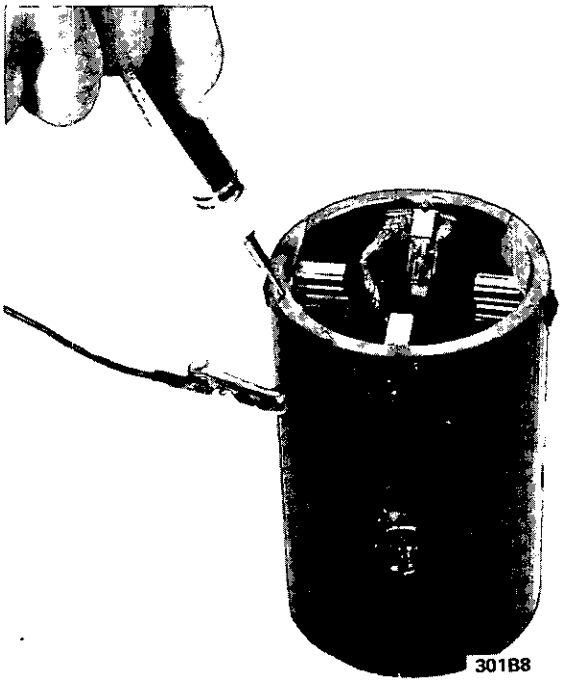

Figure lB-8 Checking Field Coils for Ground

Replacing Field Coils

1. Mark locations of pole shoes to avoid incorrect installation.

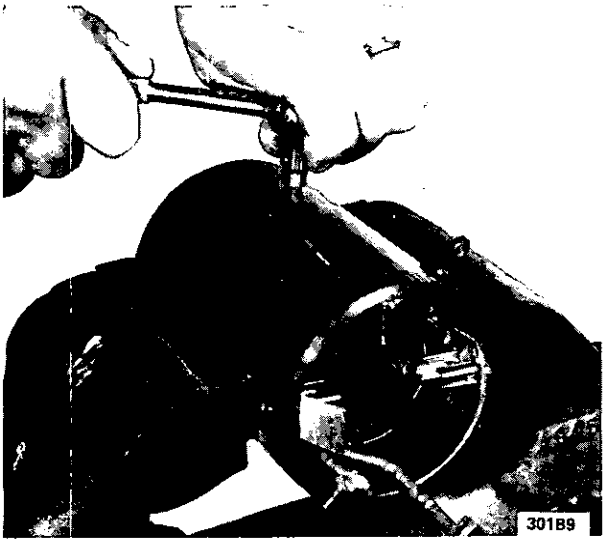

Figure 1B-9 Removing Pole Shoes

2. Unscrew the four (4) pole shoe attaching bolts and take field coils out of field frame. See Figure 1B-9.

3. To ensure proper installation of the pole shoes, align shoes exactly parallel with the armature shaft prior to tightening attaching bolts.

Checking and Replacing Brushes

1. Check both positive brush holders for ground. See Figure 1B-10. Test lamp must not light up.

Figure 1B-10 Checking Positive Brush Holder for Grounds

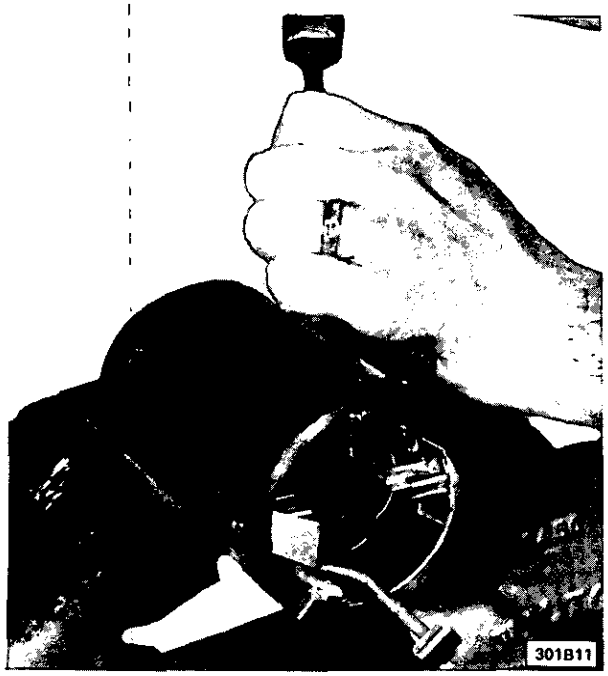

Figure 1B-11 Removing Rivet

2. Check brushes. Replace brushes, if worn down to .28 inches or less. Always replace all four (4) brushes.

3. To replace positive brushes, cut off wires at the connecting strap of the field coil. Clean soldered joint and solder stranded wire of new brushes. Hold wire with flatnose pliers so that no tin enters wire strands.

4. On replacement of the negative brushes, the complete brush holder with the welded brush has to be replaced.

5. Shear off rivet head with a chisel and drive rivet out. See Figure 1B-11.

6. A tool to replace the negative brush holder and rivet can be made up out of 1/4 inch steel. See Figure 1B-12.

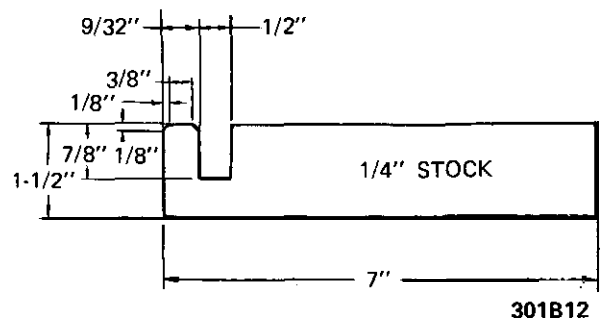

Figure 1B-12 Negative Brush Holder Installation Tool

7. Place new brush holder and new rivet on installation tool and insert rivet into bore of field frame. See Figure 1B-13.

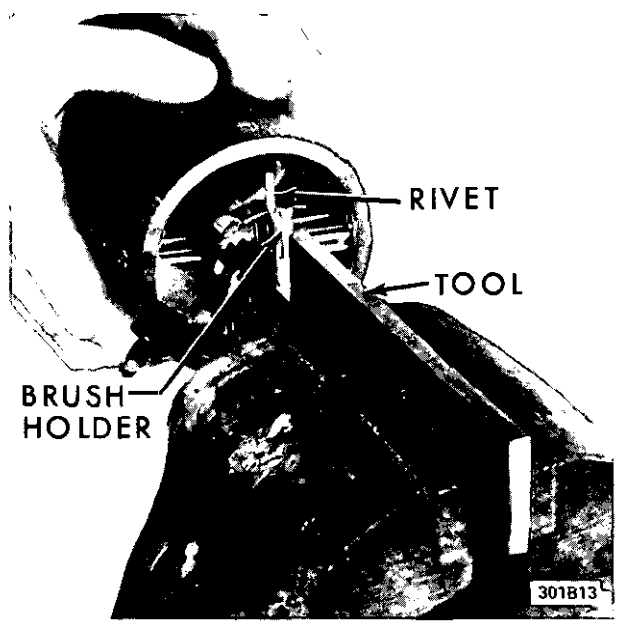

Figure 1B-13 Brush Holder and Rivet Installed on Tool

8. Making sure that brush holder is aligned at right angles to the field frame, rivet brush holder to field frame. See Figure 1B-14.

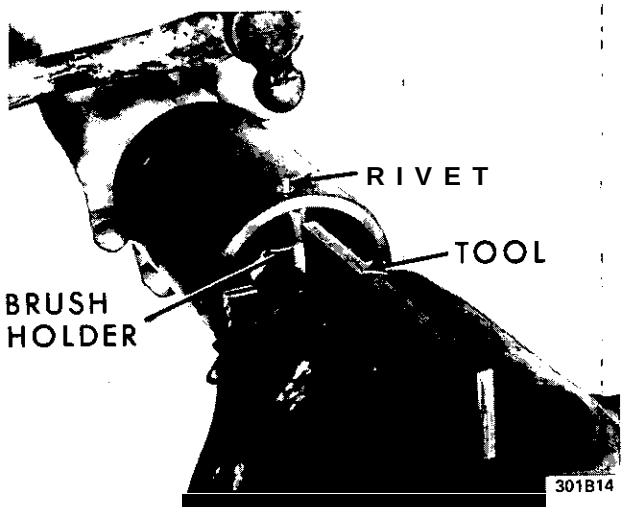

Figure 1B-14 Riveting Brush Holder to Frame

Replacing Bushings

If sintered bronze bushings in. commutator end frame and drive housing are worn, they must be **replaced.** Soak new bushings in engine oil for at least half an hour prior to installation. Press out old bushings and press in new bushings. See Figure 1B-15.

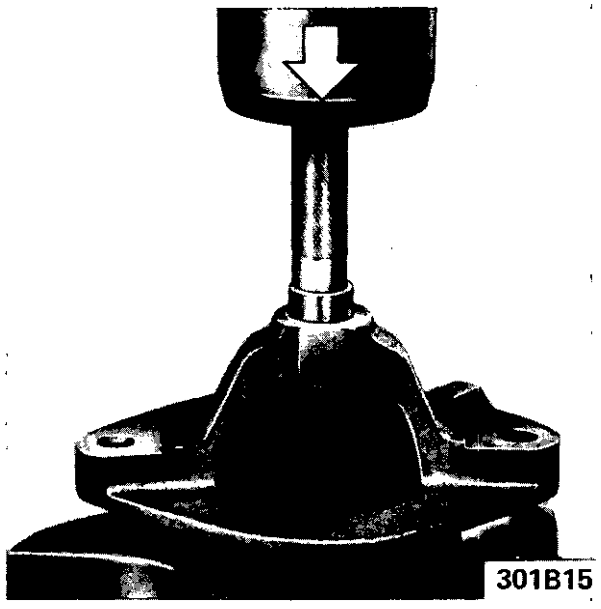

Figure 1B-15 Installing New Bushings

Starter Assembly

1. Lubricate armature shaft. Install drive assembly with pinion outward.

2. Slide pinion stop retainer down over shaft with recessed side outward.

3. Place a new snap ring on drive end of shaft and hold it in place with a hard **wood** block. Strike block with hammer to force snap ring over end of shaft, then slide the ring down into groove in shaft. See Figure 1B-16, view A.

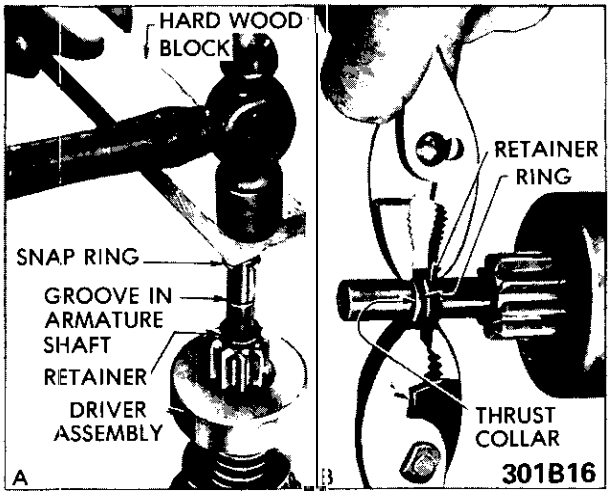

Figure 1B-16 Pinion Stop Retainer and Snap Ring Installation

4. Place thrust collar on shaft with shoulder next to snap ring and move the retainer into contact with ring. Using pliers on opposite sides of shaft, squeeze retainer and thrust collar together until snap ring is forced into the retainer. See Figure 1B-16, view B.

5. Lubricate drive housing bushing and install armature and drive assembly in housing.

6. Install solenoid thrust spring and solenoid.

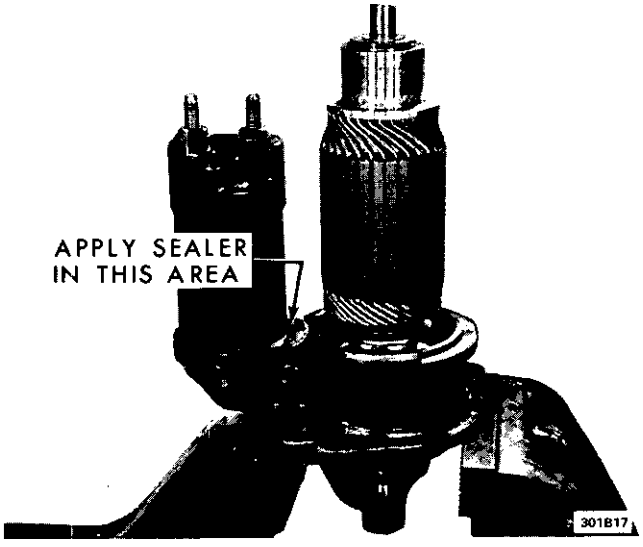

Figure 1B-17 Applying Sealer to Starter

7. Seal area between solenoid and frame. See Figure 1B-17.

8. With brushes and spring in housings held in place with a 29 millimeter socket, slide frame assembly in position.

9. Install insulating sleeves in field frame.

10. Install end frame and replace through bolts and tighten bolts.

11. Install bolt holding field frame to solenoid.

12. Check starter on bench before installing.

Starter Installation

1. Hold starter in position.

2. Install two bolts, one nut and lockwashers. Tighten securely.

3. Install support **bracket.** To ensure a stress-free installation, install bolt and two nuts only finger tight. First tighten the bolt at the engine, then tighten the two nuts at the starter end frame.

SPECIFICATIONS

Starter Specifications

Starter Number	EF 12V0 .8 PS
Rated Voltage	12
No Load Test:	
Volts	10.6
Amperes	30-50
RPM	7300-8500
Cranking Amperes Test (In Car-Engine at Operating Temp.)	175-205
Lock Test:	
Volts	6 Min.
Amperes	280-320
Voltage Required to Close Solenoid Contacts	7.5
Minimum Diameter of Commutator in Inches	1.46
Brush Spring Pressure in Ounces	40-46
Minimum Length of Brushes in Inches	.28

IGNITION SYSTEM

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DESCRIPTION AND OPERATION

INGITION SYSTEM

The ignition system basically consists of an ignition switch, ignition coil, distributor, battery and related wiring. The ignition switch is located in the steering column, the ignition coil is located left front inner fender **skirt** and the distributor is located at the left front of the engine.

IGNITION SWITCH

The combined ignition switch and steering lock can **be** switched to any one of the below listed positions. Insert key with notch pointing upward.

(Fully counterclockwise) Lock position. Ignition locked, steering locked, only with key removed. Electrical circuits disconnected except to main lighting switch and dome lamp. The **key can be** removed.

0- (First position clockwise from lock) Garage position. 'The key and lock assembly must be pushed "in" to reach this position from lock. The steering is unlocked and the ignition is off. The electrical circuits are the same as in lock position. The key cannot be withdrawn.

1- *(On position.)* All electrical circuits controlled by ignition switch are completed through the switch. The key cannot **be** removed while switch is in drive position.

11- *(Start position.)* The ignition key must be released as soon as engine starts. The switch then returns automatically to the on position.

IGNITION COIL

The ignition coil consists of a laminated non- magnetic iron core enclosed by two coils; the primary winding and the secondary winding.

The primary circuit consists of the power source (battery), the ignition switch, the ignition coil primary winding, the distributor breaker points with ignition condenser connected in parallel, and all connecting low tension wiring.

The secondary circuit consists of the ignition coil secondary 'winding, the spark plugs, all connecting high tension wiring, the distributor cap and the rotor.

When the' ignition switch is turned on and the breaker pdints are closed, current flows through the ignition coil primary winding and produces a magnetic field wound the coil windings.

When the breaker points are separated by the revolving distributor cam, the magnetic field collapses and induces a high voltage surge in the secondary winding, producing a spark between the spark plug electrodes.

The ignitidn condenser which is connected in parallel with the breaker points, prevents arcing between the separated breaker contacts, and current flow after the breaker points have been separated, thus causing a very rapid collapse of the magnetic field around the Ignition coil.

IGNITION 'DISTRIBUTOR

The ignitidn distributor breaks the primary current, distributes the high voltage surges induced in the coil secondary winding to the spark plugs according to the engine tiring order and sets ignition timing in relation to. engine RPM and load.

The housing of the distributor contains the centrifugal advance mechanism and the movable breaker plate with a breaker lever and contact support. The vacuum advance mechanism is attached to the breaker plate and mounted on the outside of the distributor, housing. See Figure 1C-1.

The distributor shaft is driven by a helical gear on the camshaft and in turn drives the engine oil pump. The ignition condenser is mounted on the outside of the housing. The engine output is to a large extent influenced by the ignition timing. Maximum engine performance is obtained when the combustion process is well underway as the piston starts down on the power stroke. The air-fuel charges are, however, not burned instantly, so it is necessary to advance the spark in relation to the piston top dead center as engine speed increases or as engine load decreases.

If the spark is too far advanced, the engine knocks, causing a drop in engine power output and overheating. If the spark is retarded, part of the energy developed during combustion is wasted which will result in reduced engine power output, excessive fuel consumption and overheating.

The ignition distributor has a double acting double diaphragm vacuum unit. See Figure 1C-1. The advance unit is supplied with "ported" vacuum. That is, vacuum is supplied from a port in the primary barrel of the carburetor located just above the closed throttle valve. This port supplies no vacuum during idling nor during closed throttle deceleration, but supplies full intake manifold vacuum at all speeds where the throttle valve is opened enough to uncover the port.

Figure 1C-1 Ignition Distributor

The retard unit is supplied with intake manifold vacuum at all times by means of a line connected directly to the intake manifold. During idling and deceleration, when there is no vacuum to the advance unit, the retard unit will cause the timing to be retarded 5 degrees. However, during part throttle operation when there is vacuum to the advance unit, the advance unit will overpower the retard unit so that the retard unit has no effect on timing.

The purpose of the retard unit is to reduce hydrocarbon and carbon monoxide emissions during idling and deceleration, where they are especially bad.

In order to avoid voltage losses for easier starting, a plastic cover has been inserted in the distributor below the rotor as a seperator to keep the inside of the distributor cup free from condensation.

There is also a plastic hood slipped over the distributor cap with an outlet for the ignition cables as an added protection against moisture from the outside. See Figure 1C-2.

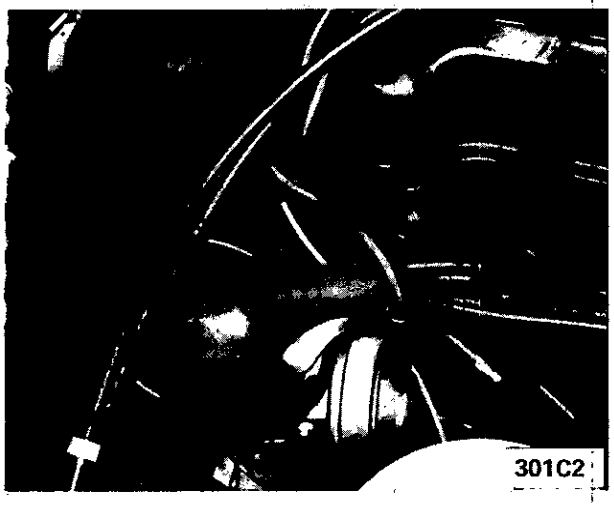

Figure 1C-2 Ignition Distributor With Hood Installed

MAINTENANCE AND ADJUSTMENTS

CONTACT POINT REPLACEMENT

Removing Contact Points

1. Remove contact support lock screw and remove contact point support. If condenser is to be replaced, it will be necessary to replace condenser and leads as an assembly.

Installing Contact Points

1. Lightly lubricate distributor cam with high temperature cam and ball bearing lubricant. Excessive lubricant will throw off into contact points.

2. Position support on breaker plate and install lock screw leaving slightly loose for later adjustment..

3. Plug breaker arm wire in.

4. Adjust breaker point gap to .016".

DWELL ANGLE ADJUSTMENT

1. Connect dwell meter.

2. Remove distributor cap. Remove rotor. Loosen breaker point set screw approximately 1/8 turn.

3. Insert screwdriver in notch of stationary breaker point. Observe dwell meter while cranking engine. Twist screwdriver as required to obtain a reading of 50 degrees plus or minus 3 degrees.

4. Tighten breaker point set screw, then recheck dwell.

5. Install rotor and cap. Start engine and recheck dwell. It is important that dwell be rechecked, as installation of rotor and cap will sometimes change the dwell angle.

IGNITION TIMING ADJUSTMENT

Preliminary Timing (Engine Won't Run)

To time the ignition on any engine which will run, use subparagraph b only. However, if the timing of an engine is completely off, the following procedure must first be used to get the engine to run.

1. With rocker arm cover removed, rotate crankshaft in a clockwise direction until both valves for No. 1 cylinder are closed and the timing marks line-up. (Valves are completely closed if rocker arms can be "rocked" slightly.)

2. Install distributor in engine so that vacuum advance unit is in original position and notch in distributor rotor lines-up with notch in housing. See Figure 1C-3. If distributor does not seat in engine block., turn distributor shaft so that rotor points about 20 degrees clockwise from distributor timing notch (see Figure 1C-18), then press lightly on distributor housing while cranking engine with starter. After oil pump tang snaps into slot in distributor shaft, start timing again from Step 1, leaving distributor installed.

Figure 1C-3 Rotor Position for Firing No. 1 Cylinder

3. Install distributor clamp and bolt, leaving bolt just loose enough to permit movement of distributor. Install distributor primary wire.

4. Rotate distributor counterclockwise slightly until contact points just start to open. This must be done very carefully or engine will not start.

5. Install distributor cap. Make sure spark plug wires are correctly installed in distributor cap, through clip and on spark plugs.

Finish Timing

Contact point gap (.016" at widest gap) or dwell 50 degrees plus or minus 3 degrees should always be checked before adjusting ignition timing.

1. Connect timing light to No. 1 spark plug.

2. Disconnect and plug vacuum advance unit and retard unit hoses.

3. Connect a tachometer from distributor side of coil to ground.

4. Start engine. Set idle speed to 900 RPM.

5. Rotate distributor as necessary to align timing marks. Timing mark is a steel ball embedded in the flywheel and a pointer in a window in the right flywheel housing. See Figure 1C-4.

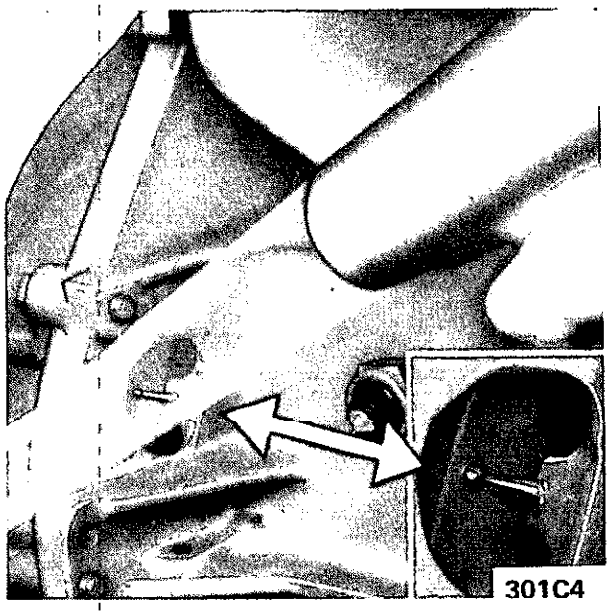

Figure 1C-4 Ignition Timing Marks

6. Tighten clamp bolt securely and recheck timing mark alignment.

7. Reconnect vacuum hoses and adjust engine idle speed and mixture.

IGNITION WIRE INSPECTION

1. The coil and spark plug wires are of a special resistance type. These secondary ignition wires reduce television and radio interference.

2. Wipe ignition wires with a cloth moistened with solvent and wipe dry. Bend wires to check for brittle, cracked or swollen insulation. Defective insulation will permit missing or cross-firing of spark plugs, therefore any defective wires must be replaced.

3. If wire insulation is in good condition, clean any terminals that are corroded and replace any terminals that are broken or damaged. Terminals must tit tight on spark plugs and in distributor cap.

4. Replace any hardened, cracked or loose cap nipples or spark plug boots.

5. Check resistance of each wire from contact inside distributor cap to spark plug or coil terminal. Replace any wire having over 10,000 ohms resistance reading. See Figure 1C-5.

Figure 1C-5 Checking Ignition Wire Resistance

CHECK IGNITION OUTPUT

1. Disconnect secondary coil wire so that engine will not start. Connect a voltmeter from the battery side of the coil primary to ground and check voltage while engine is cranking. Reading should be 10 volts or more. Low reading could be caused by a defective battery, a discharged battery, high starter current draw, a bad connection in the starter circuit or a bad connection in the primary ignition circuit.

2. Connect an oscilloscope according to manufacturer's instructions. Disconnect coil wire. Crank engine and read coil output voltage. Reading should exceed 20 KV (20,000 volts).

3. Start engine and disconnect a wire from a spark plug. Read output voltage of disconnected spark plug circuit. Reading should exceed 20 KV (20,000 volts).

CHECK DISTRIBUTOR

1. Clean distributor cap and inspect it for cracks or tracking. Inspect inner segments for erosion and outer sockets for corrosion.

2. Clean and inspect ignition wires. Make sure resistance of each wire is less than 10,000 ohms. Replace any defective spark plug boots or distributor cap nipples. See paragraph 1C-12.

3. Inspect breaker points and replace if necessary. Adjust breaker point gap to .016 inch with rubbing block on **peak of** cam lobe or check dwell and adjust if not 50 degrees plus or minus 3 degrees. 4. Check dwell variation by reading dwell at idle and at 3000 RPM. Dwell must not vary more than 3 degrees. Excessive variation means distributor shaft, cam or breaker plate are worn or damaged--overhaul distributor and replace defective parts.

5. Check distributor condenser for a minimum series resistance and insulation leakage. Check for a capacity between .15 and .20 microfarads.

6. Check total advance (centrifugal and vacuum) at 2500 engine RPM using a timing light having a dial for reading advance.

(a) The timing marks are aligned with both the vacuum advance and the vacuum retard hoses disconnected and plugged.

Engine idle should be 900 RPM.

(b) Reconnect vacuum hoses. Run engine at 3600 RPM and adjust knob until timing marks are aligned. Read advance on dial. Maximum centrifugal advance should **be** between 28-32 degrees.

7. **If** total advance is out of specifications, check centrifugal advance only, at 2500 RPM. Disconnect and plug all vacuum hoses. Maximum vacuum advance should be l-5 degrees at 4.5-5.0 in. hg.

8. Replace centrifugal or vacuum advance parts as required to bring distributor total advance within specifications.

9. Check operation of vacuum retard unit (rear unit) by first making sure timing marks are aligned with vacuum hoses disconnected and at slow idle (700 RPM). Then connect vacuum hose to vacuum retard unit (rear unit). Timing ball should move in a retard direction (upward).

CHECK SPARK PLUGS

1. Remove spark plugs. If electrodes are badly worn, discard plugs. If inner or outer porcelain is cracked or broken, discard plugs.

2. Note color and general appearance of inner end of spark plug. Brown to grayish - tan deposits and slight electrode wear indicate correct spark plug heat range. Plugs having this appearance may be cleaned, regapped, **tested** and reinstalled.

3. Clean spark plugs in a sand blast type cleaner. Clean only enough to remove deposits, not enough to wear away porcelain. If deposits are too hard to remove or if porcelain is glazed, discard plugs.

4. After cleaning spark plugs, clean tiring surfaces of electrodes with a line file.

5. Test cleaned spark plugs on a pressure tester by comparing spark of the used plugs with that of a new plug. Install tested plugs, using new **gaskets.**

6. If removed spark plugs have excessive carbon fouling and if the car will be driven mostly at low speeds in city driving, it is advisable to replace plugs with a hotter plug, AC43FS.

7. If removed plugs show rapid electrode wear or inner porcelain breakage at low mileage. Check for a vacuum leak such as a poor manifold to head fit.

8. Gap spark plugs carefully (new or cleaned) using a .030 round wire feeler gage.

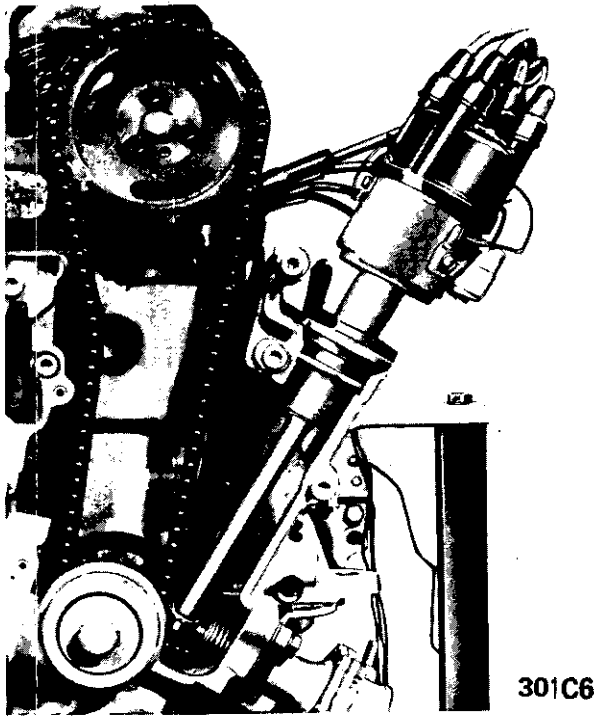

Figure 1C-6 Distributor Installation

9. Install spark plugs using a 13/16 deep socket, an extension and a torque wrench. Tighten to 22-29 lb.ft.

MAJOR REPAIR

DISTRIBUTOR OVERHAUL

Distributor Removal

1. Remove fuel pump. This is necessary because the fuel pump will block the distributor drive gear, thereby preventing removal of the distributor. See Figure 1C-6.

2. Set No. 1 cylinder at firing point by turning engine until cutout in distributor shaft (or rotor tip) points to notch in distributor housing. See Figure 1C-7.

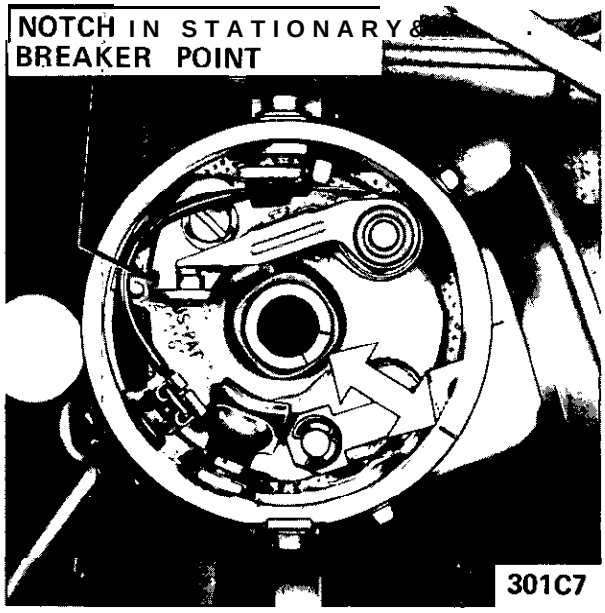

Figure 1C-7 Aligning Shaft Cutout With Notch

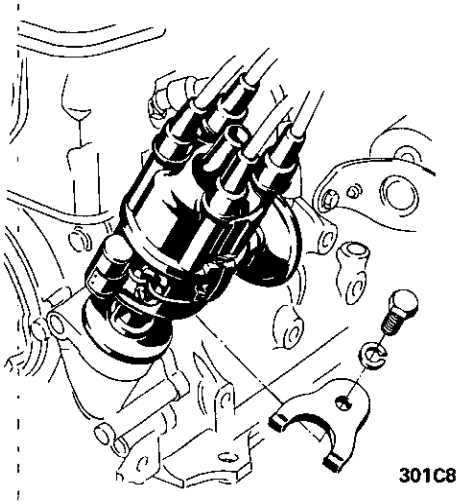

Figure 1C-8 Removing Distributor

3. Ball imbedded in flywheel should be approximately aligned with pointer in housing. See Figure 1C-4.

4. Remove distributor hold-down clamp and remove distributor. See Figure 1C-8. Cover bore in timing case to prevent foreign material from dropping into engine. To make reinstallation of distributor easy, do not rotate crankshaft or oil pump.

Disassembly

1. Remove distributor cap retaining spring clips, and vacuum control units. See Figure 1C-9.

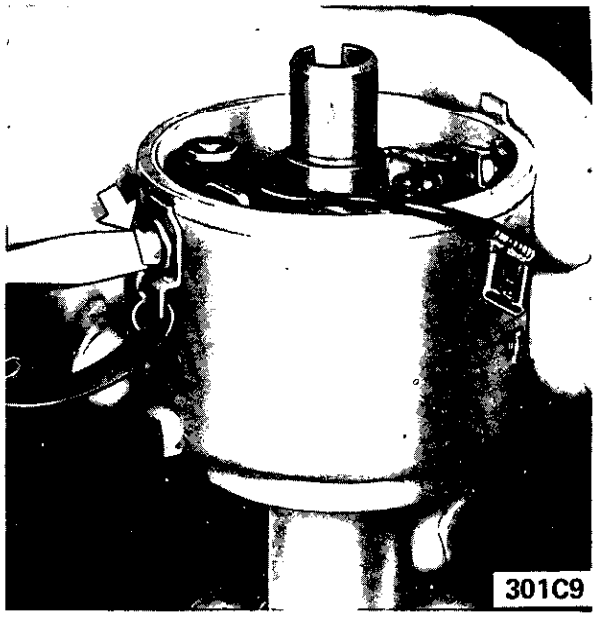

Figure 1C-9 Removing Retaining Clips

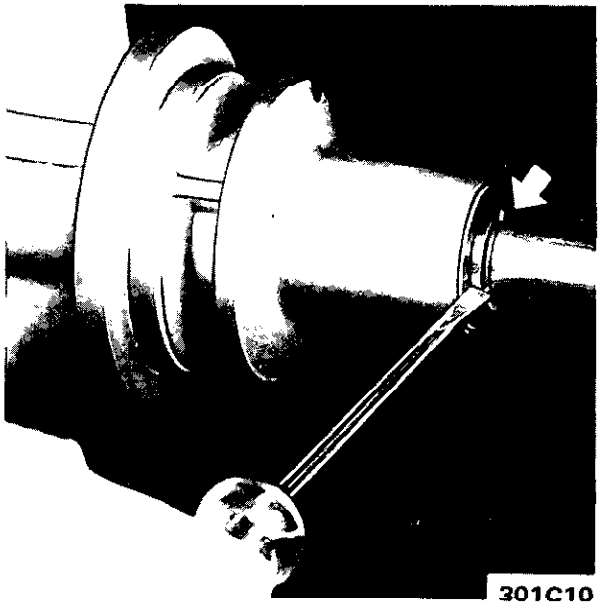

Figure 1C-10 Removing Retaining Ring

2. Push retaining ring out of groove in distributor shaft. See Figure 1C-10.

3. Push up on distributor shaft. Remove breaker plate from distributor housing. Remove breaker points from breaker plate. See Figure 1C-1 1.

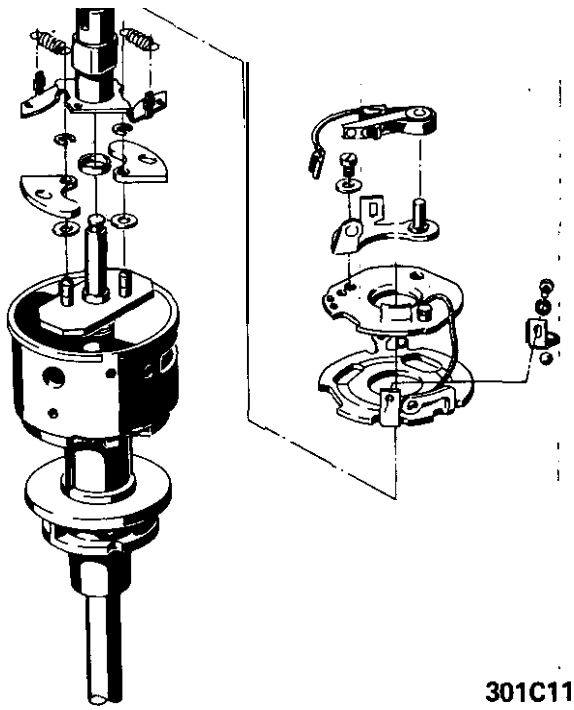

Figure 1C-11 Removing Breaker Plate

4. Disassemble breaker plate by unscrewing ball thrust spring screw. Remove spring and ball. See Figure 1C-12.

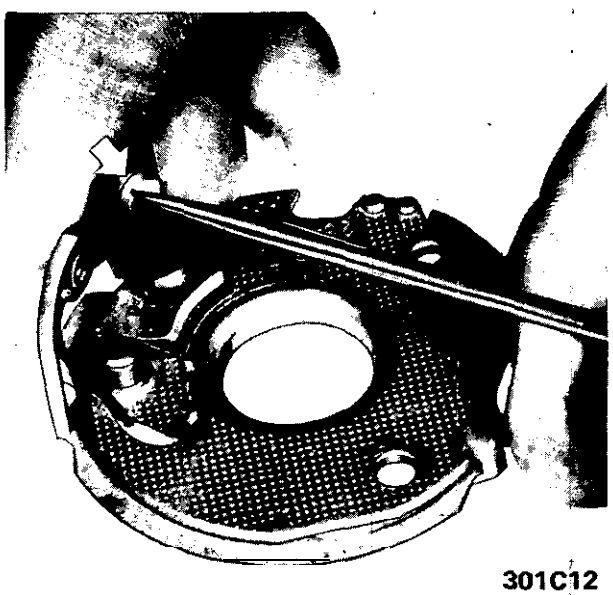

Figure 1C-12 Disassembling Breaker Plate

5. For cleaning, partly pull distributor shaft together with centrifugal advance mechanism out of distributor housing. Do not disassemble advance mechanism.

6. Clean and check all parts. Replace any defective parts.

7. Coat sliding parts of centrifugal advance mechanism and return springs with grease. See "A" in Figure 1C- 13.

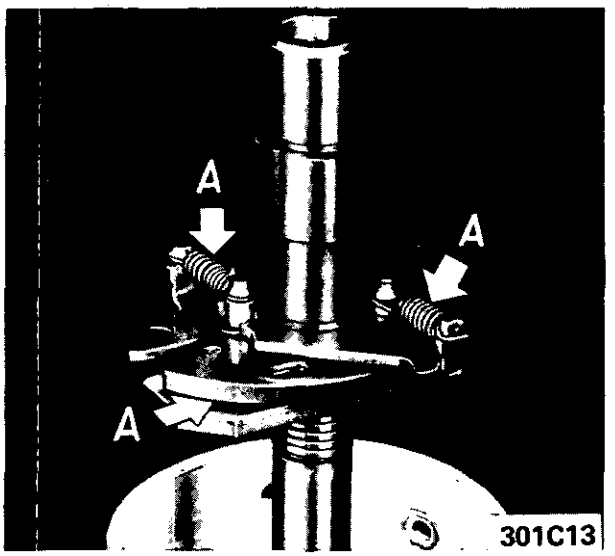

Figure 1C-13 Lubricating Centrifugal Mechanism

Reassembly

1. Install new breaker points on breaker plate.

2. Install retaining ring on distributor shaft.

3. Install vacuum units, ignition condenser and cap retaining clips.

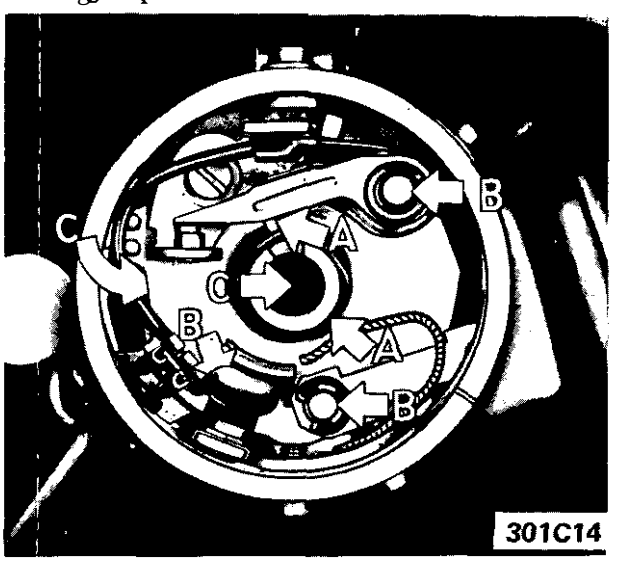

Figure 1C-14 Lubricating Upper Distributor

4. Oil sliding parts of breaker plate at "B". Oil felt in cam at "C". Apply a thin layer of high melting point grease to the cam, using a finger at "A". See Figure K-14.

5. Adjust breaker point gap to .016 inches.

6. Grease control rod eye at "A". See Figure 1C-15.

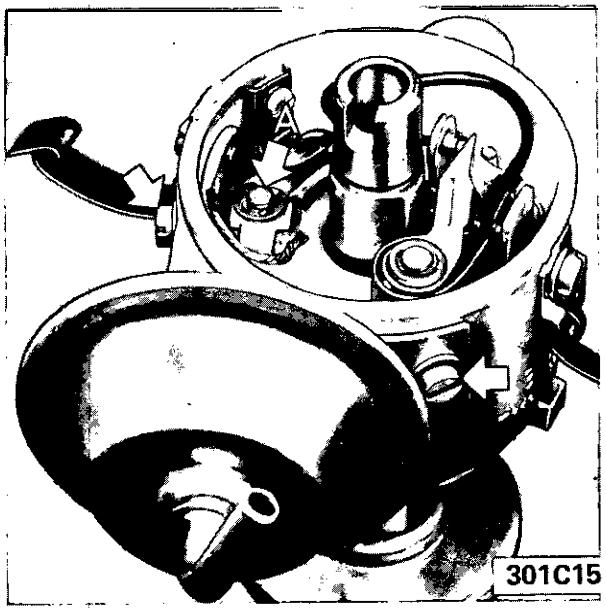

Figure 1C-15 Lubricating Control Rod Eye

7. Reinstall distributor cap nipples and spark plug boots. If hardened or cracked, use new parts. See Figure 1C-16.

Figure 1C-16 Reinstalling Nipples

Distributor Installation

1. Make sure oil pump slot is in position to receive distributor shaft tang. See Figure 1C-17.

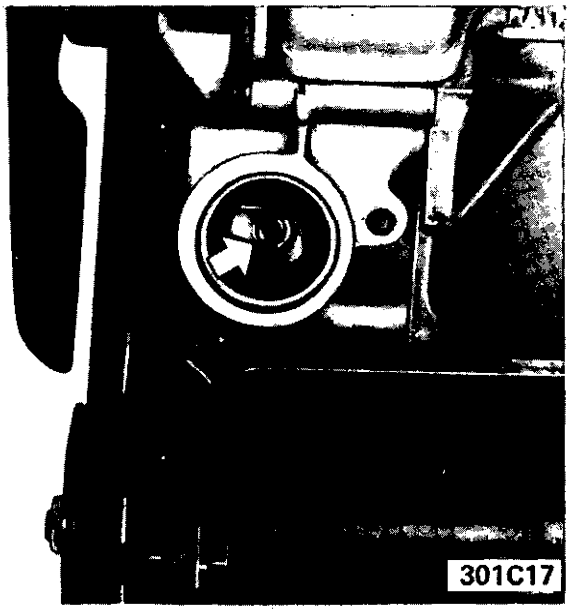

Figure 1C-17 Oil Pump Slot

2. Inspect paper gasket on distributor housing and replace if necessary.

3. Install distributor with vacuum units in original position and with shaft cutout (rotor tip) in position shown in Figure 1C-18. Distributor shaft will turn as distributor is installed, causing the rotor tip notch to align with the housing notch when distributor is seated.

Figure 1C-18 Shaft Position for Starting Installation

4. Install distributor clamp, bolt and lockwasher tinger tight. Align marks on rotor tip and housing.

5. Install fuel pump.

6. Adjust ignition timing.

SPECIFICATIONS

IGNITION COIL

Ignition Coil Number	K12 V
Ignition Coil Current Draw, Amperes at 12.5 Volts	
Engine Stopped	3.8
Engine Idling	2.3

DISTRIBUTOR

Distributor Type Number:	JFU4
Total Advance (Centrifugal and Vacuum), Engine Degrees at 3600 R.P.M. Engine RPM	29-37
Centrifugal Advance, Engine Degrees and RPM	
Start Advance, at RPM	1000-1200
Medium Advance, Degrees at RPM	7.5-15 at 1400
Maximum Advance, Degrees at RPM	28-32 at 3600
Vacuum Advance, Engine Degrees and In. of Vacuum	
Start Advance, at In. of Vacuum	-5 at 2.9-4.1 In.
Maximum Advance, Degrees at In. of Vacuum	1-5 at 4.5-5.0 In.
Vacuum Retard, Engine Degrees at Closed Throttle	-5
Condenser Capacity in MicroFarads	15-.20
Breaker Spring Tension in Ounces	14 to 19
Breaker Point Gap in Inches	,016
Dwell angle in Engine Degrees	50 $\pm$ 3
Firing Order	1-3-4-2
Spark Plug or Coil Cable, Max. Resistance in Ohms	10,000

SPARK PLUGS

Make and Model - Production	AC42FS
Make and Model - Replacement	AC42FS
If carbon fouling occurs, use	AC43FS
Spark Plug Torque in Lb.Ft.	22-29
Spark Plug Gap in Inches	.028-.031

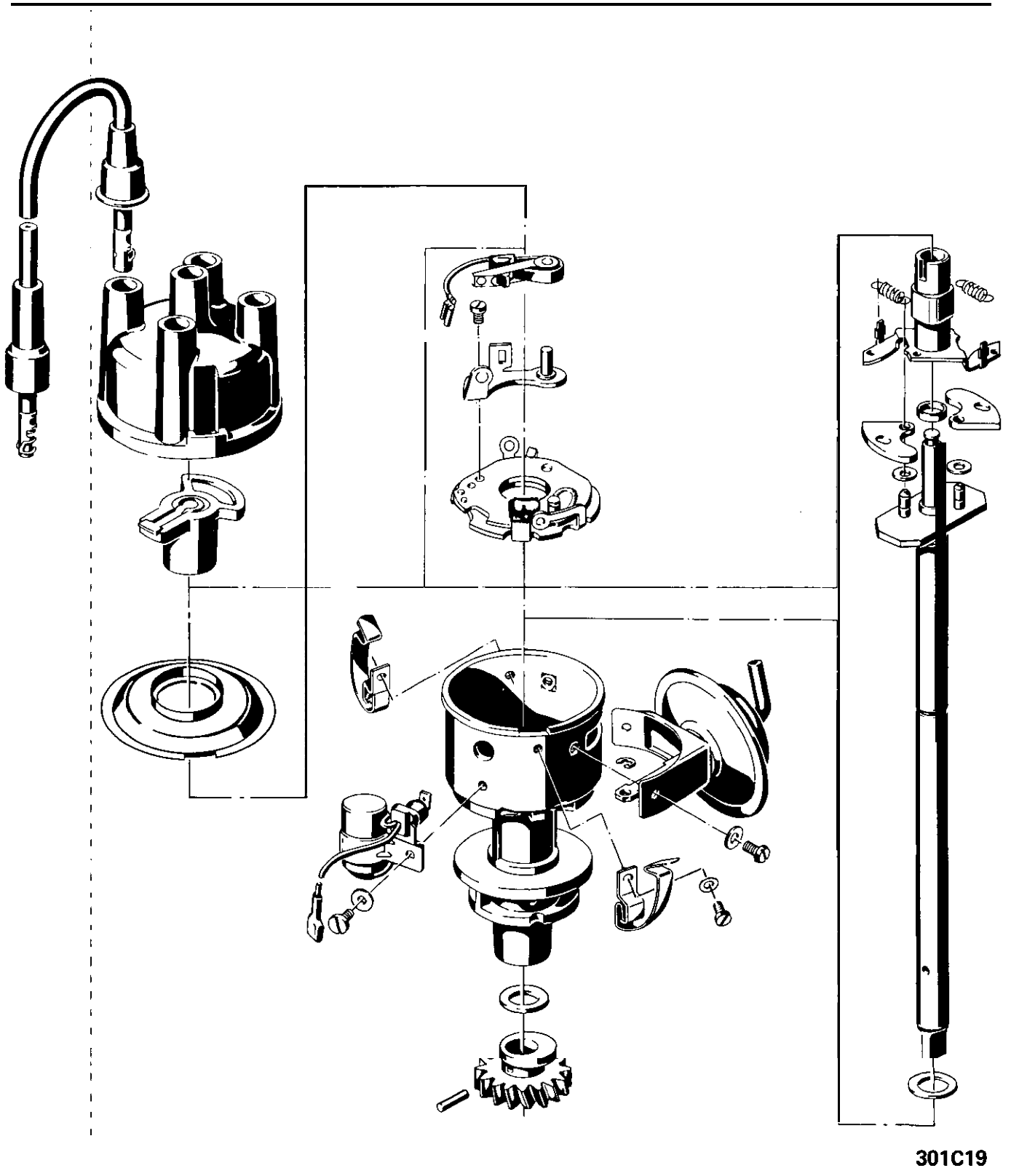

Figure 1 C-l 3 Distributor Exploded

CHARGING SYSTEM

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Alternator	1 D-35
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DESCRIPTION AND OPERATION

ALTERNATOR DESCRIPTION

The K1, 35 amp alternator is standard equipment on all 1973 models.

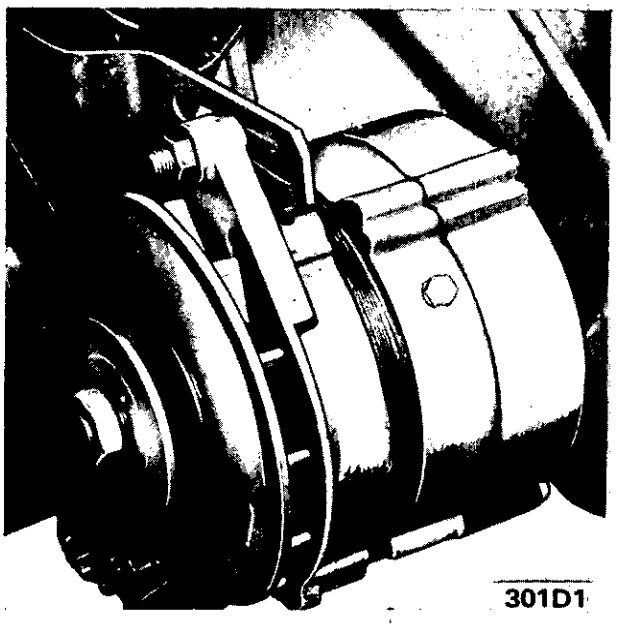


Figure 1D-1 Alternator Installed

The alternating current generator (alternator) is a continuous-output (even at idle), diode rectified generator. See Figure 1D-1.

The rotor, which carries the field winding, is mounted in ball bearings at both ends. Each bearing has a sealed-in grease supply which eliminates the need for periodic lubrication. Two brushes and two slip rings are used. One brush conducts the current provided by the voltage regulator to one end of the field coil; the other brush conducts the current from the other end of the rotating field coil to ground.

The three phase stator windings are assembled on the inside of a laminated core that forms the center section of the alternator frame. Nine rectifier diodes are connected to the stator windings (three to each phase lead). The diodes change the alternator AC voltages to DC voltage coming out of the B positive and the D positive terminals of the alternator.

If the alternator will not meet output specifications when supplied with full field current, the assembly must be overhauled. If the voltage regulator does not limit maximum voltage within specifications, adjust the voltage regulator. If steady voltage regulation, within specifications, cannot be achieved, the voltage regulator assembly must be replaced.

REGULATOR DESCRIPTION

The regulator contains only one unit - a double contact voltage regulator. See Figure 1D-2.

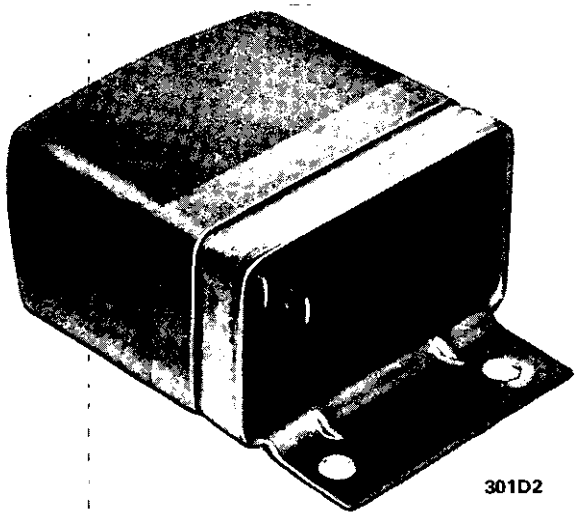
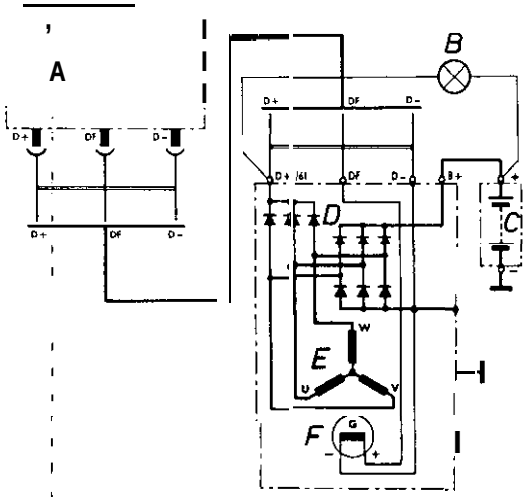


Figure 1 D-2 Voltage Regulator

Since the alternator field is grounded inside the alternator, the voltage contacts are in series with the field. Field current is supplied from the D- terminal of the alternator, goes through a small red wire to the voltage contacts in the regulator, comes out of the regulator through a brown wire, into the DF terminal of the generator, and through the field winding to ground inside the generator. See Figure 1D-3.



A = REGULATOR
B = CHARGING INDICATOR LAMP
C = BATTERY
D = DIODES
E = STATOR
F = ROTOR

301D3

Figure 1D-3 Charging Circuit Diagram

The diodes in the alternator, since they act like one-way check valves, make a cutout relay unnecessary; battery current can flow only as far as the diodes, but cannot discharge through the alternator. However, whenever alternator voltage is higher than battery voltage, current flows freely through the diodes in the other direction to charge the battery.

A current-regulator is not necessary. Any alternator is limited by its design in regard to maximum current output. Regardless of current need, an alternator cannot put out more than its rated current output and, therefore, cannot overheat and damage itself due to excessive output.

MAINTENANCE AND ADJUSTMENTS

ALTERNATOR AND REGULATOR TESTS

Test Current Output

1. Check alternator belt condition and tension. Adjust to 45 lbs. using Gauge J-23600.

2. Install a battery post adapter at the positive post of the battery.

3. Connect ammeter leads to adapter with red lead toward generator and black lead toward battery positive post. Connect ground lead to battery negative post. See Figure 1D-4.

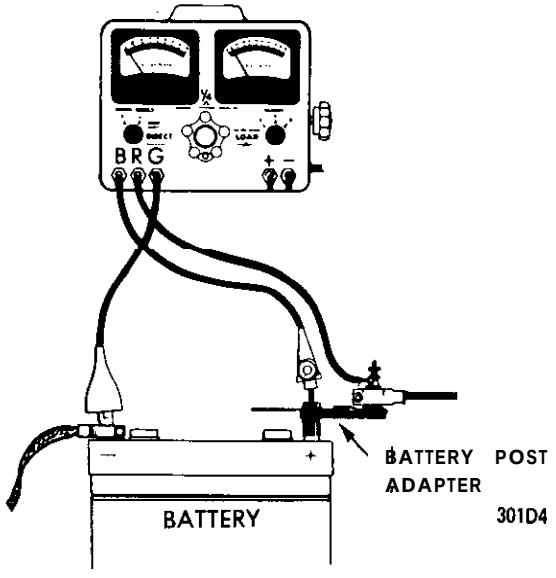


Figure 1D-4 Connecting Ammeter Leads

4. Connect voltmeter across the battery: red lead at generator side of battery post adapter and black lead to battery negative post.

5. Connect a tachometer to ignition system.

6. Make sure all electrical accessories are turned off. Start engine with battery post adapter switch closed; open switch as soon as engine is started.

7. Adjust engine speed to 2500 RPM.

8. Turn tester control knob to "LOAD" position and adjust knob to obtain highest possible ammeter r&d-ing. Output must be 30 amperes minimum. If output is okay, proceed to voltage regulator test below.

9. If output is low, defect may be in alternator or in regulator. To eliminate regulator, supply field current direct to cause full alternator output. Unplug three-way connector from regulator and plug in a jumper between the red and black leads. See Figure 1D-5. Retest as described in Steps 7 and 8. If output is still low, generator is faulty and must be removed.

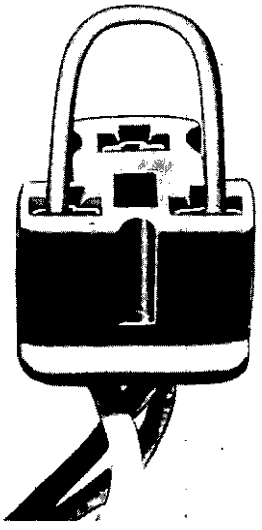


Figure 1D-5 Alternator Output Check

10. If output (using field jumper) is now okay, defect is in the regulator or wiring harness. Check all wiring connections. If all wiring is okay, try replacing regulator; if output now tests okay (without using field jumper), you have found the trouble. Always follow-up with a voltage regulator test.

Test and Adjust Voltage Regulator Setting

1. Always test alternator output first, as described in subparagraph a above. Leave all test instruments connected, but make sure field jumper is removed; if used.

2. With engine speed at 2500 RPM, turn tester control knob to "1/4 OHM" position. Make sure all electrical accessories are turned off. After voltage reading stabilizes, any reading between 13.5 and 14.5 volts is okay.

3. If voltage reading is out of limits, remove regulator cover and adjust voltage regulator armature spring tension to obtain a middle reading of 14.0 volts. If reading fluctuates, voltage contacts are dirty.

4. Replace regulator cover and recheck voltage setting. A steady voltage reading between 13.5 and 14.5 volts means voltage regulator is okay.

5. Adjust engine speed to specified idle. Reseal voltage regulator cover carefully, using electrical tape.

MAJOR REPAIR

ALTERNATOR OVERHAUL

Always disconnect battery ground cable before making any electrical repairs.

Alternator Removal

1. Disconnect battery ground strap.

2. Unplug wiring connector from alternator.

3. Disconnect battery lead from alternator.

4. Remove adjusting brace bolt, lockwasher, plain washer and nut.

5. Loosen pivot bolt. Push alternator inward and remove belt from pulley.

6. Drop alternator down and remove pivot bolt, nut, lockwasher and plain washer.

7. Remove alternator.

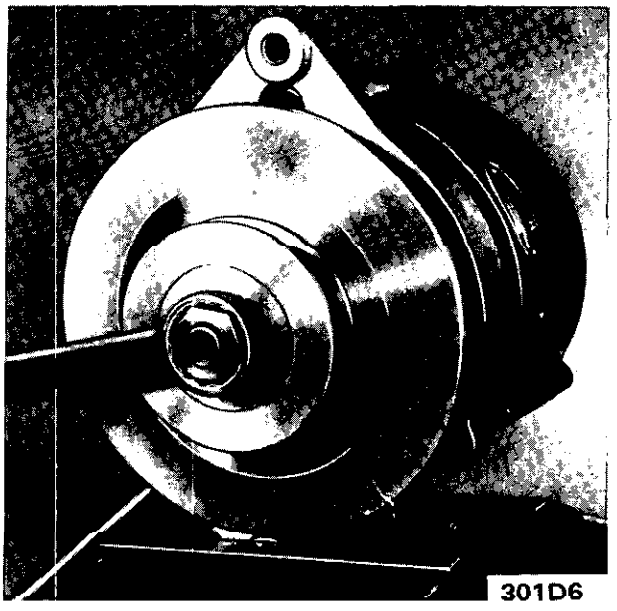


Figure 1D-6 Removing Alternator Pulley

Alternator Disassembly

1. Remove nut and alternator pulley. See Figure 1D-6. Remove pulley and fan from rotor shaft.

2. Mark 'drive end frame, stator and rear end frame to ensure correct installation of parts on reassembly. Remove drive end frame. See Figure 1D-7.

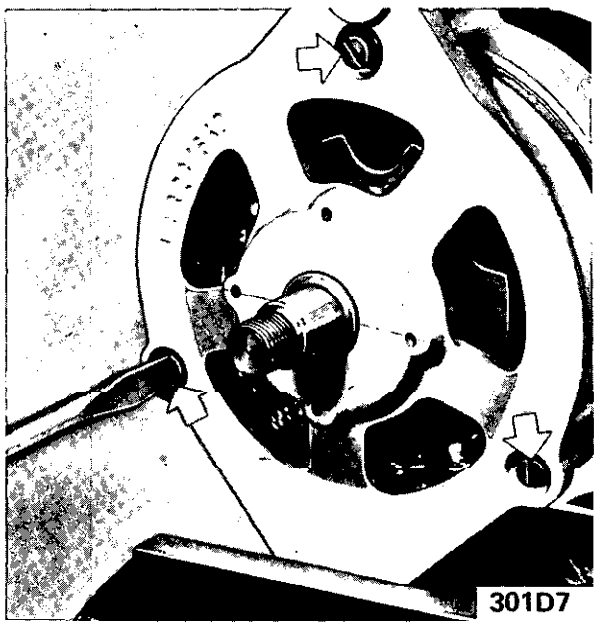


Figure 1D-7 Removing Drive End Frame and Rotor Assembly

3. Remove drive end frame and rotor assembly from generator. See Figure 1D-8.

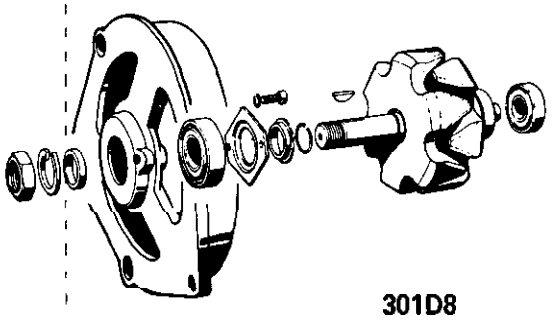


Figure 1D-B Drive End Frame and Rotor Assembly

4. Pull drive end frame off rotor shaft. See Figure 1D-9.

5. With puller remove rear ball bearing from rotor shaft. See Figure 1D-10.

6. Remove positive diode support. See Figure 1D- 11.

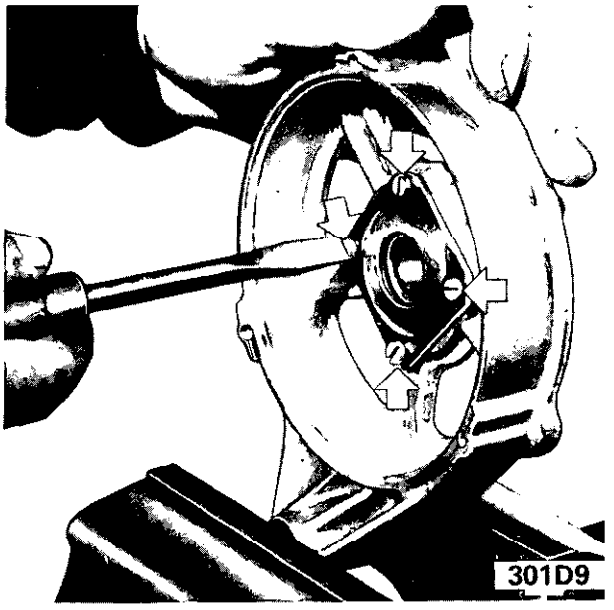


Figure 1D-9 Removing Drive End Frame Bearing

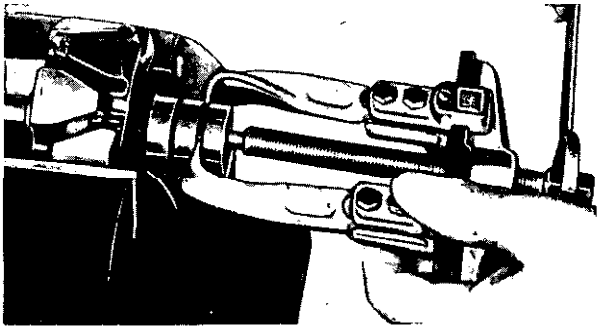


Figure 1D-10 Removing Rear Bearing

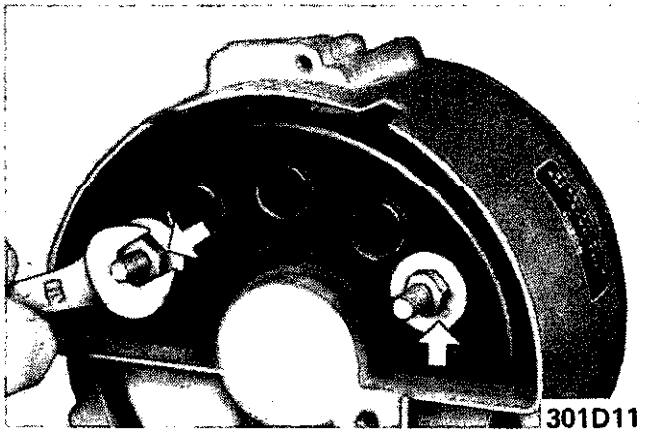


Figure 1D-11 Removing Positive Diode Support

7. Disconnect brush connector from negative diode support. See Figure 1D-12.

8. Remove brush holder. See Figure 1D-13.

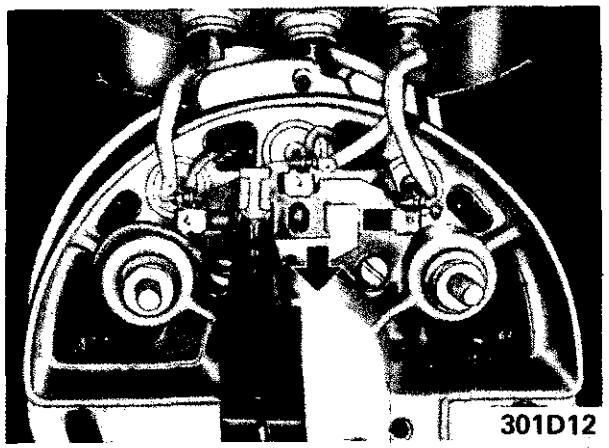


Figure 1D-12 Disconnecting Brush Connector

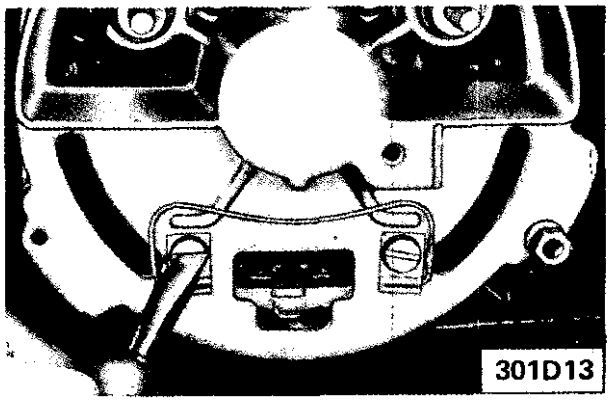


Figure 60-13 Removing Brush Holder

9. Unsolder diode connections and stator winding ends. Clamp pliers on wire to transfer heat away from diodes. Unsolder quickly using a very hot soldering iron, as the diodes are very sensitive to heat. See Figure 1D-14.

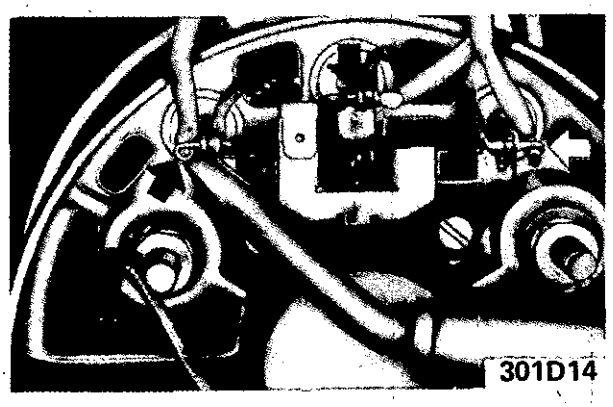


Figure 1 D-l 4 Unsoldering Connections

10. Remove stator assembly from housing.

11. Remove two screws and negative diode support.

12. Unsolder brushes, if they are worn to a length of 3/8 inch or less. Solder new brushes in place. To do this, hold connecting wire in flat-nosed pliers to prevent **solder** from flowing between wire strands, otherwise the wire strands will become rigid and the brushes unserviceable. See Figure 1D-15.

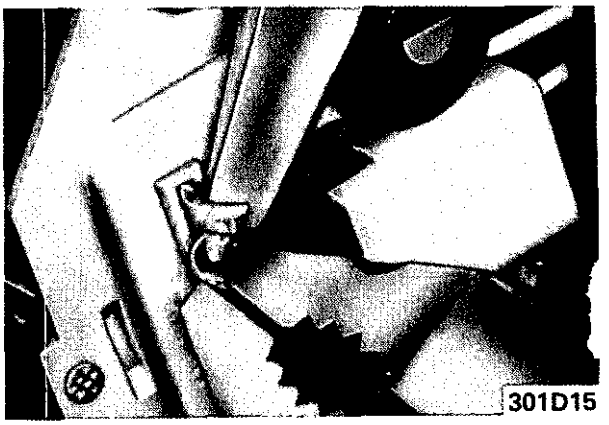


Figure 1 D-l 5 Soldering New Brushes

Note brush wire installation of correct assembly. See Figure 1D- 16.

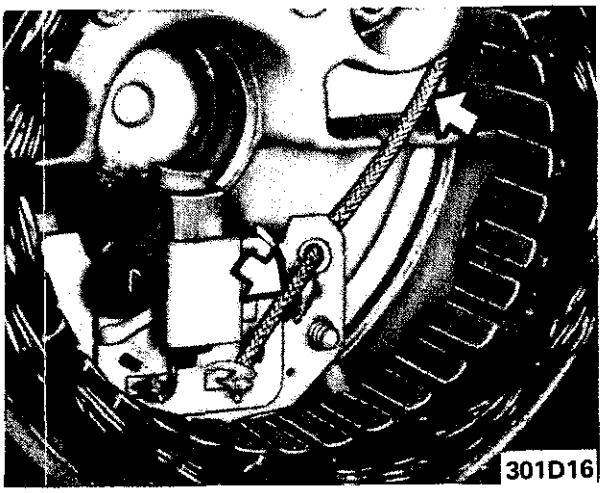


Figure 1 D-l 6 Brush Wire Installation

13. Test rotor windings and slip rings for a ground, using a test light or an ohmmeter. Test light should not light; ohmmeter should read near infinite resistance end of scale. See Figure 1D-17.

14. Test rotor windings for a short by connecting an ohmmeter between the two slip rings. Ohmmeter should read between 4.0 and 4.4 ohms. See Figure 1D- 18.

15. **Test stator** windings for a ground, using a test light or an ohmmeter. Test light should not light; ohmmeter should read near infinite resistance end of scale. See Figure 1D-19.

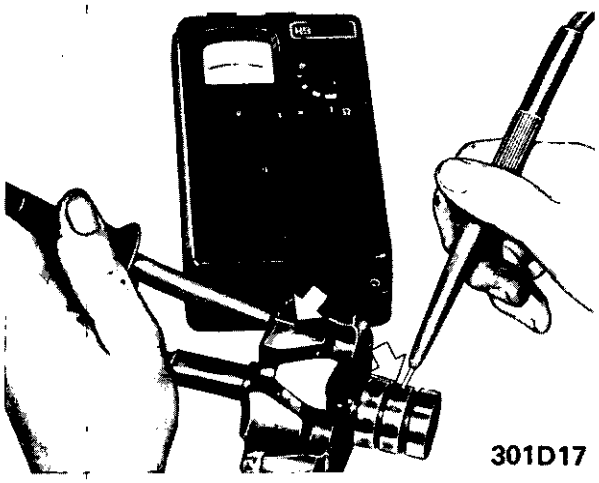


Figure 1D-17 Checking Rotor for Ground

Figure 1D-18 Checking Rotor for Short

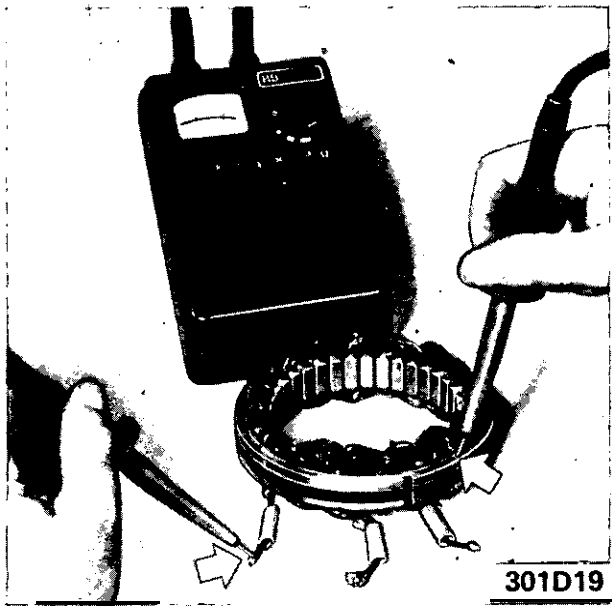


Figure 1 D-I 9 Checking Stator for Ground

16. Check stator windings for a short, using a low reading ohmmeter. Check two phases at a time by holding ohmmeter prods alternately on winding ends. Ohmmeter should read between .26 and .29 ohms. See Figure 1D-20.

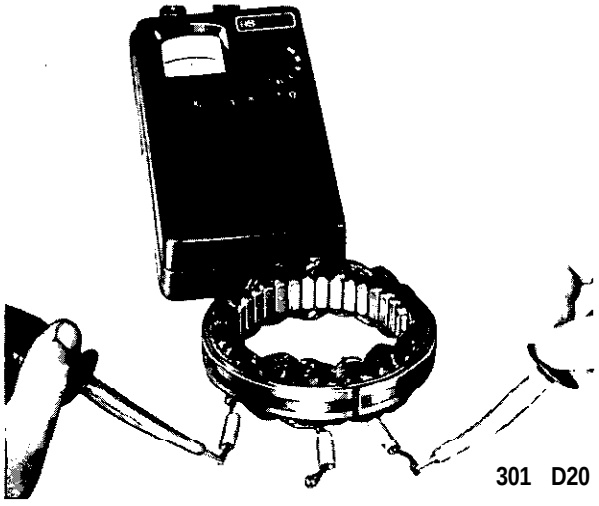


Figure 1 D-20 Checking Stator for Short

17. Clean slip rings with fine emery cloth and polish them. To avoid generating flat surfaces on slip rings, spin rotor on a lathe when cleaning and polishing. Slip rings that are not concentric can be turned down to a diameter of 1-1/4 inches. When doing this, remove only enough material to just clean up the worn surface, then polish slip rings and blow clean with compressed air.

18. If alternator current output is low one or more of the nine diodes may be defective. See Figure 1D-3.

19. If a defective diode is suspected, test diodes. Before testing diodes, disconnect them, otherwise it is not possible to determine which diode is defective. Use a test light supplied with a DC voltage of not more than 24 volts.

20. To test a diode, place one test light prod on diode connection and other on diode housing, then reverse test light prods. Test light should light brightly in

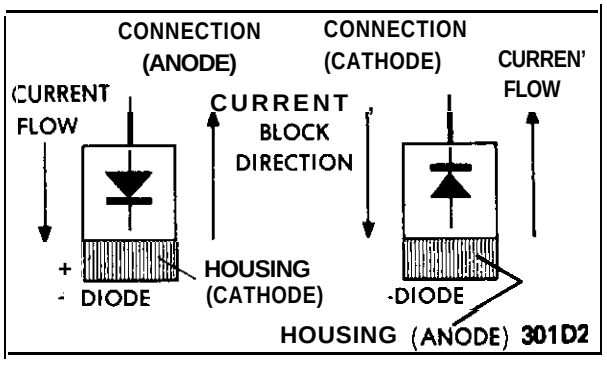


Figure 1 D-2 1 Positive and Negative Diodes

one direction, but should not light at all in the otlier direction. Diodes in each set of three should pass current and block current in the ‘same directions as the others in the set. See Figure 1D-21.

Removing Diodes

Positive Diodes

1. Press defective diode out of diode support, backing-up support with a sleeve slightly larger than the diode and pushing diode through with a shaft slightly smaller than diode. See Figure 1D-22.

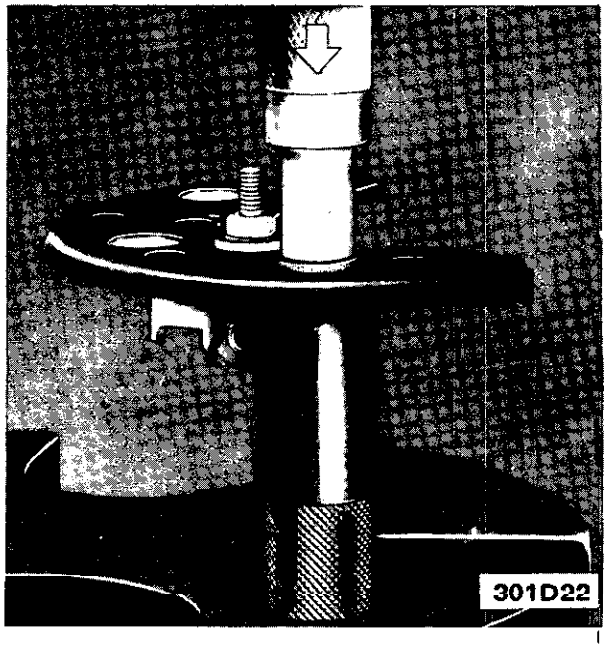


Figure 1 D-22 Removing Diode

Negative Diodes

1. Clip lead from defective diode. Clip lead close enough to diode so that tool will function properly.

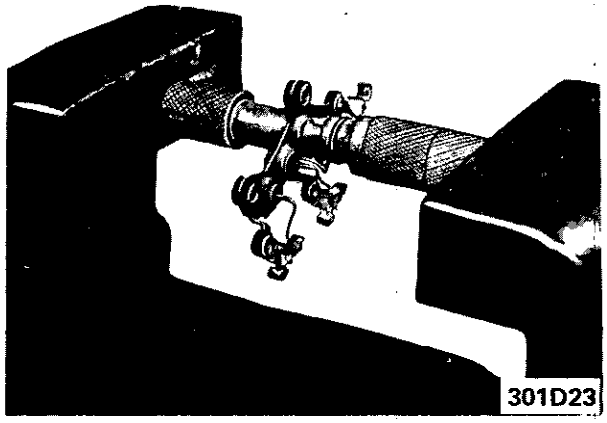


Figure 1 D-23 Removing Diode

2. Using Tool J-23526, press diode from support. See Figure 1D-23.

Installing Diodes

Positive Diodes

1. Press new diode into diode support. See Figure 1D-24.

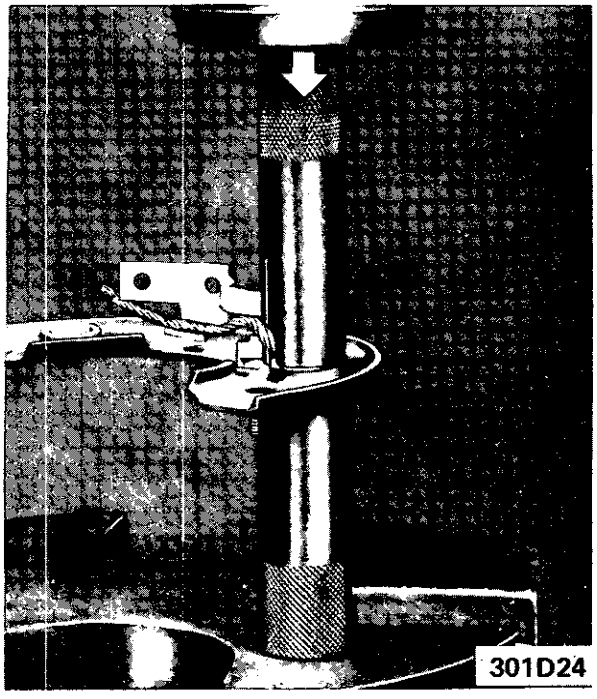


Figure 1D-24 Installing Diode

Negative Diodes

1. Using Tool J-23526, press diode into support. See Figure 1D-25. Insert negative diode pigtail lead through tool pilot.

Alternator Reassembly

1. Clean and inspect all parts. Check brushes. Replace them if they have worn **down to 3/8 inch.**

2. Lubricate both bearings with special ball bearing lubricant.

3. Press rear bearing on rotor shaft and install front bearing into drive end frame.

4. Assemble stator together with windings into rear end frame.

5. Install both diode supports.

6. Solder diode connections and ends of stator windings together. Since diodes are very sensitive to heat, solder quickly using a very hot soldering iron.

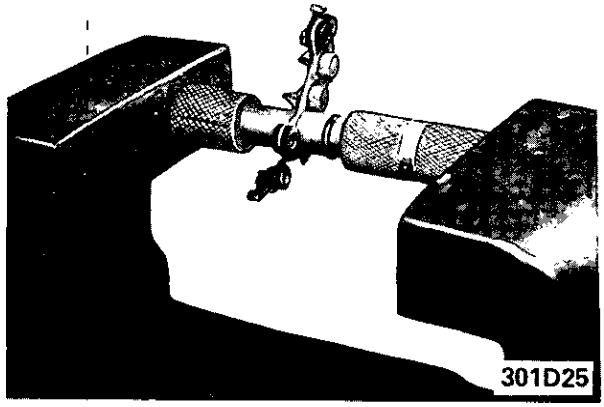


Figure 1D-25 Installing Diode

7. Install rotor together with drive end frame into stator and assemble generator in reverse order of disassembly. Make sure marks made during disassembly are aligned.

8. Install pulley and fan. Tighten nut to 30 lb.ft.

9. Test generator on test bench, if available. If not, install alternator on car and test.

Alternator Installation

1. Hold /alternator in position and install pivot bolt, plain washer, lockwasher and nut finger tight.

2. Install alternator belt.

3. Install adjusting brace bolt, lockwasher, plain washer and nut finger tight.

4. Position a belt tension gage such as Gage J- 23600 on belt. Pull alternator outward until gage reads 45 Ibs., then tighten adjusting brace bolt.

5. Tighten alternator pivot bolt.

6. Connect battery lead to alternator.

7. Plug three-way wiring connector into alternator and engage safety catch.

8. Connect battery ground strap.

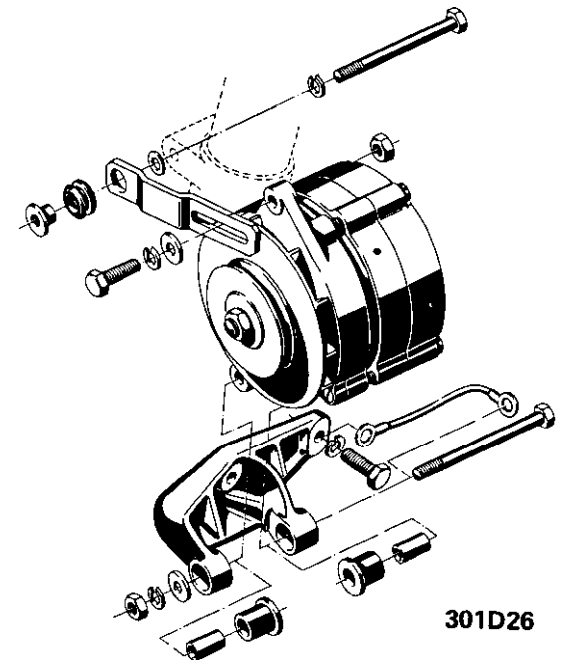


Figure 1 D-26 Alternator Installation

SPECIFICATIONS

ALTERNATOR

35, AMP	
Alternator Number	Kl 14V35A20
Rated Output in Volts	14
Continuous Rated Output in Amperes	35
Test Output in Amperes at 2000 Engine RPM	23 Min.
Resistance of Field Coil in Ohms	4-4.4
Resistance of Stator Windings in Ohms	26-29
Alternator Pulley Nut Torque in Lb.Ft.	30
Belt Tension in Pounds	45

REGULATOR

Regulator Number	AD 1/14 V
Regulator Setting in Volts at 2500 Engine R.P.M.	14 $\pm$ .5

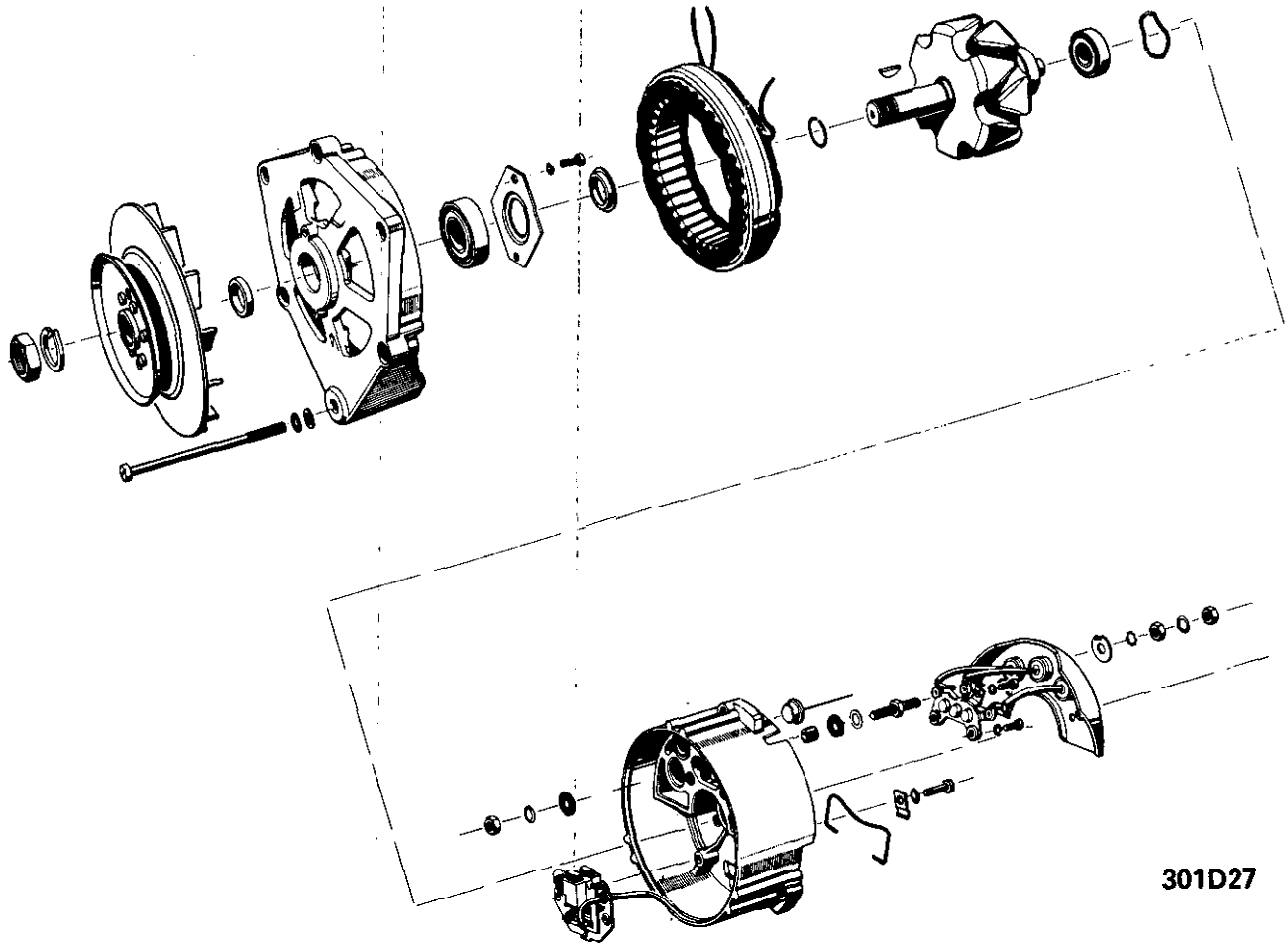


Figure 1 D-27 Alternator - Exploded View

WINDSHEILD WIPERS

ALL MODELS

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DESCRIPTION AND OPERATION

GENERAL DESCRIPTION

The two-speed wiper consists of a round shaped permanent magnet type motor and speed reduction gear box.

OPERATION

The wiper motor is controlled through a dash mounted switch on all cars. The Rallye and GT, in addition to the dash mounted switch, also have a switch mounted in conjunction with the windshield washer fodt pump. Depressing the washer pump will allow the wipers to operate while the pump is depressed.

DIAGNOSIS

PRELIMINARY INSPECTION

1. Make certain of firm wire connections at wiper motor fuse block and wiper switch.

2. Check to see that the fuse is not blown.

3. Be sure wiper motor is not loose on fire wall.

4. With the yellow wire disconnected from terminal No. 53 on the wiper motor, turn the ignition switch and wiper switch to the on position and check voltage available to the wiper motor. There should be 12 volts available at the purple wire with a properly charged battery.

Checking Wiper Operation

1. Turn ignition switch on and engage wiper switch to see if wiper motor will operate.

2. If wiper action is slow or inoperative, turn switches off and detach wiper control arm from crank arm.

3. Operate wiper manually checking for excessive bind in linkage. Correct if necessary.

4. Turn switch on to see if wiper motor will function with wiper linkage detached. If wiper motor will not run, disconnect connector at wiper motor and connect *hot* lead from battery to terminal No. 53 on wiper motor. If wiper motor runs, the wiper switch is faulty or there is an break in the lead wire. If wiper motor still will not run, remove and bench test.

MAJOR REPAIR

WIPER TRANSMISSIONS

Removal (1900 and Manta)

1. Remove wiper blade (2).

2. Remove the wiper transmission retaining nut, washer, and rubber seal ring. See Figure 1E-1.

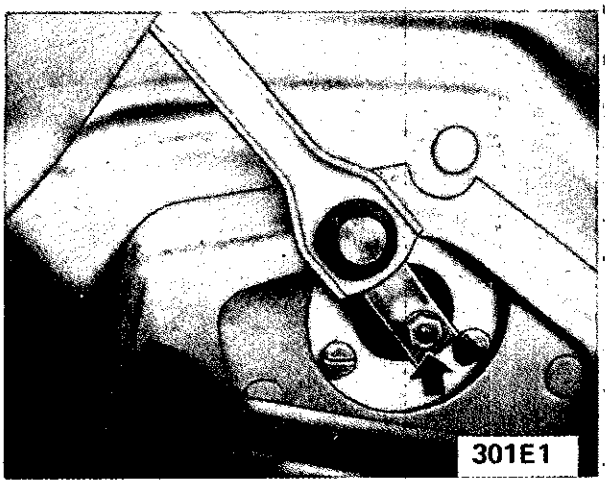


Figure 1E-1 Crank Arm Retaining Nut

3. Remove instrument cluster housing.

If only left wiper transmission is to be serviced, it can be done without removing any 'other instrument panel components. If the right side, or both, transmissions are to be serviced, then it will be necessary for complete instrument panel removal. On the Rallye models, the gauge carrier must also be remove& On all 1900 and Manta Models the defroster ducts are secured to the instrument panel cover, by two ('2) spring clips, and should not be removed from dash cover. Remove cover and duct as, a unit.

4. Remove retaining clips from transmission connecting rod pins. Pull connecting rods off pins. See Item "A", Figure 1E-2.

5. Remove the screws securing the wiper transmission to the inner side of the cowl (Items "B", Figure 13), and remove the transmission assemblies.

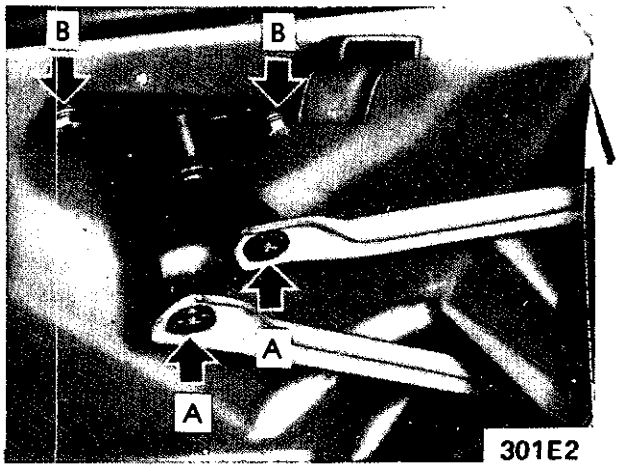


Figure 1E-2 Connecting Rod Retaining Clips

Installation

1. Place wiper transmissions into position at cowl and install holding screws.

2. Push connecting rods onto transmission cranking arm pins and install retaining clips. See Figure 1E-2, Item "A".

3. Reinstall dash and instrument cluster parts.

4. Install the rubber seal ring, washer, and transmission retaining nut. See Figure 1E-1.

5. Install wiper blades and check the position of the blades in the park position. See Figure 1E-3.

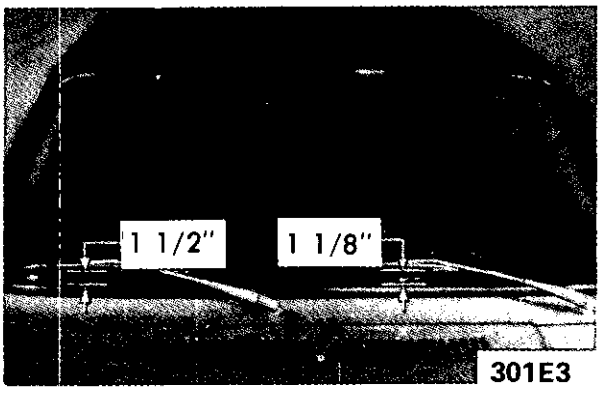


Figure 1E-3 Wiper Blades in Park Position

Removal and Installation of GT W/per Transmission

1. Remove nuts and remove both wiper arms. See Figure 1E-4.

2. Remove three (3) bolts from each windshield

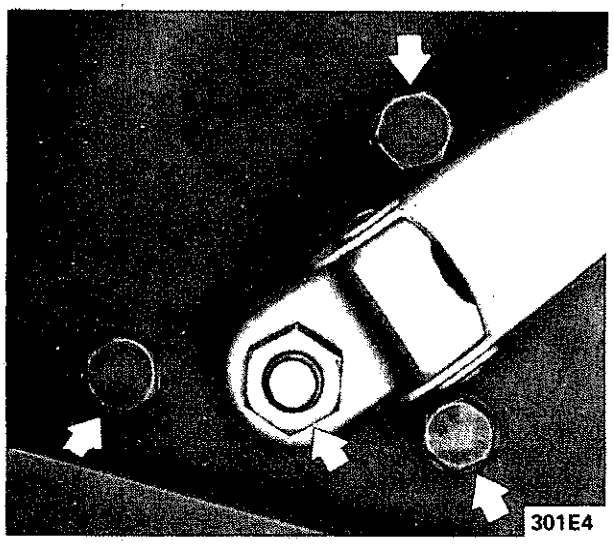


Figure 1 E-4 Removing Wiper Arms-GT

wiper transmission and drop wiper transmissions from deflector panels. See Figure 1E-4.

3. Remove screws from left and center deflector panels. See Figures 1E-5 and 6.

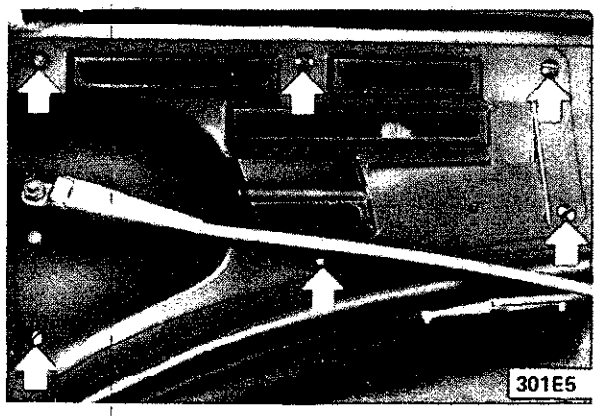


Figure 1E-5 Removing Screws from Left Deflector Panel

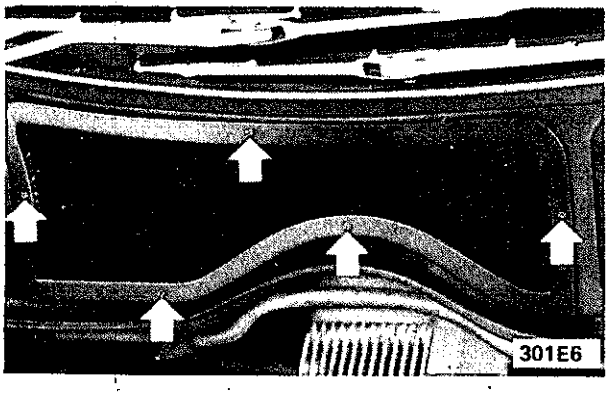


Figure 1E-6 - Removing Screws from Center Deflector Panel

4. Remove center deflector panel. Remove left deflector panel together with wiper motor and complete wiper linkage. See Figure 1E-7.

Figure 1E-7 - Removing Left Panel, Motor and Linkage

5. Remove nut and lockwasher from wiper motor shaft and remove complete wiper linkage.

6. Install in reverse sequence, checking all parts for wear. Replace any worn parts.

WIPER MOTOR OVERHAUL

Removal of Wiper Motor

1. Remove the wiper motor to crank arm attaching nut, this is done from the inside of vehicle. The nut is located on inner side of cowl, just above the steering column. See Figure 1E-1.

2. Pull crank arm off motor drive shaft.

3. Remove three (3) wiper motor attaching screws. See Figure 1E-8.

Figure 1 E-8 Wiper Motor Attaching Screws

4. Remove motor from cowl.

5. Remove wiper motor electrical connector from motor.

Disassembly

1. Remove two (2) motor housing attaching screws (Item No. 4) and two (2) angle brackets (Item No. 3). See Figure 1E-9.

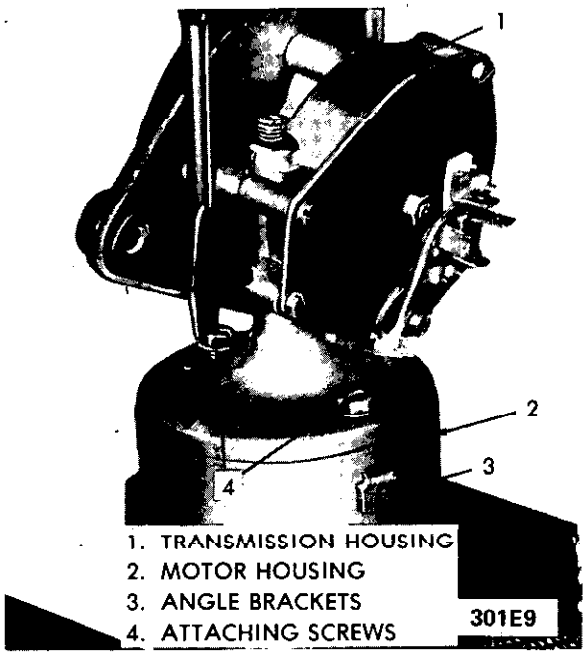


Figure 1 E-S Removing Motor Housing Attaching Screws

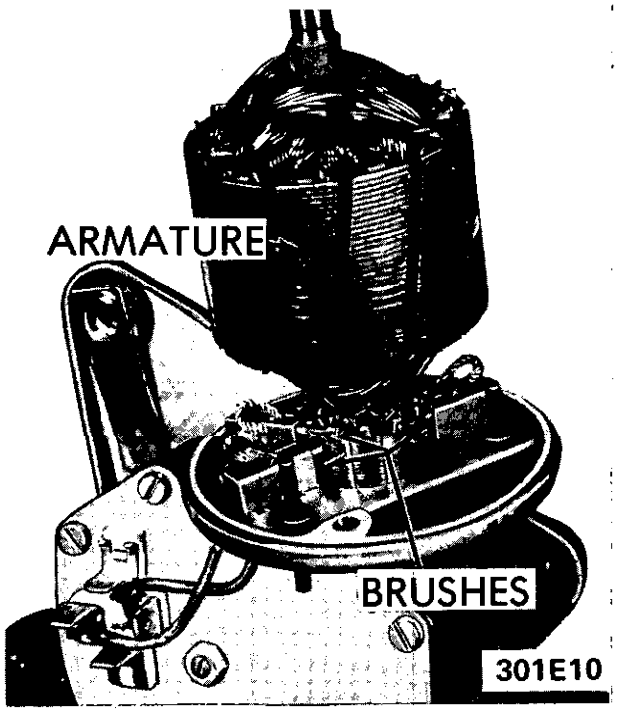


Figure 1 E-I 0 Transmission and Armature Removed from Motor Housing

2. Remove transmission housing together with armature from motor housing. See Figure 1E-10. It may be necessary to hold armature in transmission housing with a screw driver.

3. Remove armature from transmission housing.

4. Remove five (5) transmission housing cover screws. See Figure 1E-11.

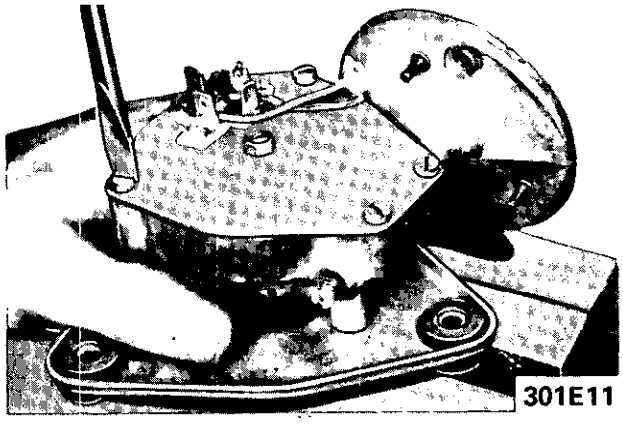


Figure 1 E-I 1 Remove Transmission Housing Cover Screws

5. Remove cover, gasket and driven gear from transmission housing. See Figure 1E-12. Remove pivot ball from driven gear. See Figure 1E-15.

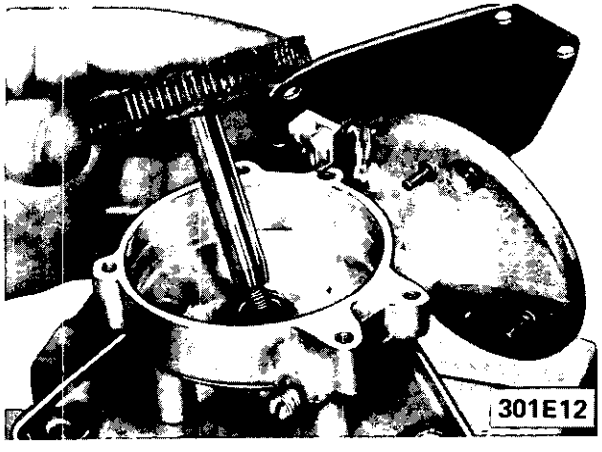


Figure 1 E-I 2 Remove Driven Gear

6. If required, remove brushes.

a. To remove positive brushes, cut brush leads off at brush holder. See Figure 1E-13.

b. To remove negative brush, remove brush retaining screw from commutator **end** frame. See Figure 1E-14.

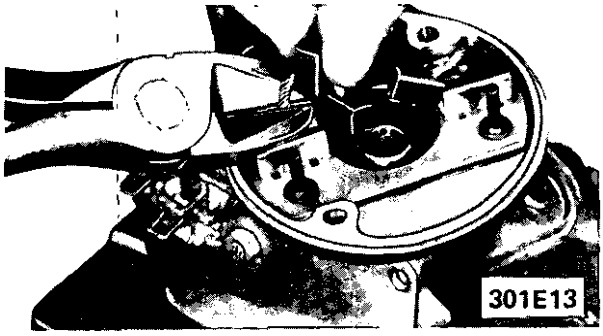


Figure 1 E-l 3 Cut Off Positive Brush Leads

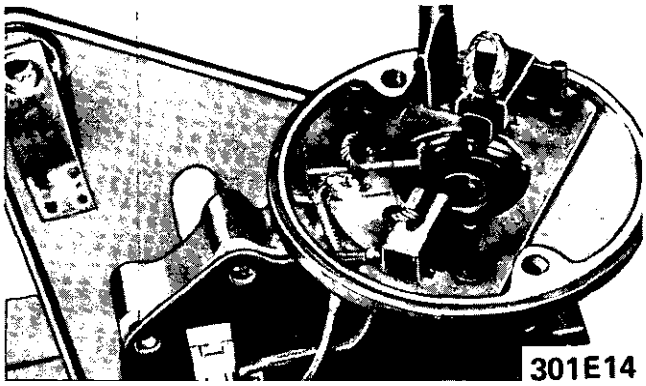


Figure 1E-14 Remove Negative Brush Retaining Screw

Cleaning and Inspection of Parts

With the exception of electrical parts and bushings, clean all components in a cleaning solvent.

1. Check armature windings for ground, or open circuit. If a ground or open circuit is evident, the armature must be replaced. If the armature checks out, the commutator can be undercut.

2. Check brush springs. Spring pressure of new brushes should be 6.35 to 8.47 ounces. Spring pressure of worn brushes should be at least 3.5 ounces. In case of lower spring pressure, replace springs.

3. Check brushes for wear and replace, if necessary. Minimum brush length should be .24 inch.

4. Check driven gear for wear and replace if necessary.

Assembly of Wiper Motor

1. Fill transmission (driven gear) housing with 1/8 inch layer' of grease meeting GM Specification 02383.

2. Install driven gear into housing

3. Apply a small amount of grease to ball cavity of driven gear and insert ball. See Figure 1E-15.

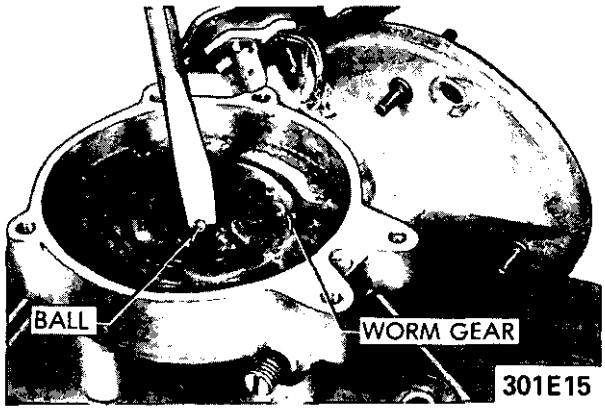


Figure 1E-15 Insert Ball into Driven Gear

4. Install transmission housing cover. See Figure 1E-16.

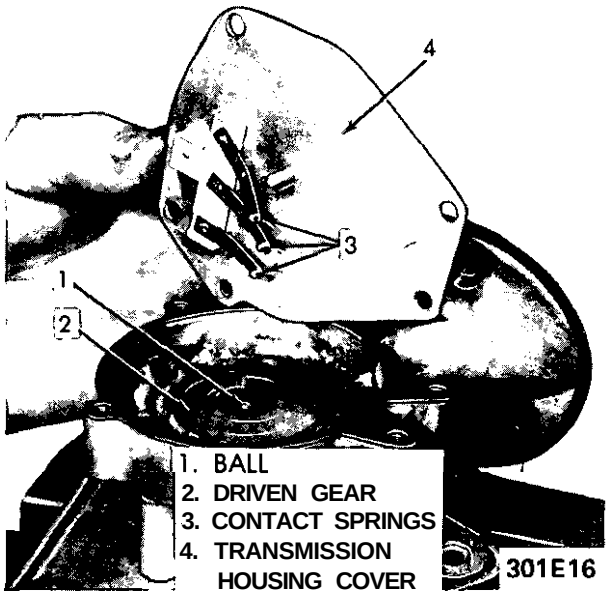


Figure 1 E-l 6 Install Transmission Housing Cover

5. Solder positive brush lead(s) to brush holder(s). Hold brush lead with needle nose pliers to prevent solder from running up wire strands. See Figure 1E-17.

6. Install negative brush

7. Apply a small amount of grease to end of armature shaft. Lightly oil armature shaft.

8. Insert brush springs and brushes into brush holders. Slide armature into housing, taking care not to damage brushes.

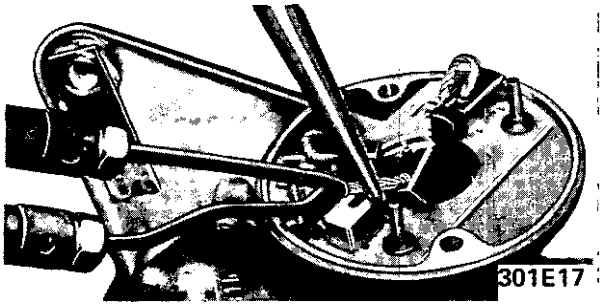


Figure 1 E-l 7 Solder Positive Brush Lead to Brush Holder

9. Install motor housing over armature so that large drain hole on housing is facing downward when motor assembly is installed in car. Insert angle brackets into motor housing and tighten attaching screws. Be sure to reseal angle brackets to motor housing after retaining screws are tightened.

10. Connect assembled motor with an ammeter and adjust end play of armature shaft and drive gear. To do so, turn in the respective adjusting screw until the current consumption increases. Then back off adjusting screw 1/2 turn. Secure driven gear adjusting screw with lock nut and armature adjusting screw with paint. See Figures 1E-18 and 1E-19.

Installation

1. Connect wiper motor electrical connector to motor.

2. Place wiper motor in position on cowl and secure. Torque attaching nuts 14 to 17 in.lbs.

3. Place crank arm on motor drive shaft and torque nut as follows: Bosch and SWF, 70 to 87 in.lbs. and Siemans, 122 to 139 in.lbs.

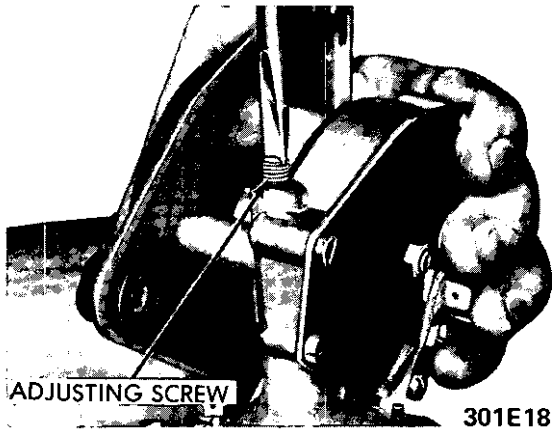


Figure 1 E-l 8 Adjusting Armature End Play

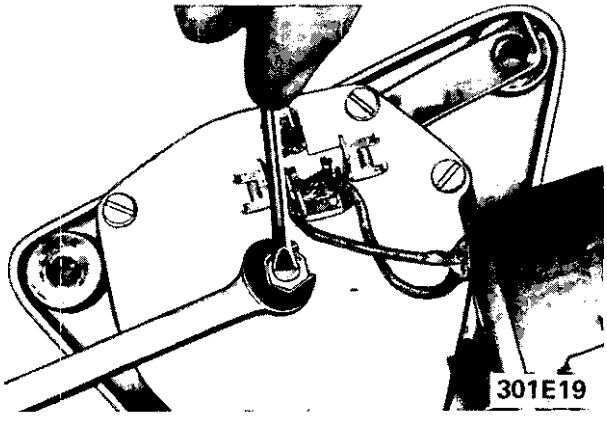


Figure 1E-19 Adjusting Driven Gear End Play

4. Check the position of the windshield wiper blades for proper position after the crank arm is attached. See Figure 1E-3 for the proper distance the blades should be from the windshield molding in the park position.

SPECIFICATIONS

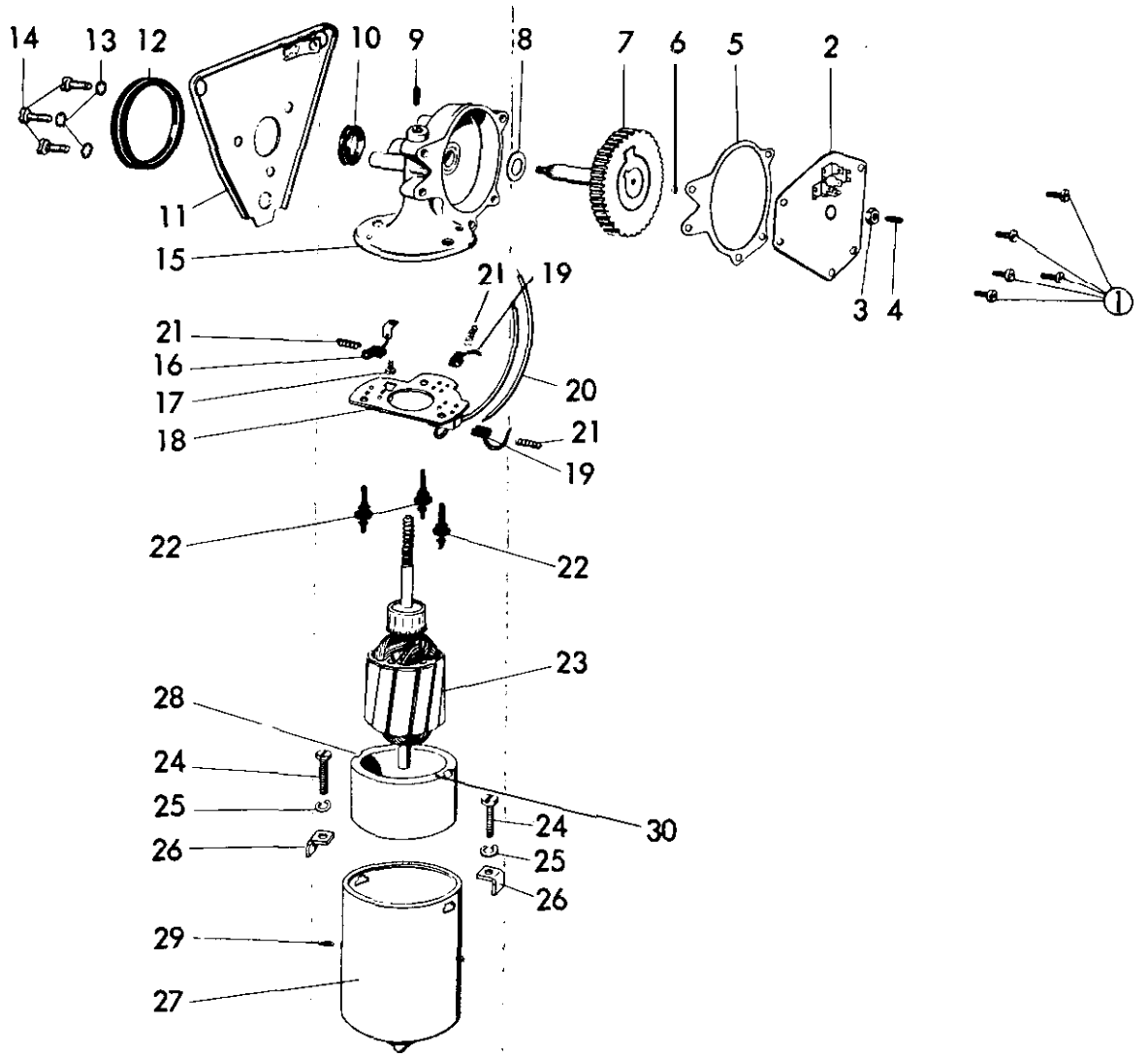
GENERAL SPECIFICATIONS

Rated Voltage	12 VDC
Test Voltage	13 VDC
Current Draw (Amps)	
No Load	
Low Speed	1.5
High Speed	2.2
Locked	
Low Speed	16
High Speed	17
Minimum Commutator Diameter	.86 in.
Brush Spring Pressure	
New Brush	6.35 to 8.47 oz.
Used Brush	3.5 oz. minimum
Minimum Brush Length	24 in.

The windshield wiper motor instead of field coils has a permanent magnet (oxide magnet). This motor design is sturdier and consumes less current.

TORQUE SPECIFICATIONS

Crank Arm to Motor Drive Shaft	70 to 87 in.lbs.
per Motor to Cowl	14 to 17 in.lbs.



1. ATTACHING SCREWS
2. TRANSMISSION COVER
3. HEX. NUT
4. THREADED END PLAY PIN
5. GASKET
6. BALL
7. DRIVEN GEAR
8. WASHER
9. THREADED END PLAY PIN
10. SLEEVE
11. MOUNTING PLATE
12. GASKET
13. TOOTHED WASHERS
14. ATTACHING SCREWS
15. TRANSMISSION HOUSING
16. NEGATIVE BRUSH
17. ATTACHING SCREW
18. RETAINING PLATE
19. POSITIVE BRUSH
20. WIRE'
21. THRUST SPRING
22. RUBBER MOUNTS
23. ARMATURE
24. ATTACHING SCREWS
25. LOCKWASHER
26. ANGLE BRACKETS
27. MOTOR HOUSING
28. MAGNET RING
29. MAGNET THREADED PIN LOCATORS
30. NORTH POLE PAINT MARKING ON THIS SIDE

NOTE: MOTOR HOUSING WITH MAGNET RING HAS TO BE INSTALLED SO THAT THE NORTH POLE MARKING (PAINT DOT ON MAGNET RING) FACES TOWARDS TRANSMISSION.

301 E20

Figure 1E-20 Wiper Motor - Exploded View

LIGHTING SYSTEMS

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Interior Light	1 F-53
Headlamp Switch	1 F-53
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DESCRIPTION AND OPERATION

DESCRIPTION OF LIGHTING SYSTEM

The three-position light switch on Opel 1900 and Manta controls the headlights, taillights, parking lights, side marker lights, instrument panel lights, and the license plate light.

When the light switch knob is pulled out to the first stop, the parking lights, side marker lights, the license plate light, and the instrument panel lights will light.

Pulling the knob out all the way turns the headlights on.

The instrument panel lights come on when the headlight switch is pulled out to the first stop or pulled out 'all the way. The instrument panel lights are turned off by turning the switch knob counterclockwise past the first detent.

Headlight High-Low Beam Control and Passing Signal

When the headlights have been switched on, high and low beam selection is made by raising the directional signal lever toward steering wheel. Each time the lever is raised, beam position, will change.

When the headlights are not on, a flashing headlight signal may be given by raising and lowering the directional signal lever. With the headlights on and in low beam position, raising and lowering the directional signal lever will also cause the headlights to flash.

Fog Light Switch

All Rallye models are equipped with two white fog lights mounted below the front bumper.

The fog light toggle switch is located on the instrument cluster to the left of the temperature and fuel gauge cluster.

The fog lights can be turned off at any time by the toggle switch, but can only be turned on when:

1. The ignition switch on or the engine running.!

2. The fog light toggle switch lower half is pushed in.

3. The parking lights and/or low beam headlights are on.

The fog lights are automatically turned off if the ignition switch is on and the headlights are switched to high beam position.

Courtesy Light

The courtesy light illuminates the interior of the Car when any door is opened. The courtesy light can also be turned on with all doors closed by tilting the lens.

GT Headlamp Mechanism

The concealed headlamps are moved mechanically. Pushing actuating lever on left side of console opens headlamps and pulling lever closes headlamps. Two (2) meshing gear segments convert the movement, of the lever to a rotation of 180 degrees. The pivots of the headlamps lie below the centerline so that with headlamps in closed position, the headlamp housing is flush with front sheet metal. Refer to Group 110, Section "F", for service procedures on the GT headlamp mechanism.

A white indicator lamp in the instrument panel lights if the headlamps are not completely opened or closed The switches of the headlamp electrical system are located behind the left headlamp operating, mechanism.

MAINTENANCE AND ADJUSTMENTS

HEADLAMP AIMING

The headlamps must be properly aimed in order to obtain maximum road illumination and safety that has been built into the headlighting equipment. With the Guide T-3 type sealed beam units, proper aiming is even more important because the increased range and power of this lamp make even slight variations from recommended aiming hazardous to approaching motorists. The headlamps must be checked for proper aim whenever a sealed beam unit is replaced and after an adjustment or repairs of the front end sheet metal assembly.

Regardless of method used for checking headlamp aim, car must be at normal weight, that is, with gas, oil, water, and spare tire. Tires must be uniformly inflated to specified pressure. If car will regularly carry an unusual load in rear compartment, or a trailer, these loads should be on car when headlamps are checked. Some States have special requirements for headlamp aiming adjustment, and these requirements should be known and observed.

Horizontal and vertical aiming of each seal beam unit is provided by two adjusting screws which move the mounting ring in the body against the tension of the coil spring. There is no adjustment for focus, since the sealed beam unit is set for proper focus during manufacturing assembly.

MAJOR REPAIR

HEADLIGHT SWITCH · OPEL 1900. MANTA

Removal

1. Remove instrument cluster cover panel. See Section H.

2. Compress retaining springs and pull switch out. See Figure 1 F- 1.

3. Pull multiple socket off switch.

Installation

1. Plug multiple socket in switch and push switch in panel until clips lock in place.

2. Replace instrument cover and secure with two (2) screws.

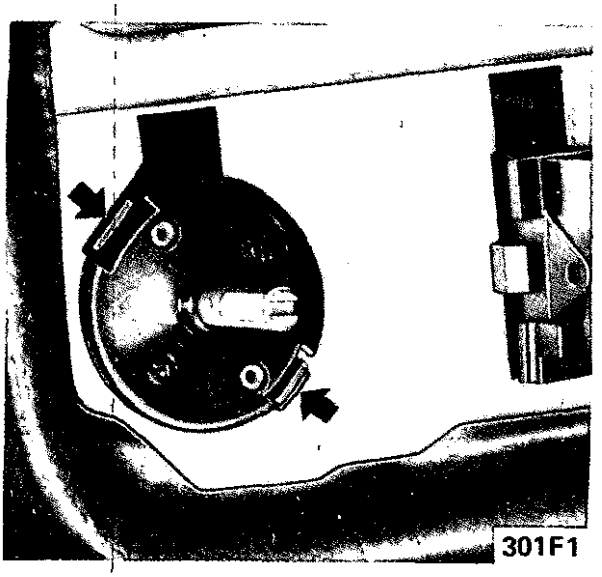

Figure 1 F-l Removing Headlight Switch

3. Replace two (2) plugs over screws and replace heater control knobs.

FOG LIGHT OR HEATED REAR GLASS SWITCH

Removal

1. Remove instrument cluster cover. See Section H.

2. Press down retaining clip and pull switch out. See Figure 1F-2.

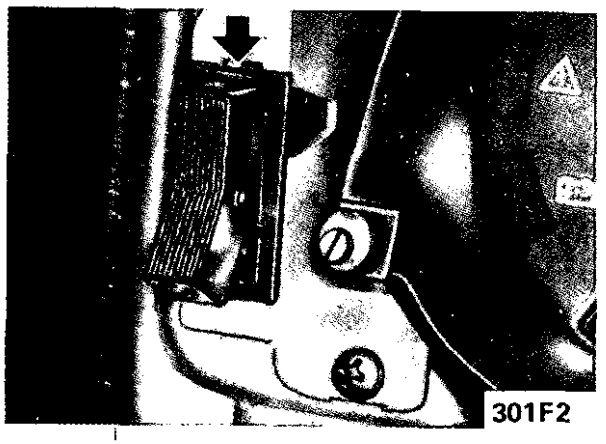

Figure 1F-2 • Removal of Fog Light or Heated Rear Glass Switch

3. Remove wires from switch.

Installation/

1. Connect wire to switch,

2. Install switch in panel.

3. Replace instrument cluster cover.

EXTERIOR LIGHTS

Models 51-53-54

Headlamp Sealed Beam Unit Removal

1. Remove two screws on headlight ring.

2. Remove four screws holding headlight retainer to body. See Figure 1F-3.

Figure 1 F-3 • Removing Headlight Retainer • Models 51-53-54

3. Disconnect wiring connectors,

4. Remove headlight from inside engine compartment.

Installation

1. Plug in wiring connector on sealed beam and replace four (4) headlight retaining screws.

2. Replace headlight ring.

Models 57-57R

Removal

1. Disconnect wiring connector.

2. Remove four screws holding headlight retainer from inside engine compartment.

3. Disassemble headlight assembly from retaining ring. See Figure 1F-4.

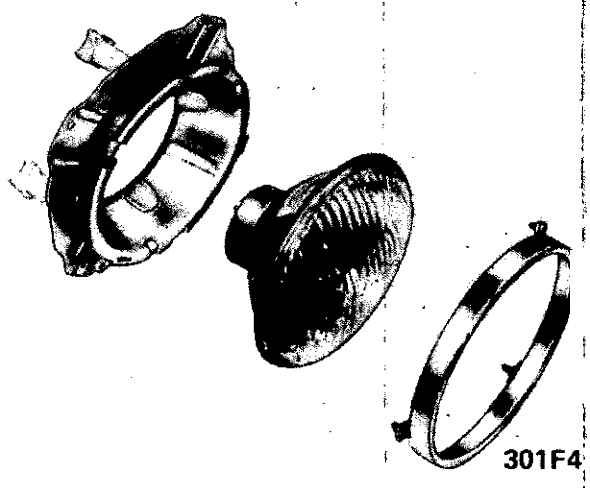

Figure 1 F-4 - Headlight Assembly - Models 57-57R

Installation

1. Assemble headlight to retaining rings.;

2. Install to body from inside engine compartment with four (4) screws.

3. Connect wiring harness.

Parking Light Housing or Lens Removal

1. Remove two screws holding lamp lens.

2. Remove two screws holding housing. See Figure 1F- 5.

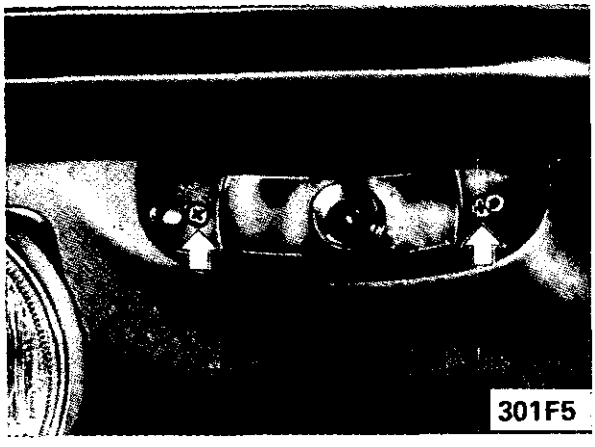

Figure 1F-5 Remove Parking Light Housing

3. Disconnect wiring harness.

Installation

1. Apply sealer to housing

2. Connect wiring harness.

3. Replace housing in body with two (2) retaining screws.

4. Replace lamp lens.

REAR STOP, TAIL, DIRECTIONAL SIGNAL, OR BACK-UP LAMP HOUSING

Models 51-53

Removal

1. In luggage compartment, unscrew housing attaching nuts. See Figure 1F-6.

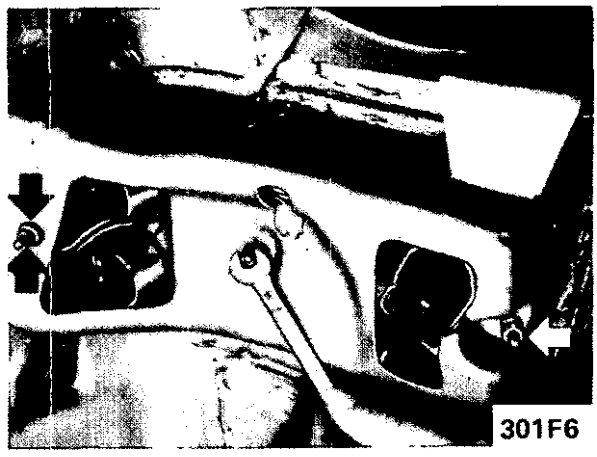

Figure 1F-6 Tail Light Housing Attaching Nuts Models 5 1-53

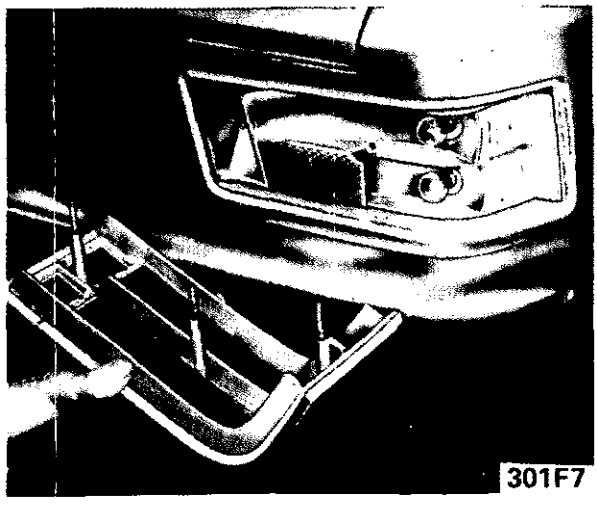

Figure 1F-7 - Removing Tail Light Lens - Models 51.53

2. Take Lens off housing. See Figure 1F-7.

3. Remove housing.

Installation;

1. Install lens in housing.

2. Replace housing.

Model 54

Removal

1. Remove lamp lens from outside.

2. Remove rear quarter trim pad.

3. Remove four screws from inside car. See Figure 1F- 8

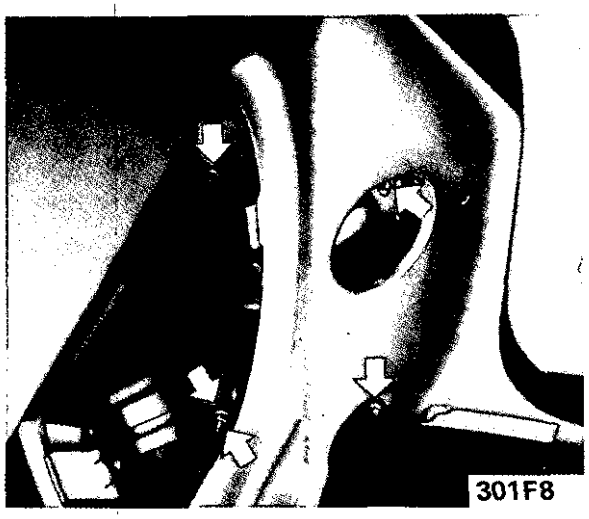

Figure 1 F-8 - Removing Tail Light Housing - Model 54

4. Disconnect wiring connector.

Installation

1. Connect wiring to lamp

2. Install housing using four (4) screws.

3. Replace rear quarter trim pad

4. Replace lens.

Models 57-57R

Removal

1. Unscrew lens from housing.

2. In luggage compartment, unscrew three (3) housing attaching nuts. See Figure 1F-9.

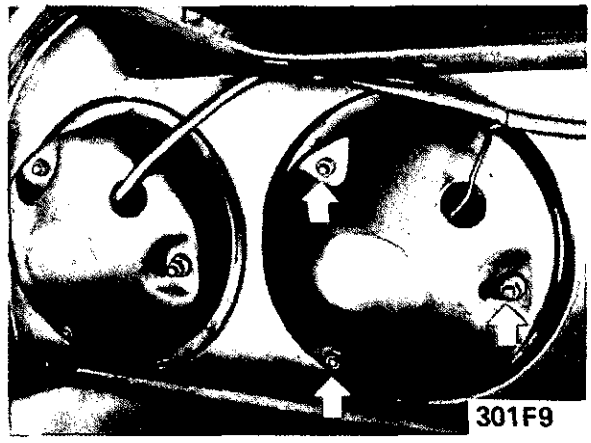

Figure 1F-9 Tail Light Housing Attaching Nuts - Models 57-57R

3. Disconnect wire connector.

Installation

1. Plug in wiring harness.

2. Replace housing with three (3) attaching nuts.

3. Replace lens.

Rear License Plate Lamp Assembly Removal

1. Remove two screws holding housing to bumper.

2. Pull lamp assembly down.

3. To replace bulb, take out two screws holding lens in place.

Installation

1. Replace bulb and lens to housing.

2. Replace lamp assembly to bumper with two (2) screws.

SIDE MARKER LIGHTS

Front Removal

1. Remove outer lens.

2. Remove two sheet metal screws for housing attachment.

3. Disconnect wire connectors.

Installation

1. Connect wiring harness.
2. Replace housing with two (2) screws.
3. Repalce lens.

Rear Removal

Remove two screws from support bracket and remove housing **and** lens. See Figure 1F-10.

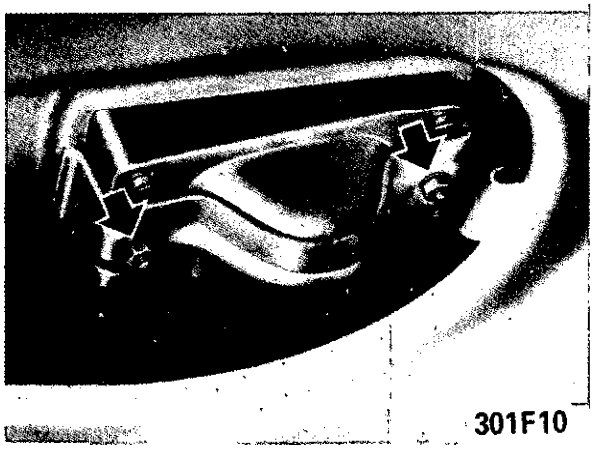

Figure 1 F-10 . Removing Rear Side Marker Lamp

Installation

Install housing **and** lens with two (2) attaching screws.

INTERIOR LIGHTS

Courtesy Light Removal

1. Pry courtesy light out of roof frame, as shown in Figure 1 F- 11.

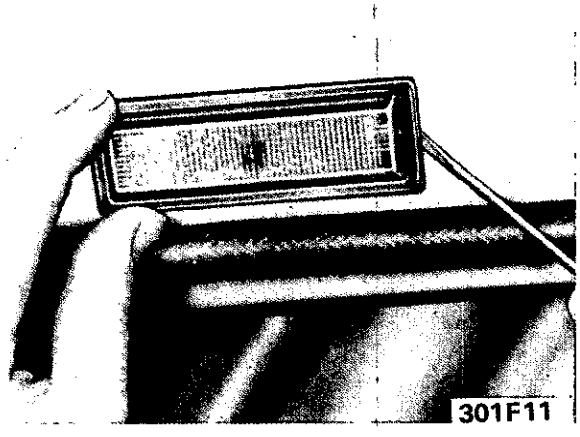

Figure 1F-1 1 . Removing Courtesy Light

2. Pull wires off flat plugs. See Figure 1F-12.

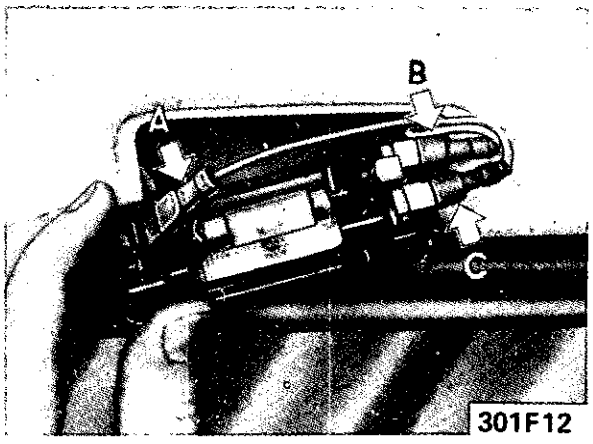

Figure 1F-12 -Courtesy Light Wire Connections

Installation

1. Connect wires to flat plugs, a) red wire, b) grey wire, and c) brown wire.
2. Push light back into roof frame.

Door Jam Switch Removal

1. Remove door jam switch attaching screws.
2. Remove switch and disconnect wire.

Installation

1. Connect wire to switch.

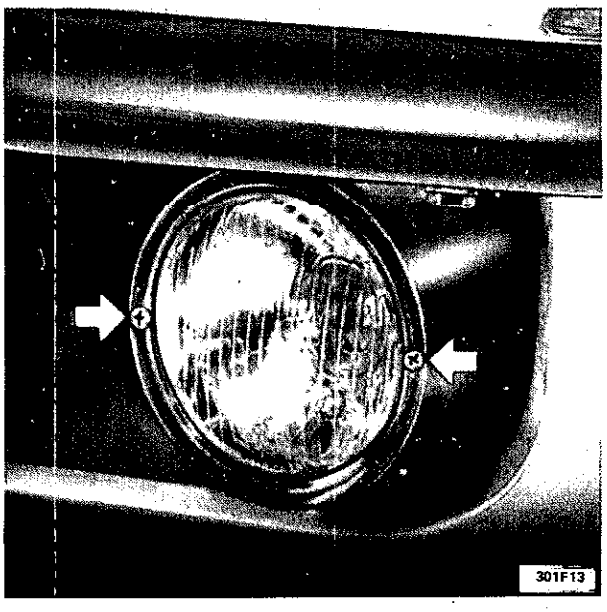

Figure 1 F-l 3 Removing Parking Light Lens

2. Install switch to door jam.

EXTERIOR LIGHTS. GT

Removing Parking-Light Housing

1. Remove lamp lens.
2. Remove lamp housing.
3. Disconnect electrical wires. See Figure 1F-13.

Installation

1. Connect electrical wires.
2. Install lamp housing and lens.

Removal of Front Directional Signal Lamp

1. Remove lamp lens.
2. Remove lamp housing.
3. Disconnect electrical wires. See Figure 1F-14.

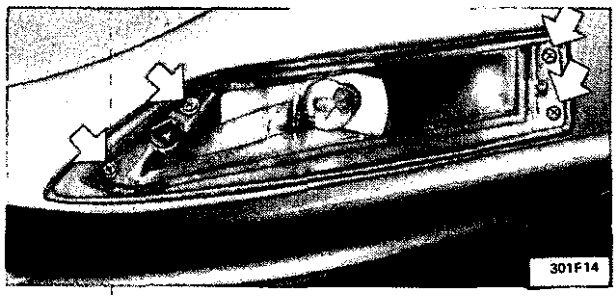

Figure 1F-14 Removal Front Directional Lamp Lens

Installation

1. Connect electrical wires.
2. Install lamp housing and lens.

Removal of Headlamp Sealed Beam

1. Rotate headlamp to open position.
2. Remove headlamp shield. See Figure 1F-15.
3. Remove headlamp attaching screws and take off headlamp.; See Figure 1F-16.
4. Disconnect electrical wires.

Installation

1. Install headlamp with three (3) attaching screws.

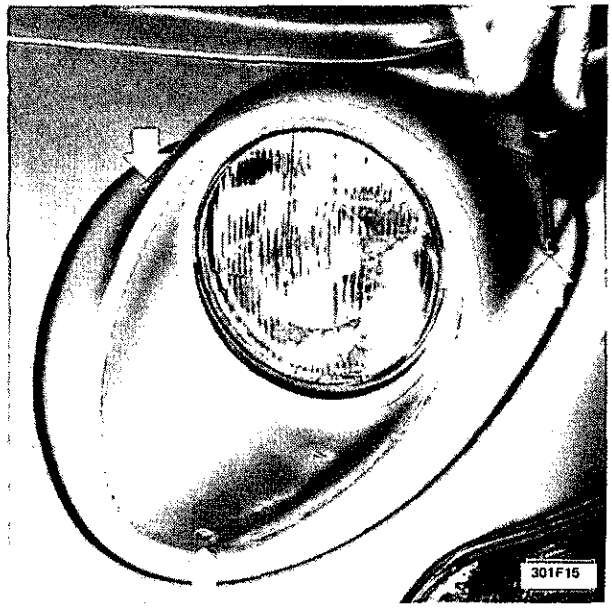

Figure 1F-15 Removing Headlamp Shield

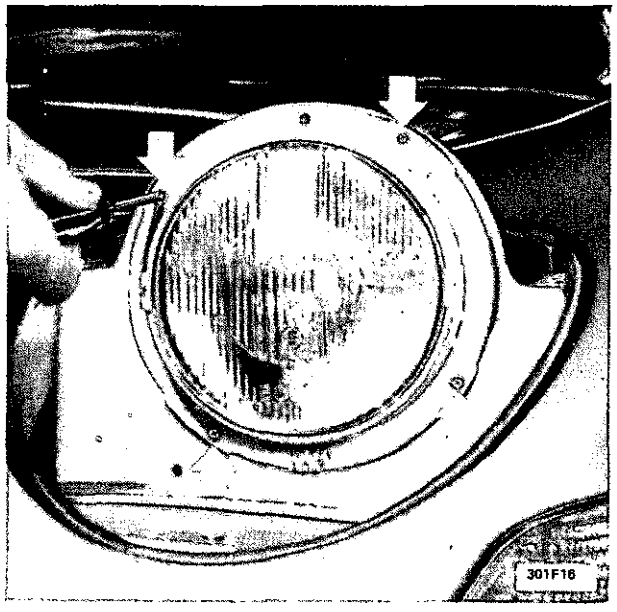

Figure 1 F-16 Removing Headlight Attaching Screws

2. Connect electrical wires.
3. Replace headlamp shield.

Before installation of headlamp shield, adjust headlamp for proper aim.

Removal of Rear Directional Signal Lamp. Stop and Tail Lamp

1. Remove lamp lens.

2. Remove lamp housing.

3. Disconnect electrical wires. See Figure 1F-100.

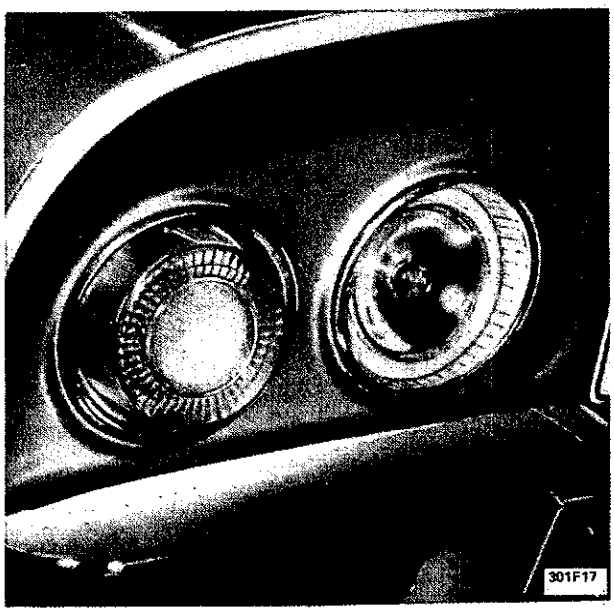

Figure 1 F-l 7 Rear Directional Signal. Stop and Tail' Lamp

Installation

1. Connect electrical wires.

2. Install lamp housing and lens.

Removal of Side Marker Lights

1. Completely remove adjacent rear directional signal lamp.

2. Through directional signal lamp opening, tbe marker lamp assembly can be removed. See Figure 1F-18.

Installation

1. Install side marker.

2. Replace directional signal lamp.

Removal of License Plate Lamp

1. Remove adjacent tail and directional signal lamp.

2. Through opening remove bumper bolts.

3. Disconnect electrical wires.

4. Remove bumper guard from bumper.

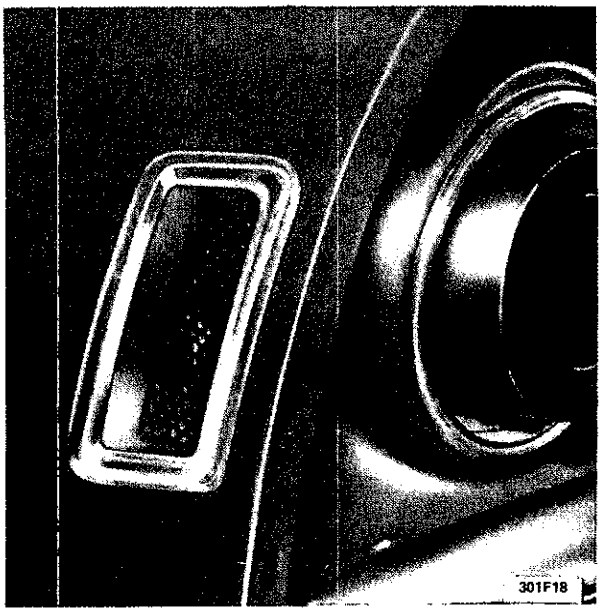

Figure 1F-18 Side Marker Light Location

5. Remove lamp housing. See Figure 1F-19.

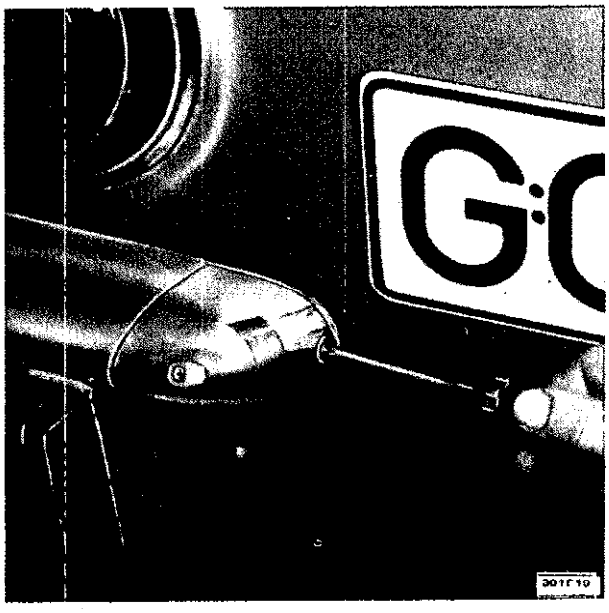

Figure 1 F-l 9 Removing License Plate Light

Installation

1. Install lamp housing.

2. Install bumper guard in bumper.

3. Connect electrical wire.

4. Install bumper bolts.

Removal of Back-Up Lamp

1. Remove back-up lens.
2. Remove lamp housing.
3. Disconnect electrical wires. See Figure 1F-20

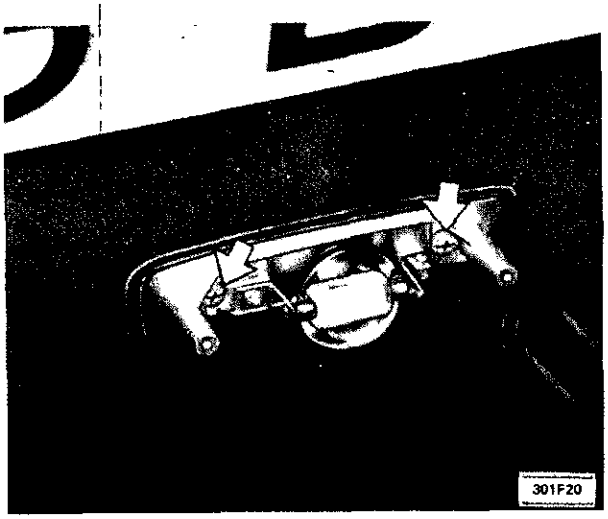

Figure 1F-20 Removal of Back-Up Light

Interior Light Removal

1. Disconnect battery.
2. Remove lens.
3. Remove base plate by removing two (2) screws.
4. Unplug wires.

Installation

1. Connect wires to proper plugs.
2. Install! base plate.
3. Install! lens.
4. Con&t battery.

Removal of Headlamp Switch

1. Completely remove left headlamp and headlamp housing.
2. Remove switch from base plate. See Figure 1F-21.

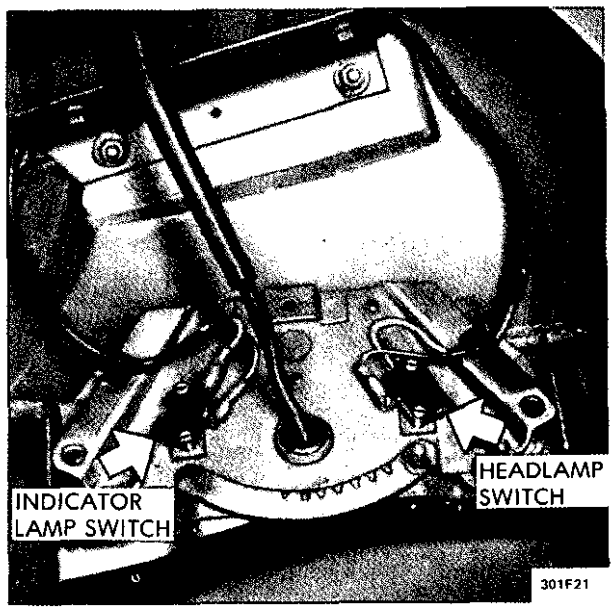

Figure 1F-2 1 Light Switch Positions

Installation

1. Install switch to base plate.
2. Install left headlamp and housing.

Door Jam Switch Removal

1. Remove door jam switch attaching screws.
2. Remove switch and disconnect wire.

Installation

1. Connect wire to switch.
2. Replace switch on door jam with attaching screw.

SIGNAL SYSTEMS

CONTENTS

Subject	Page No.
DESCRIPTION AND OPERATION:	
Directional Signal Lever	1 G-54
Horn	1 G-54
Hazard Warning Flasher	1 G-55
Brake System Warning Light	1G-55
DIAGNOSIS:	
Signal System	1 G-55
MAINTENANCE AND ADJUSTMENTS:	
MAJOR REPAIR:	
Directional Signal Switch	1 G-55
Horn Removal	1G-55
Removing Horn Contact	1 G-55
SPECIFICATIONS:	
Fuse Chart	1 G-56

DESCRIPTION AND OPERATION

DIRECTIONAL SIGNAL LEVER

The direction signal switch lever is a multi- purpose lever controlling direction signals, passing signal, and high and low beams. See Figure 1G-1.

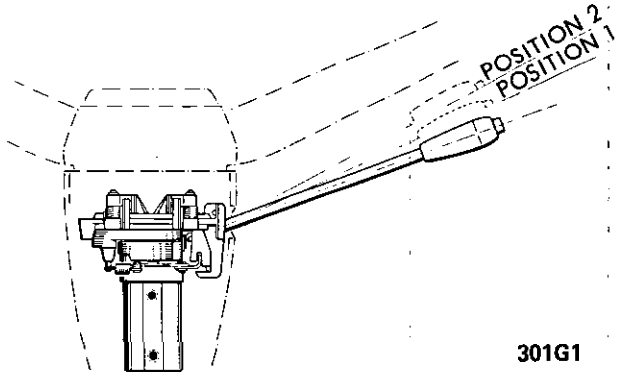

Figure 1G-1 Directional Signal Position for Headlamp Operation

The direction signal lever is provided with a two-step mechanism for operation of headlight high and low beams, and passing signal (not in New Jersey). With headlights off, moving the lever repeatedly towards steering wheel flashes headlights as a passing signal. With headlights on, moving the lever repeatedly towards steering wheel up to first stop also flashes passing signal regardless whether or not the direction signals are switched on. When the lever is moved up to the second stop, the headlights are changed from high to low beam or vice versa. On all Rallye cars, when switching from low to high beam position, with the fog lamp instrument panel switch "ON" and ignition switch in "RUN" position, the fog lights are automatically switched off. Direction signals work in the normal manner; pushing the lever up for right turn signal and pulling the lever down for left turn signal.

HORN

The horn button is located in the center part of the steering wheel. The horn is actuated by pushing down on the ends of both spokes on Opel 1900 and Manta's or on the center horn button on the Rallye. The button is provided with a spring-loaded plunger. See Figure 1G-2.

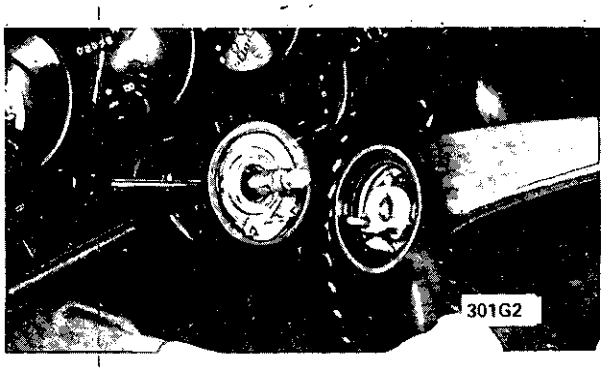

Figure 1G-2 Horn Button and Contact

HAZARD; WARNING FLASHER

The hazard warning flasher is operated by the button on the top of the steering column. When the button is pressed down and released, all four turn signal lights will flash. To turn the flasher system off, press down on the button and release. When the hazard warning system is operating, a flashing light in the instrument cluster will operate. The hazard warning flasher switch is part of the directional signal switch.

BRAKE SYSTEM WARNING LIGHT

The brake system warning light is located in the left side of the instrument cluster assembly. The light will come on when the brake pedal is depressed and the ignition is on if there is a hydraulic leak in the brake system. The light will go out when the foot is removed from the brake pedal. The light will also glow with the parking brake applied and the ignition on. (On automatic transmission equipped vehicles, light is a reminder to release parking brake; and on manual transmission equipped vehicles, light glows when the clutch pedal needs adjustment,)

DIAGNOSIS

SIGNAL SYSTEM

The indicator light on the dash will show defects in the directional signal system as follows:

1. Indicator light on dash gives only one quick flash.

One of the switched-on directional signal lamp bulbs is defective. The other signal lamp will continue to flash. The most common defect is a burned out bulb.

2. Indicator light on dash stays on when directional signal lever is switched to either side. Check flasher unit.

MAJOR REPAIR

Removing and Installing Directional Signal Switch

Proceed as outlined in Group 3, Section E.

HORN REMOVAL

1. Remove grille (GT only).
2. Remove horn bracket attaching bolt.
3. Disconnect wires and remove horn.

Installation

1. Install horn with bracket attaching bolt.
2. Connect horn wire.
3. Install grille (GT only).

Removing Horn Contact

1. Disconnect battery.
2. Remove horn cap.
3. Bend lockplate tabs down and remove steering wheel nut, lockplate, and washer.
4. Mark shaft and wheel hub for reassembly alignment.
5. Remove steering wheel using Wheel Puller J-21686.
6. Remove horn contact from wheel.

installation

1. Replace horn contact.
2. Before installing steering wheel, lubricate return pin and slide area on directional signal switch return cams and contact ring.
3. With steering wheel properly aligned to shaft, install washer, lockplate, and nut. Torque nut to 15 lb.ft.
4. Bend up lockplate tab and install horn cap.
5. Connect battery.

FUSE POSITION	AMPS.	CIRCUITS PROTECTED
		OPEL 1900 & 'MANTA (51,53,54,57,57R)
1	5	LEFT PARKING LIGHT, LEFT TAIL LIGHT, LEFT SIDE MARKER LIGHTS
2	5	RIGHT PARKING LIGHT, RIGH TAIL LIGHT, RIGHT SIDE MARKER LIGHTS, INSTRUMENT PANEL LIGHTS, SHIFT QUADRANT LIGHTS, LICENSE PLATE LIGHT, FOG LIGHTS (RALLYE ONLY)
3	8	IGNITION KEY WARNING BUZZER, TRUNK LIGHT, HAZARD WARNING FLASHER, COURTESY LIGHT, CLOCK
4	15	BACKUP LIGHTS, BLOWER MOTOR, CIGAR LIGHTER; RADIO, SAFETY BELT WARNING BUZZER AND LIGHT
5	15	WINDSHIELD WIPERS, WINDSHIELD WASHER (RALLYE ONLY), HORN
6	8	STOP LIGHTS, TURN SIGNAL AND INDICATOR LIGHT, PARKING BRAKE WARNING AND BRAKE FAILURE LIGHT, FUEL GAGE, TEMPERATURE GAGE, OIL PRESSURE INDICATOR LIGHT. CHARGING INDICATOR LIGHT, TACHOMETER AND OIL PRESSURE GAGE (RALLYE ONLY)
		AIR CONDITIONING – 20 AMP INLINE FUSE
		OPEL GT (77)
1	8	WINDSHIELD WIPERS, WINDSHIELD WASHER, HORN, BACKUP LIGHT, SAFETY BELT WARNING BUZZER AND LIGHT
2	5	STOP LIGHTS, TURN SIGNAL AND INDICATOR LIGHT, PARKING BRAKE WARNING LIGHT (AUTOMATIC ONLY), BRAKE FAILURE WARNING LIGHT, RADIO, TACHOMETER, OIL PRESSURE GAGE & INDICATOR LIGHT, FUEL GAGE, TEMPERATURE GAGE, CHARGING INDICATOR LIGHT
3	16	CIGAR LIGHTER, BLOWER MOTOR
4	5	IGNITION KEY WARNING BUZZER, COURTESY LIGHT, CLOCK, HAZARD WARNING FLASHER
5	5	LEFT PARKING LIGHTS, LEFT TAIL LIGHT, LEFT REAR SIDE MARKER LIGHT
6	5	RIGHT PA'RKING LIGHTS, RIGHT TAIL LIGHT, RIGHT REAR SIDE MARKER LIGHT
7	5	INSTRUMENT PANEL LIGHTS, LICENSE PLATE LIGHT. SHIFT QUADRANT LIGHT
		AIR CONDITIONING – A/C HAS A 20 AMP INLINE FUSE AND IS CONNECTED TO THE HOT SIDE OF FUSE NO. 2

INSTRUMENT PANEL

CONTENTS

Subject	Page No.
DESCRIPTION AND OPERATION:	
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Instrument Panel - GT	1 H-58
DIAGNOSIS:	
MAINTENANCE AND ADJUSTMENTS:	
MAJOR REPAIR:	
Instrument Cluster Housing - Opel 1900 - Manta	1 H-59
Windshield Wiper Switch	1 H-61
Instrument Cluster Bulbs	1H-61
Instrument Cluster Housing - GT	1 H-61
Combined Switch Assemblies	1 H-63
Cigar Lighter	1 H-64
SPECIFICATIONS: (Not Applicable)	

DESCRIPTION AND OPERATION

INSTRUMENT PANEL (OPEL 1900. MANTA)

Headlight Switch

The three position light switch controls the headlights, taillights, parking lights, side marker lights, license plate light and instrument panel lights and is located at the lower left on the instrument panel.

With thk switch knob pulled outward to the first stop, the parking lights, side marker lights, license plate light and instrument panel lights will light. The instrument panel lights can be turned off by turning the lightswitch knob counterclockwise past the first detent.

By pulling the lightswitch knob out all the way, the headlights will also be turned on.

Fog Light Switch (Rallye)

The fog light toggle switch is located in the instrument cluster to the left of the temperature and fuel gauge cluster. The fog lights can be turned off at any time by the toggle switch, but can only be turned on when:

1. The ignition switch is on or the engine running.
2. The fog light toggle switch lower half is pushed in.
3. The parking lights and/or low beam headlights are on.

The fog lights are automatically turned off if the ignition switch is on and the headlights are on high beam.

Windshield Wiper Switch

The windshield wiper switch is located on the instrument panel to the right of the headlight switch.

By pushing the lower half of this switch in to the first stop, the wipers will operate at slow speed. By pushing in to the second stop, the wipers will operate at fast speed.

Electrically Heated Rear Window Switch (If Equipped)

The heated rear window switch is located in the instrument panel to the right of the clock opening.

To operate (only possible with the engine running), push in on the lower half of the switch. When the rear window is being heated, the switch will be lighted.

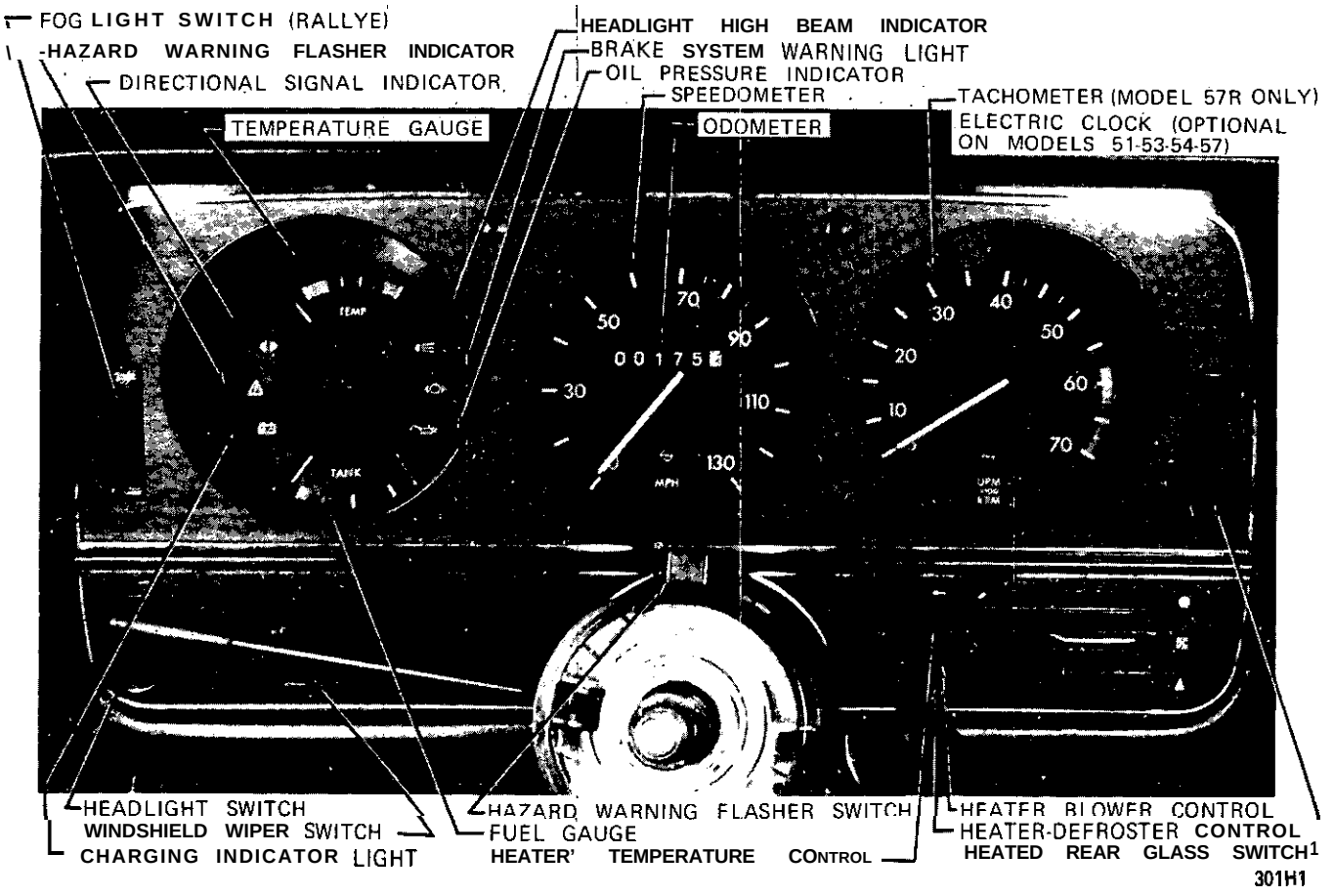

Figure 1 H-I - 1900 Instrument Arrangement

INSTRUMENT PANEL (GT)

Headlight Switches

There are two headlight switches, one for turning on the headlights and the other operates an indicator light on the instrument panel. Both switches are located behind the left headlamp assembly.

When the headlamp lever is pushed forward,' the operating mechanism rotates the headlights to open position, turns the headlight and instrument panel indicator light switches on until the headlamps are locked in full open position at which time the indicator lamp switch is turned off.

Along with the headlights, the headlight switch also turns on the parking lights, taillights, license plate lights and rear side marker lights.

Parking Light and instrument Panel Light Switch Assembly

The left switch of this assembly is the Parking Light Switch. By pushing inward on the lower half of this switch, the parking lights, taillights, license plate lights and rear side marker lights are **turned** on and can **be** turned off by pushing inward on the upper half of the switch providing the headlights are not turned on.

The center portion of this switch assembly is inoperative and controls nothing.

The switch on the right end of this assembly is the Instrument Panel Light switch. By pushing inward on the lower half of the switch turns on the instrument panel lights. The brightness of the instrument panel lights can be adjusted by movement of the switch. If either the Parking Light or Instrument Panel switch becomes defective, the switch assembly must be replaced.

Combined Windshield Wiper, Electrically Heated Rear Window and Heater Blower Switch

This switch assembly is located to the right of the cigar lighter. If any one of these switches should fail, the complete switch assembly must be replaced.

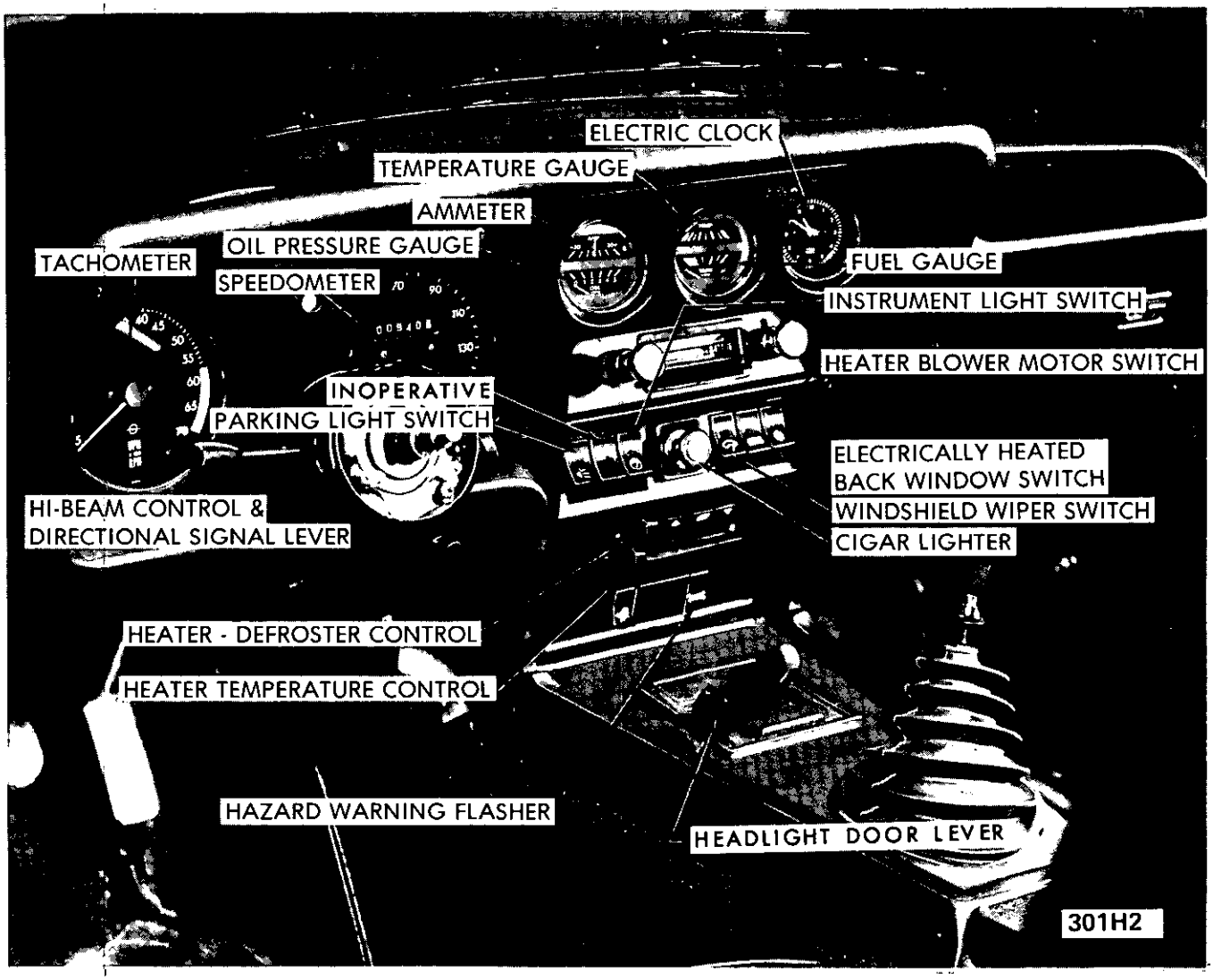

Figure 1 H-2 - GT Instrument and Switch Arrangement

The Windshield Wipers have two-speed operation. By pushing the lower half of the switch inward to the first stop, the wipers will operate at half speed and by depressing to the second stop will provide full speed operation. When the switch is returned to the off position, the wiper blades automatically return to their park position.

The Electrically Heated Rear Window Switch is standard whether or not the vehicle is equipped with this option. The engine must be running before sufficient current can be generated to energize this circuit even though the switch is depressed to the "ON" position! When the window is being heated, a warming light on the instrument panel will glow. This light is located below the left ventilation inlet.

The Heater Blower Switch is a three position switch. By depressing the lower half of the switch to the first stop. the blower will operate at low speed. When depressed to the second stop, the blower will operate at high speed.

Four Way Hazzard Warning Flasher Switch

The hazzard warning flasher switch is located below the heater controls in the center console. By depressing the lower half of the switch, all four turn- signal lamps flash at the same time. Although this system makes use of the regulat turn signal system, it has a separate feed wire to the switch which allows for its operation even with the ignition switch and doors locked. No vehicle should be driven with this system in operation because of its universal meaning "This Vehicle Is Not Moving". To turn the system off, simply depress the upper half of the switch.

MAJOR REPAIR

Removal of Instrument Cluster Housing Assembly. Opel 1900 Manta

Before starting any instrument panel repair, always disconnect battery ground cable first.

1. Remove headlight switch button by depressing retaining clip on shaft and pulling back on switch knob. See Figure 1H-3.

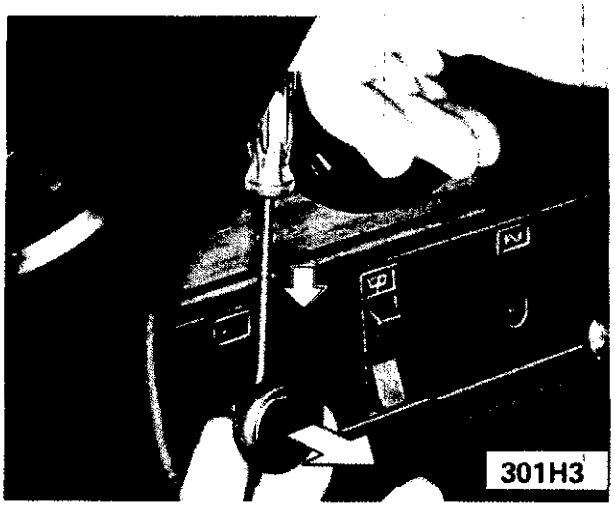

Figure 1H-3 - Removing Headlight Switch Knob,

2. Remove two (2) plugs on cluster panel. See Figure 1H-4.

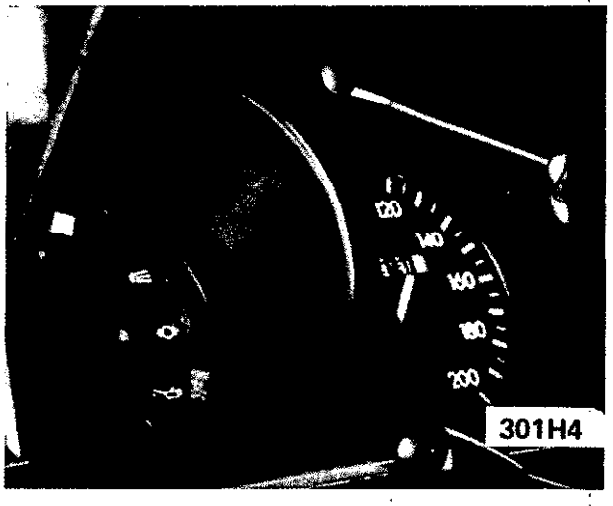

Figure 1 H-4 Removing Plugs

3. Remove two (2) sheet metal screws behind plugs on cluster. See Figure 1H-5.

4. Pull off heater control knobs toward front.

5. On top, carefully pull instrument 'trim plate towards steering wheel and remove plate.

6. Remove two screws for lower housing attachment. See Figure 1H-6.

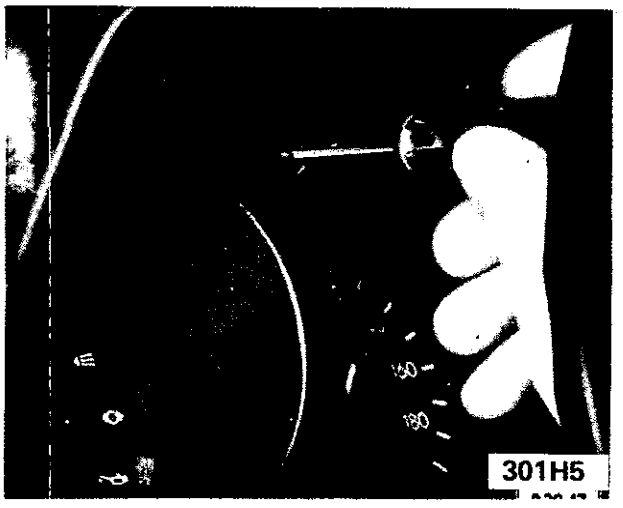

Figure 1 H-5 - Removing Cluster Screws

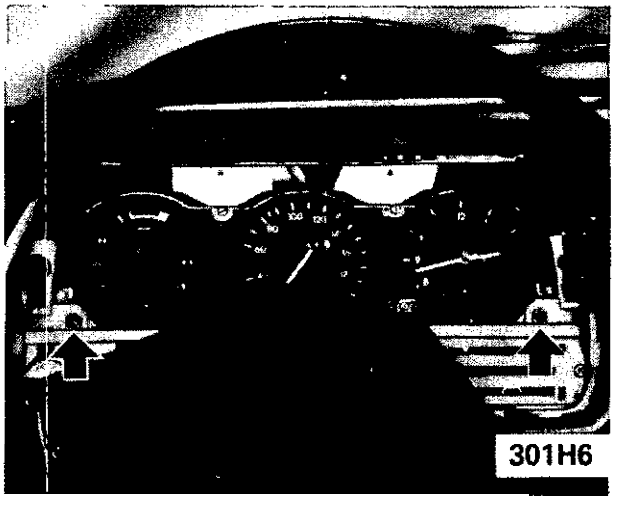

Figure 1 H-6 Lower Housing Attaching Screws

7. Disconnect speedo cable at cluster by turning coupling counterclockwise.

8. If equipped, pull heated rear window or fog lamp switch out of instrument housing and disconnect wires from switches.

9. Pull cluster right and left sides partially out and disconnect wires on back of cluster. See Figure 1H-7.

Installation

1. Place instrument cluster in position and connect wires on back of cluster.

2. Pull fog light or heated back glass switch wires into opening, if equipped, and connect wires and replace switch.

3. Connect two screws on lower housing attachment.

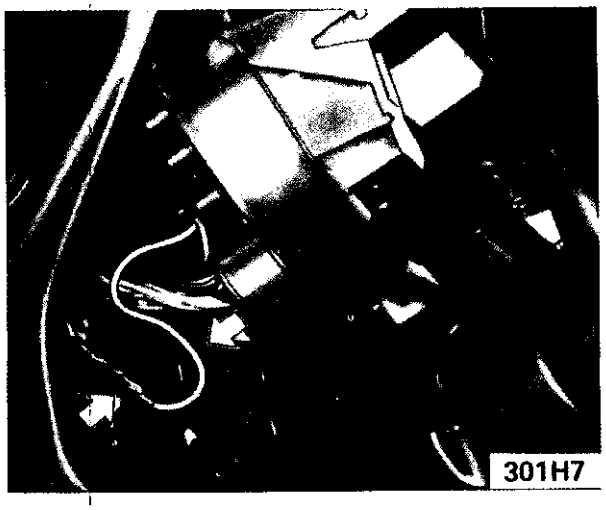

Figure 1 H-7 - Disconnecting Cluster Wires

4. Install instrument cluster trim plate and replace two screws and plugs.

5. Con&t speedo cable by turning coupling clockwise.

6. Install light switch button and heater control knobs.

7. Connect battery cable.

Removing Windshield Wiper Switch - Opel 1900 Manta

1. Remove instrument cluster trim plate.

2. Compress retaining clips and remove switch. See Figure 1H-8.

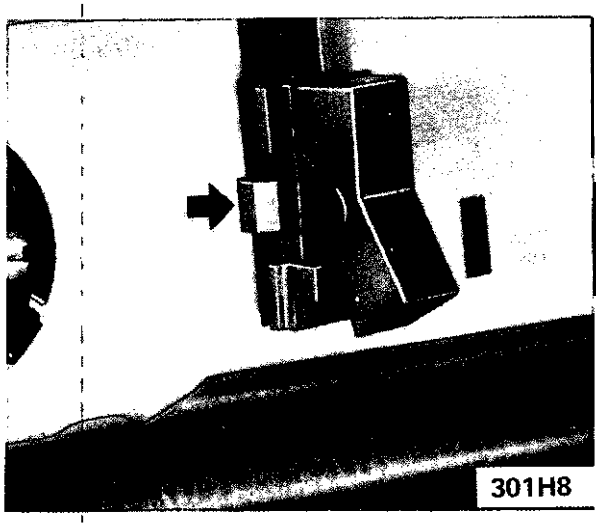

Figure 1H-8 . Removing Windshield Wiper Switch

3. Disconnect wiring connector.

Installation

1. Connect wiring to switch.

2. Snap switch back into panel.

3. Replace instrument cluster trim plate.

Removing Instrument Cluster Bulbs - Opel 1900 - Manta

1. Remove instrument cluster assembly.

2. Replace bulbs from back ofcluster. See Figure 1H-9.

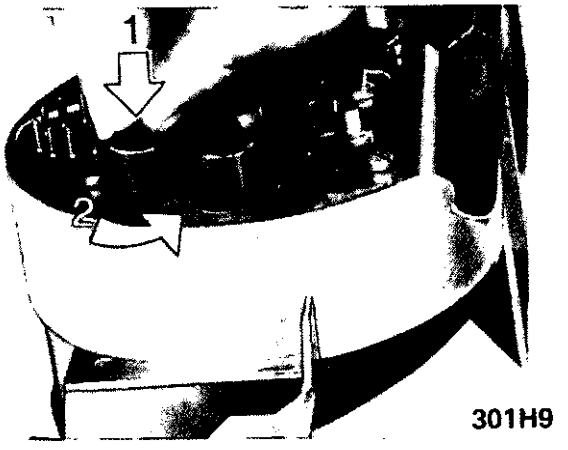

Figure 1H-9 Removing Instrument Cluster Bulbs

Installation

1. Replace bulbs in cluster.

2. Replace instrument cluster assembly.

Removing and Installing Ignition Switch

Refer to Group 3, Section F.

Removal of Instrument Cluster Housing Assembly. GT

Disconnect battery before making any electrical repairs.

1. Disconnect battery cable.

2. Remove right access cover and remove screw. See Figure 1H-10.

Figure 1 H-10 Removing Right Access Cover and Screw

3. Remove left access cover and remove screw. See Figure 1H-11.

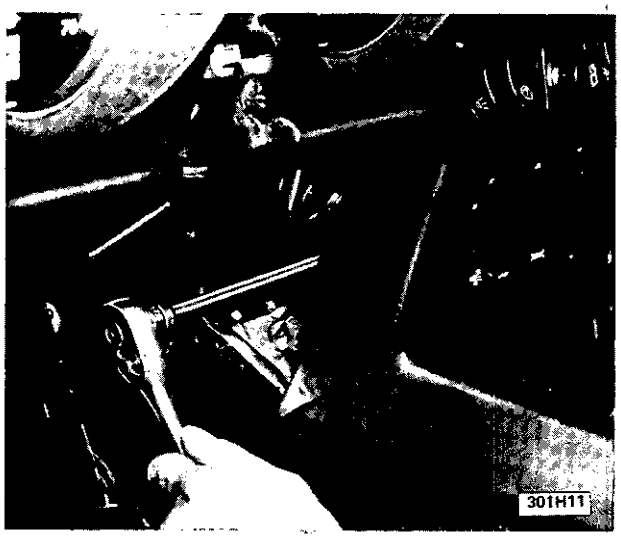

Figure 1H-11 Removing Left Access Cover and Screw

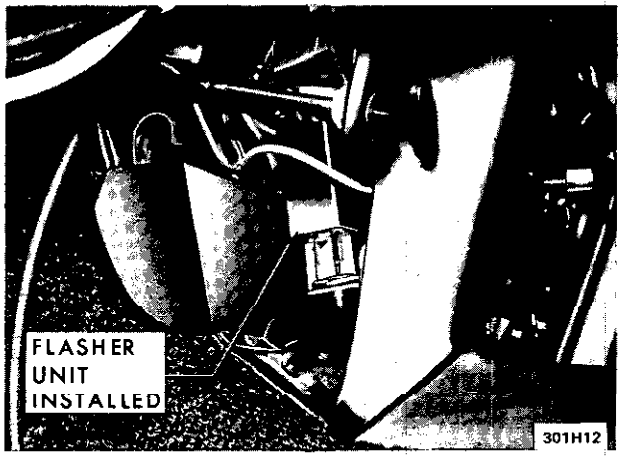

Figure 1H-12 Flasher Unit Installed

4. Remove flasher unit. See Figure 1H-12.

5. Position steering so that wheels are straight ahead.

6. Pull off heads of both tear bolts by first drilling a 3/16 inch pilot hole and then using a stud extractor to remove tear bolts. See Figure 1H-13.

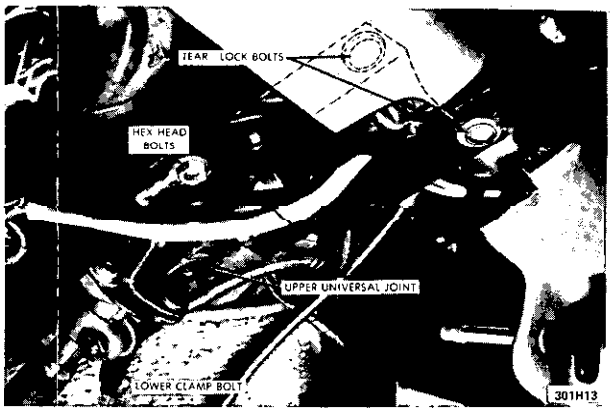

Figure 1 H-l 3 Steering Column Attaching Bolts

7. Disconnect ignition (white) and directional signal (black) wire set plugs.

8. Support steering column assembly and remove both hex head bolts. See Figure 1H-13.

9. Drop steering column assembly to floor.

10. Disconnect speedometer cable.

11. Remove six (6) screws on instrument cluster. See Figure 1H- 14.

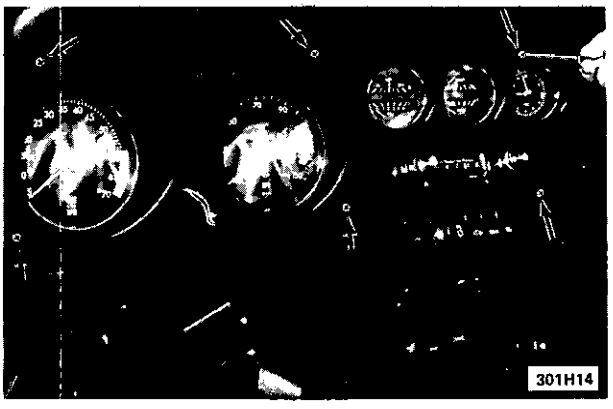

Figure 1H-14 Instrument Cluster Screws

12. Pull back on instrument cluster from top to remove. See Figure 1H-15.

13. Disconnect wires on back of radio. See Figure 1H-16.

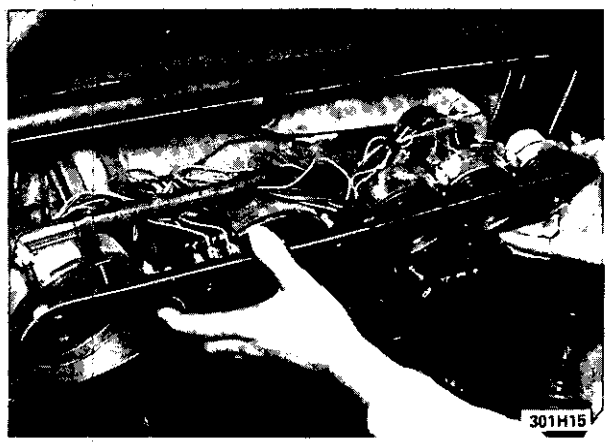

Figure 1H-15 Removing Instrument Cluster Assembly

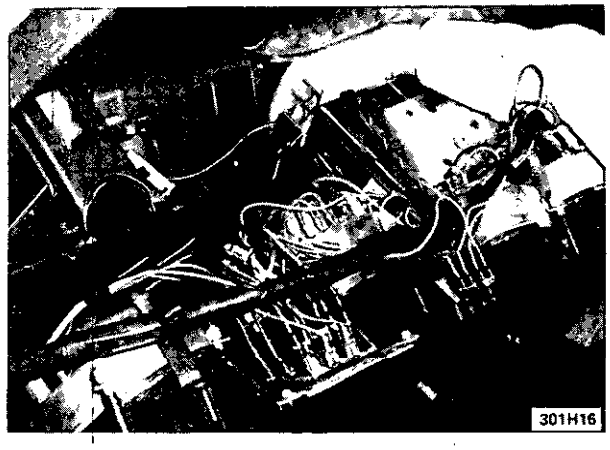

Figure 1 H-I 6 Disconnecting Radio Wires

14. Disconnect antenna lead-in at right lower corner of radio!

15. Pull' cluster housing out and turn sideways to remove any instrument gauge or switches.

Installation

CAUTION: ***Fasteners in subparagraph B are important attaching parts in that they could affect the performance of vital components and systems, and-/or could result in major repair expense. They must be replaced with one of the same part number, or with an equivalent part if replacement becomes necessary. Do not use a replacement part of lesser quality or substitute design. Torque values must be used as specified during reassembly to assure proper retention of these parts.***

1. Plug antenna lead-in cable and power source to radio.

2. Put instrument cluster in position and replace six (6) screws in cluster.

3. Connect speedometer cable.

4. Raise steering column into position and install hex head bolts. Be sure to install ground wire. Tighten hex head bolts to 14 lb.ft.

5. Tighten tear lock bolts until hex head of bolt is torn off.

6. Connect ignition and directional signal wire set plugs.

7. Install flasher unit.

8. Replace screws in right and left lower instrument panel and replace both access covers.

9. Connect battery cable.

Removal of Combined Switch Assemblies. GT

1. Remove instrument cluster.

2. Turn instrument cluster to the side to remove switch assembly.

3. Remove switch by removing two retaining nuts. See Figure 1H-17.

4. Remove wiring from switch.

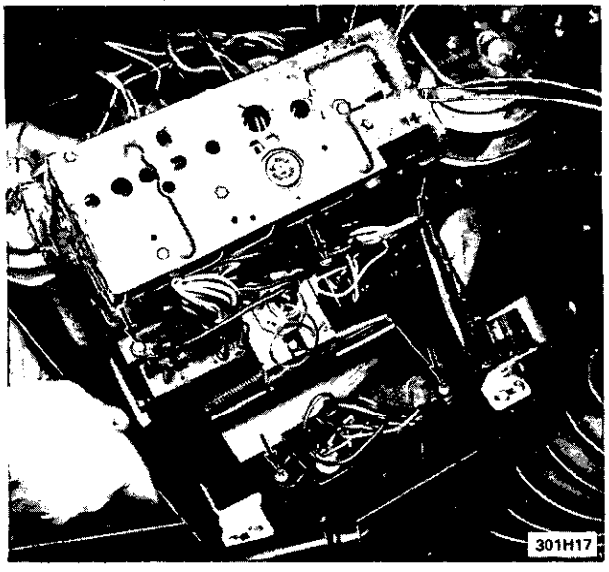

Figure 1 H-I 7 Removing Switches

Installation

1. Plug wiring into switch.

2. Install switch on panel.

3. Install instrument cluster.

Removal of Cigar Lighter GT

1. Remove **instrument** housing.
2. Disconnect electrical wire.
3. Remove hex nut on back of cigar lighter base.
4. Remove cigar lighter base.

Installation

1. Install cigar lighter base.
2. Install hex nut on back of lighter base.
3. Connect wire to lighter.
4. Replace instrument cluster.

GAUGES

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DIAGNOSIS

TEMPERATURE & FUEL GAUGE - SYSTEM DIAGNOSIS (OPEL 1900, MANTA)

Condition	Possible Cause	Correction
Temperature and gas gauge inoperative	1. Blown fuse	1. Replace fuse. If new fuse blows, repair short.
	2. Defective voltage stabilizer	1. Install 40 ohm resistors between ground & connectors (disconnect from units) of temperature sending unit and gas gauge tank unit. If both dash units do not move to full scale (tolerance - one pointer width of either side of full scale reading) and the distance of movement on the scale is the same,, replace the voltage stabilizer.

Condition	Possible Cause	Correction
Gas gauge does not read full when tank tilled	1. Tank unit misadjusted	1. Install 40 ohm resistor between connector and ground (disconnect from unit). If dash unit reads full within one pointer width. Remove gas tank unit from tank, install connector, ground unit and adjust tab to obtain full reading on dash. Reinstall tank unit.
	2. Defective' voltage stabilizer	1. See corrective action above.
Gas gauge not operating	1. Corroded tank unit terminal	1. Check tank unit terminal, if corroded clean, pack connector with grease and reinstall connector..
	2. Loose dash gauge	1. Install 40 ohm resistor between sending unit connector. and ground (disconnect from tank terminal). If dashgauge does not read rull, check dash gauge attaching nuts for secureness and tighten if required. (Requires removal of dash panel) Momentarily touch dash gauge attaching studs to 12 volt source. If indicator moves, reinstall panel; if not, replace gauge. (Caution do not keep studs connected to 12 volt source for more than a few seconds - damage to gauge can result)
	3. Open wiring	1. Remove connector from sending unit and ground (40 ohm resistor may be used if ohmmeter available. Remove multiple connector from rear of dash. Connect test light to ground and touch other end to connector socket with blue and black wire, if it does not light (40 ohm reading of ohm meter used) repair open circuit.
	4. Defective gas tank sending unit	1. Install 40 ohm resistor between temperature sending unit and ground (disconnect from unit) if dash unit reads full scale. Replace tank unit (check for terminal corrosion before replacing).

Condition	Possible Cause	Correction
Car runs out of gas with gauge indicating fuel in tank.	1. Tank unit misadjusted	1. Follow corrective action as stated above (obtain empty reading on dash)
	2. Defective voltage stabilizer.	1. See corrective action above.
Temperature gauge not	1. Loose dash gauge attaching nut.	1. See corrective action above.
	2. Defective temperature sending unit	1. Install 40 ohm resistor between temperature sneding unit and ground (disconnect from unit). If dash unit reads full scale, replace temperature sending unit.
	3. Open wiring.	1. Follow corrective action as stated above (connector socket with blue wire).
Temperature gauge indicates hot when engine temperature normal.	1. Incorrect temperature sending unit	1. Check for correct sending unit (white porcelain) replace if incorrect.
	2. Defective temperature sending unit.	1. See corrective action above.
	3. Defective voltage stabilizer.	1. See Corrective action above.

GAS GAUGE TROUBLE DIAGNOSIS - GT

An inoperative gas gauge reading can normally be found to result from a poor grounding condition within the circuit. Using the procedure as outlined below may lead to the correction of the inoperative reading without replacement of either the tank unit or the dash unit.

1. Make certain the gas tank (ground) strap is properly secured.

2. Make certain the ground wire (brown in color) for gasoline/ and temperature gauges is properly connected to the windshield wiper motor and is secured. (This ground wire is also common for the heater blower motor.)

If the above procedure does not produce a satisfactory gauge reading, an attempt to isolate the defective part, i.e. tank or dash unit should be made.

3. Remove a tank unit from parts stock.

4. Disconnect the tank unit lead wire (light blue with black tracer) from the tank unit.

5. Connect the stock tank unit; ground unit, and operate manually.

6. If the dash unit shows a correct reading, then replacement of the tank unit is required as the correction.

A correct reading will be one which resembles the movement of the manually-operated tank unit.

7. If the dash unit does not show a correct reading, then its replacement is necessary.

MAJOR REPAIR

OPEL 1900. MANTA

Removing Voltage Stabilizer

1. Remove instrument cluster housing assembly.

2. Pull voltage stabilizer of back of printed circuit. See Figure 1I-1.

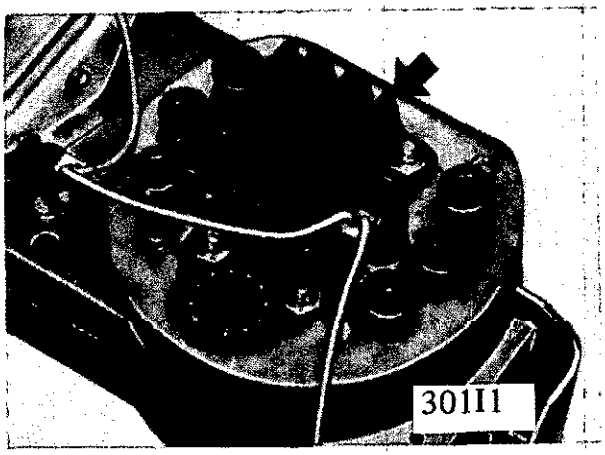

Figure 1I-1 -Voltage Stabilizer

Installation

1. Install voltage stabilizer on back of printed circuit.

2. Install instrument cluster housing assembly.

Removing Speedometer

1. Remove instrument cluster housing.

2. Remove six screws shown in Figure 1I-2 and remove both instrument cluster lens.

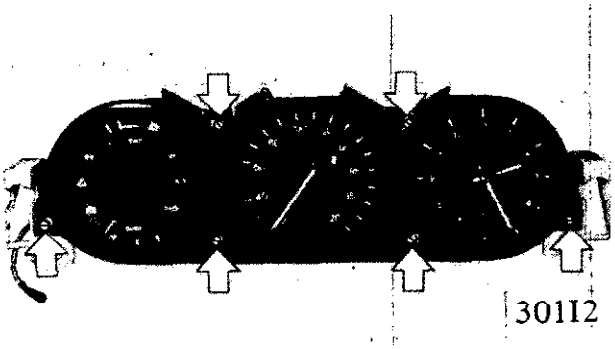

Figure 1 I-2 - Removing Instrument Cluster Lens

3. Remove three speedometer attaching screws. See Figure 1I-3.

Installation

1. Replace speedometer in cluster with three (3) attaching screws.

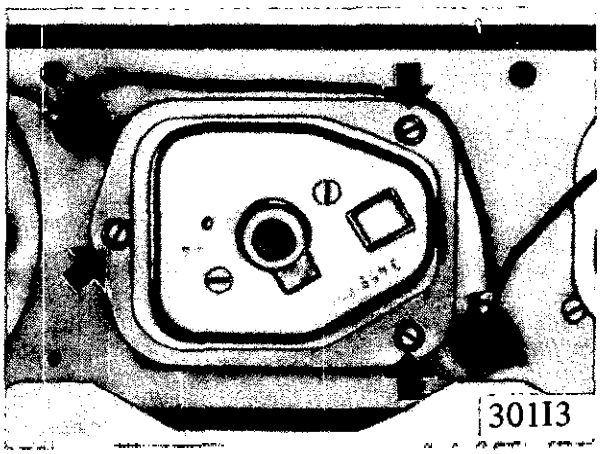

Figure 1 I-3 - Speedometer Attaching Screws

2. Install six (6) screws holding instrument cluster lens in housing.

3. Replace cluster housing.

Removing Electric Clock or Tachometer

1. Remove instrument housing.

2. Remove six screws and remove both instrument cluster lens, as shown in Figure 1I-2.

3. Remove three screws, as shown in Figure 11-4, and remove clock or tachometer.

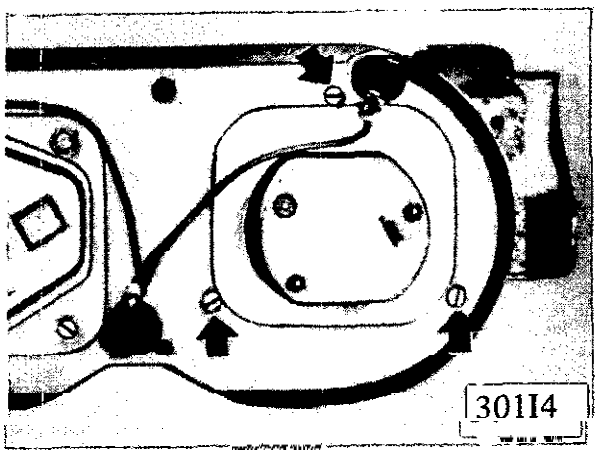

Figure 1 I-4 - Removing Electric Clock or Tachometer

Installation

1. Install clock or tachometer in instrument cluster with three (3) attaching screws.

2. Install six (6) screws holding instrument cluster lens.

3. Replace instrument housing.

Removing Temperature Indicator or Fuel Gauge

1. Remove instrument cluster housing.

2. Remove six screws and remove both instrument cluster lens. See Figure 1I-2.

3. Pull voltage stabilizer off printed circuit and remove four instrument attaching screws, as shown in Figure 1I-5.

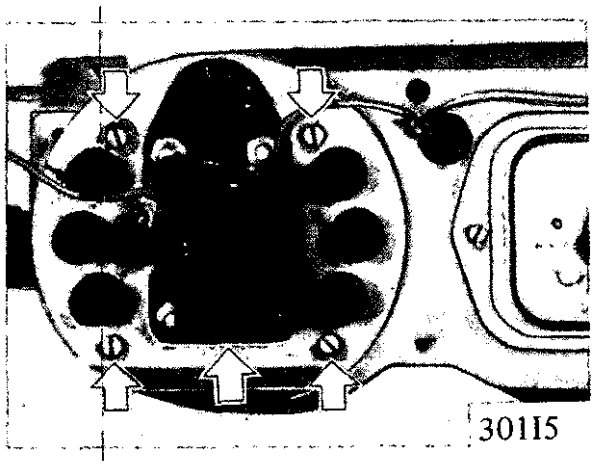

Figure 1I-5 Removing Four Instrument Attaching Screws

4. Take temperature or fuel gauge out of cluster

Installation

1. Install temperature or fuel gauge in cluster.

2. Replace voltage stabilizer on back of printed circuit.

3. Replace both instrument cluster lens.

4. Install /instrument cluster housing.

Removing Rallye Gauges

1. Remove glove compartment.

2. Remove radio, if equipped.

3. Remove screws holding instrument carrier from instrument panel.

4. Disconnect wires from instrument gauge.

5. Remove attaching nuts from gauge and remove.

Installation

1. Replace gauge with attaching nuts on panel.

2. Hook up wires to gauges.

3. With holding screws, attach gauge cluster to instrument panel.

4. Replace radio.

5. Replace glove compartment.

Removal of Temperature Sending Unit

1. Drain and collect coolant.

To drain radiator, remove end of lower radiator hose that is connected to radiator.

2. Remove wire from temperature sending unit.

3. Unscrew temperature sending unit from thermostat housing. See Figure 1I-6.

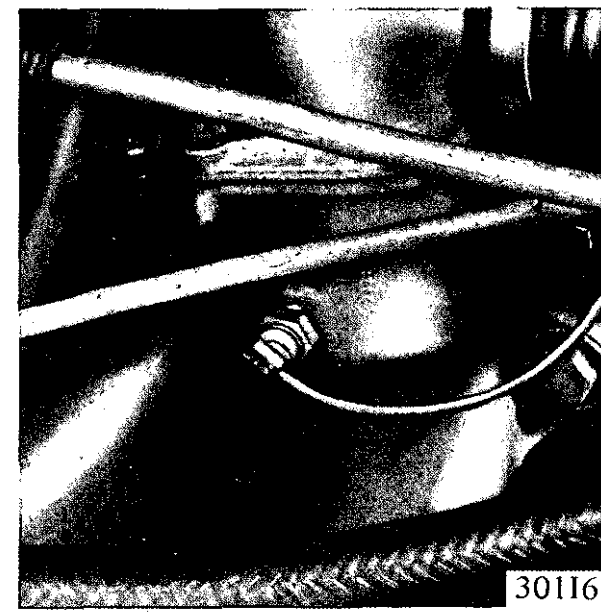

Figure 1I-6 -Temperature Sending Unit

Installation

1. Screw temperature sending unit into thermostat housing after sealing unit with non-hardening permatex.

2. Install wire on sending unit.

3. Replace coolant.

Removing Oil Pressure Sending Unit

1. **Disconnect wire** from sending unit.

2. Unscrew oil pressure sending unit from block. See Figure 1I-7.

Figure 1I-7 - Oil Pressure Sending Unit

Installation

1. Replace oil pressure sending unit into block.

2. Connect wire to unit.

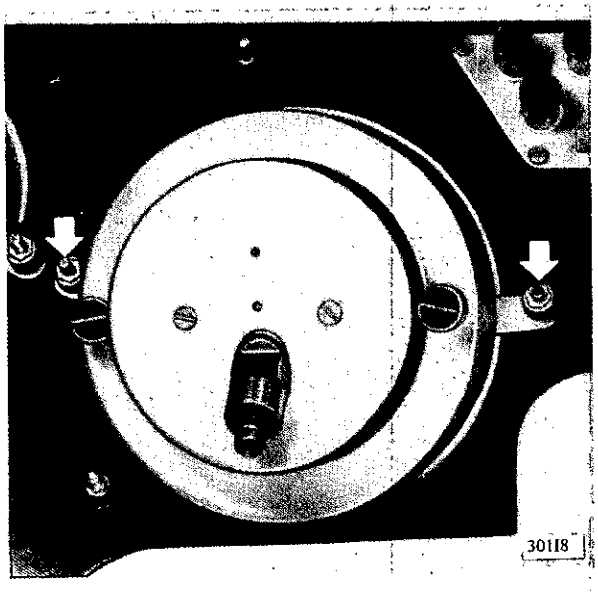

Figure 1 I-8 Rear View of Speedometer

Removal of Speedometer

1. Remove instrument housing.

2. Remove speedometer. See Figure 1I-9 1.

Installation

1. Install speedometer.

2. Install instrument housing per paragraph 1I-71.

Removal of Tachometer

1. Remove instrument housing.

2. Remove tachometer.

3. Disconnect electrical wires. See Figure 1I-9.

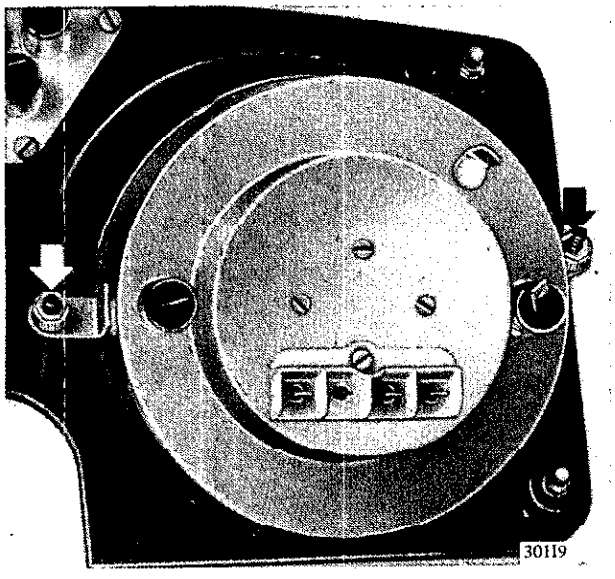

Figure 1I-9 Rear View of Tachometer

Installation

1. Connect wires.

2. Install tachometer.

3. Install instrument cluster.

Removal of Temperature Indicator and Fuel Gauge Dash Unit

1. Remove instrument housing.

2. Remove temperature indicator and fuel gauge **dash** unit.

3. Disconnect electrical wires. See figure 1I-10.

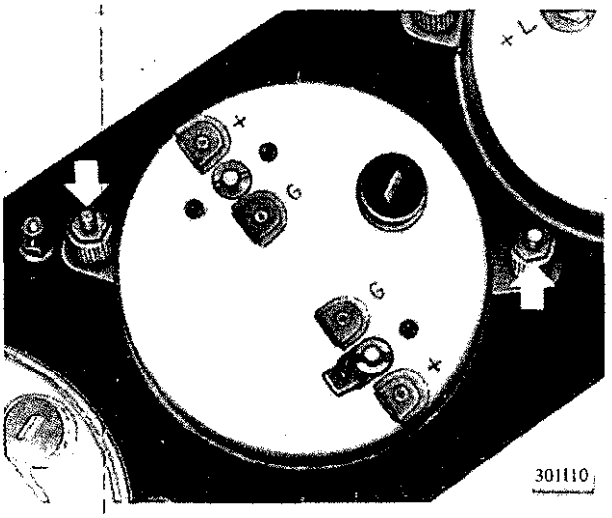

Figure 1 I-10 Rear View of Temperature Indicator and Fuel Gauge Dash Unit

Installation

1. Connect wires and install unit.
2. Install! instrument cluster housing.

Removal of Electric Clock

1. Remove instrument housing.

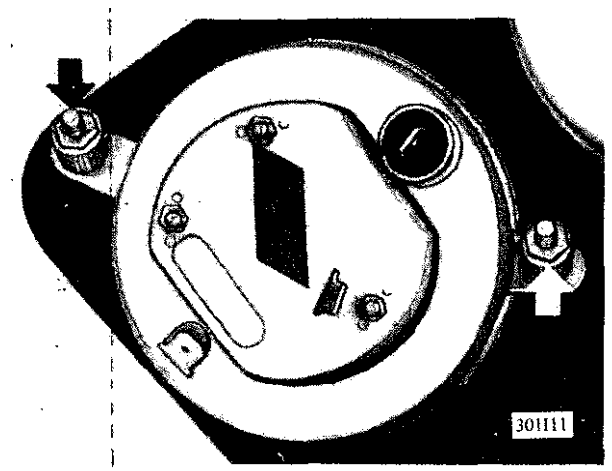

Figure 1 I-1 1 Rear View of Electrical Clock

2. Remove electrical clock.
3. Disconnect electrical wires. See Figure 1I-1 I.

Installation

1. Install clock and connect wires.
2. Install instrument cluster housing.

Removal of Ammeter and Oil Pressure Gauge

1. Remove instrument housing.
2. Remove ammeter and oil pressure gauge.
3. Disconnect electrical wires. See Figure 1I-12.

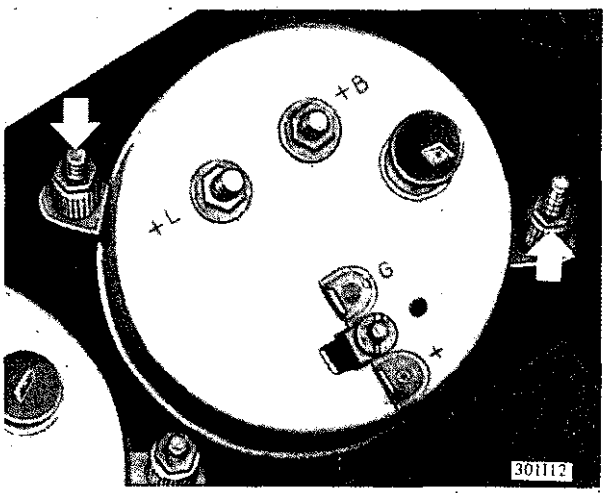

Figure 1 I-1 2 Rear View of Ammeter and Oil Pressure Gauge

Installation

1. Connect wires to ammeter and oil pressure gauge and install.
2. Install instrument cluster housing.

WIRING DIAGRAMS

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GT Color Schematic	1 J-107

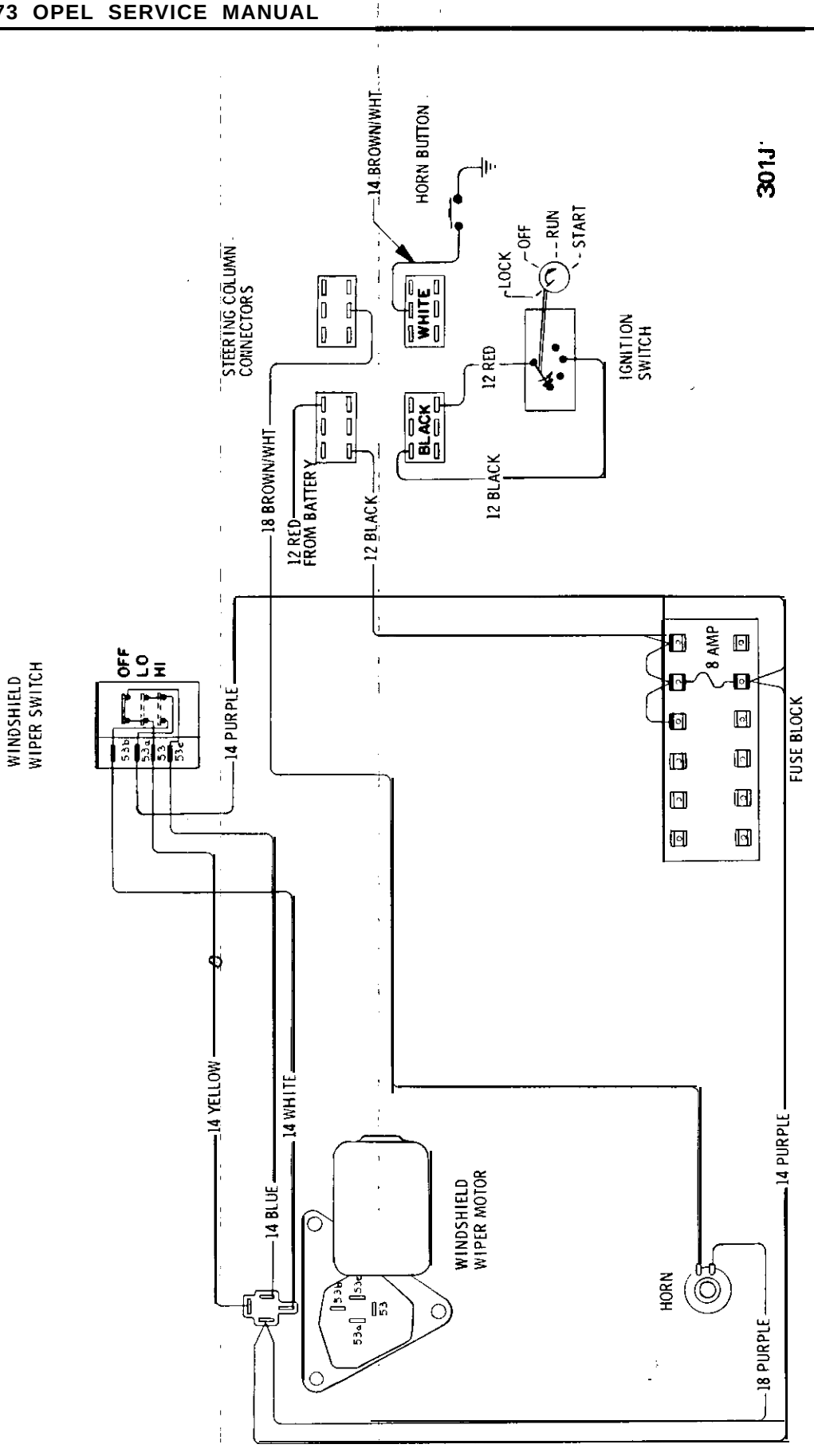

Figure 1J-1 Windshield Wiper and Horn - Opel 1900 - Manta

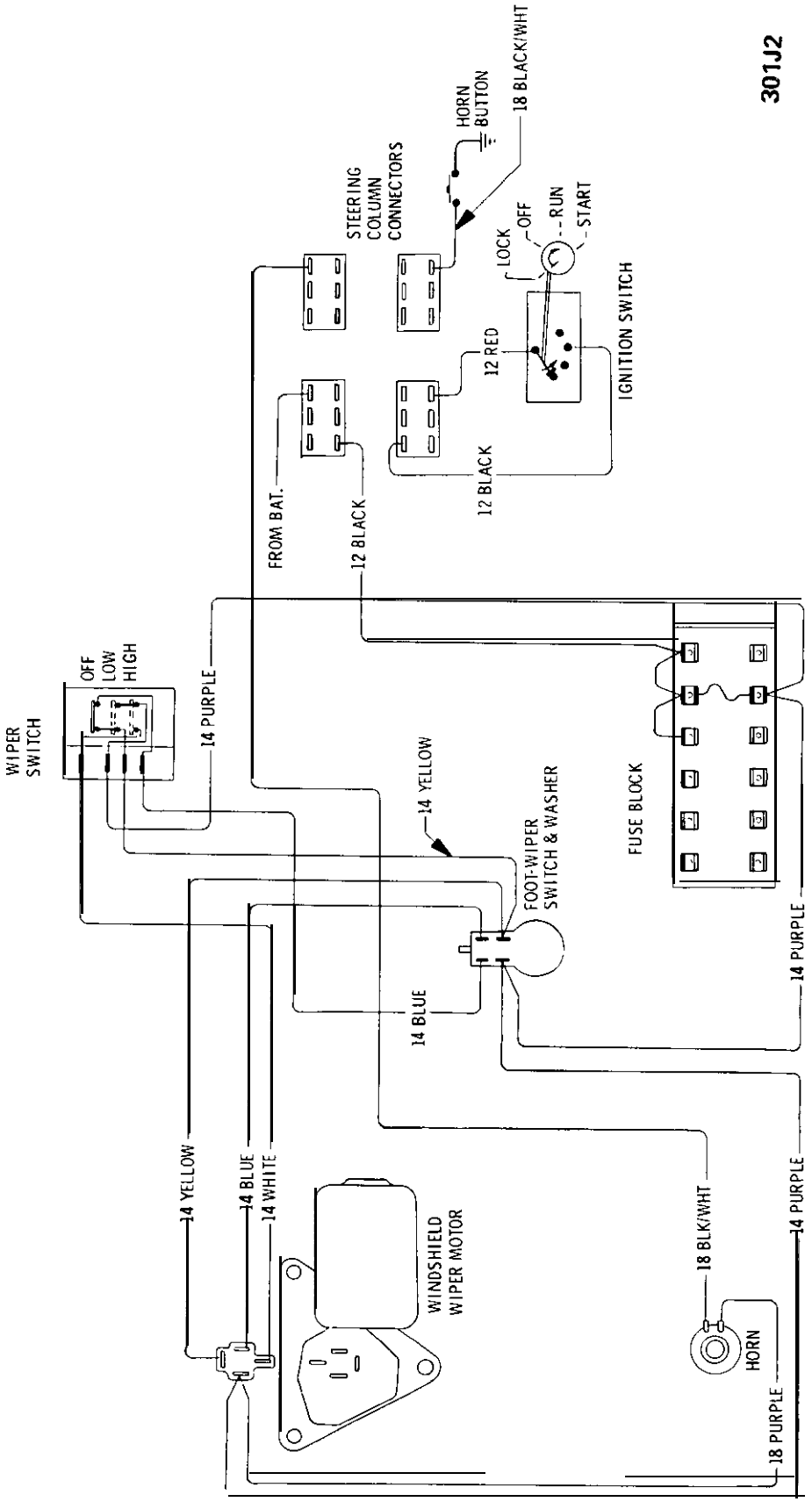

Figure 1J-2 Windshield Wiper and Horn - Rallye

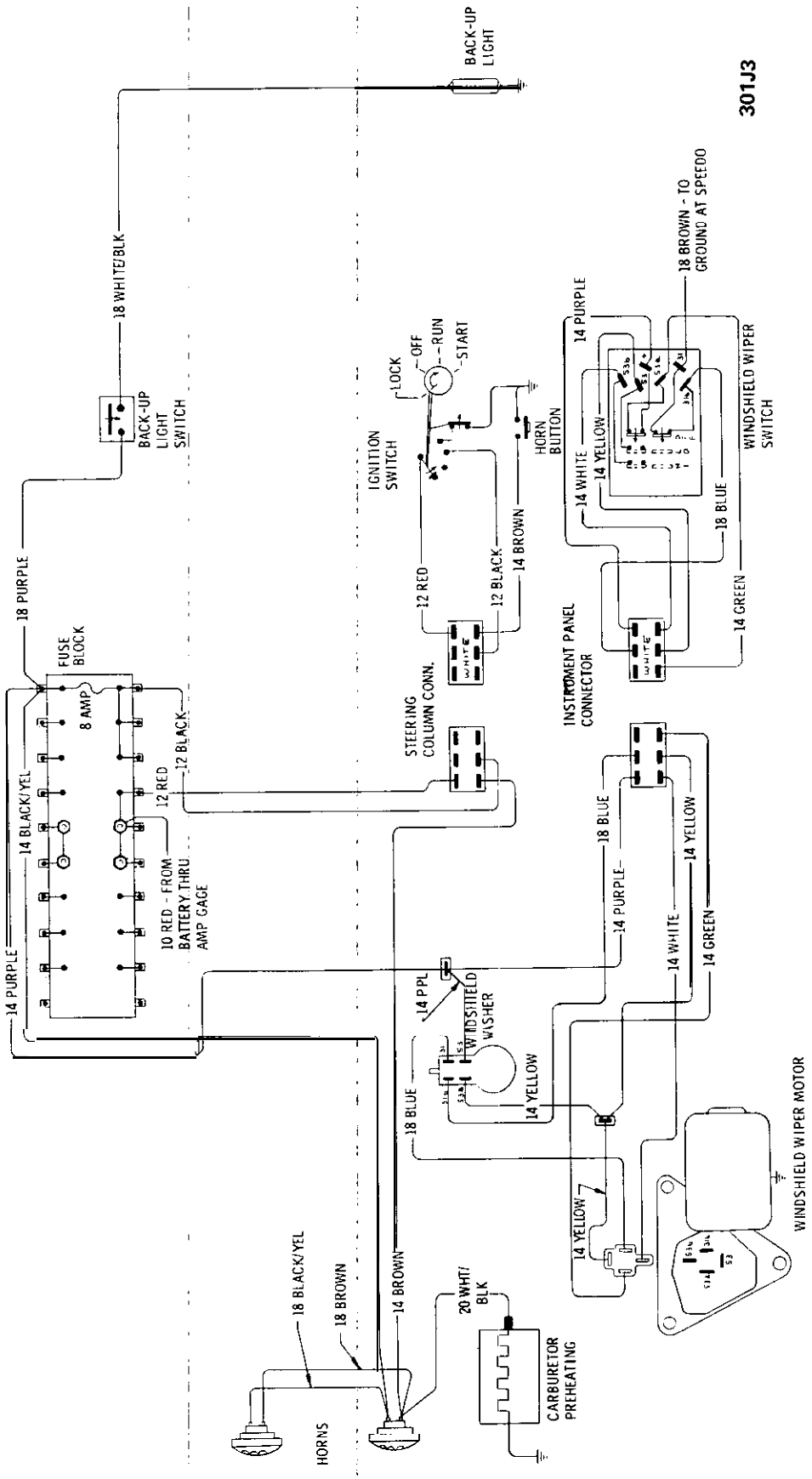

Figure 1J-3 Windshield Wiper and Horn • GT

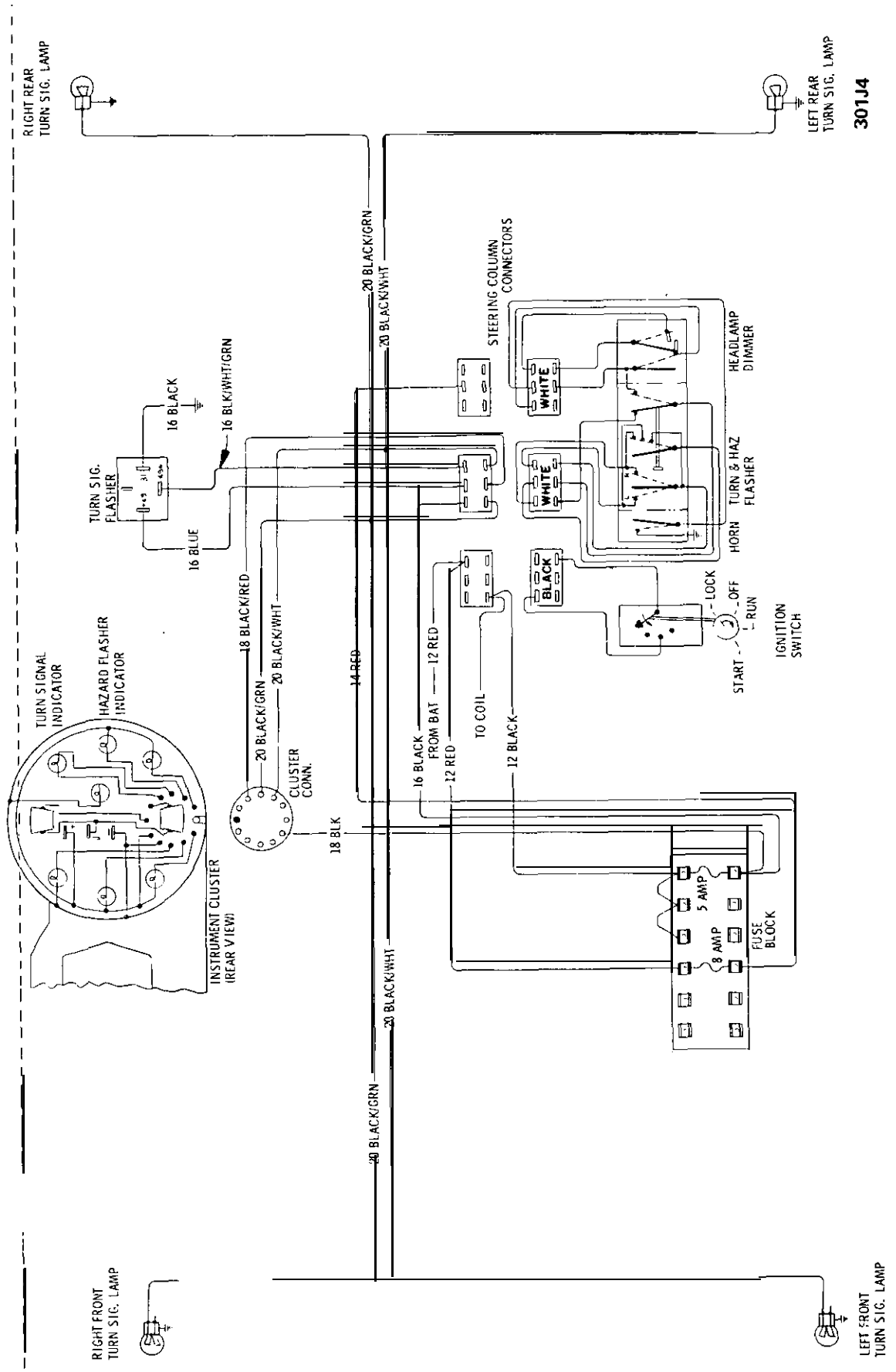

Figure 1 J-4 Turn Signal and Hazard Flasher . Opel 1900 - Manta

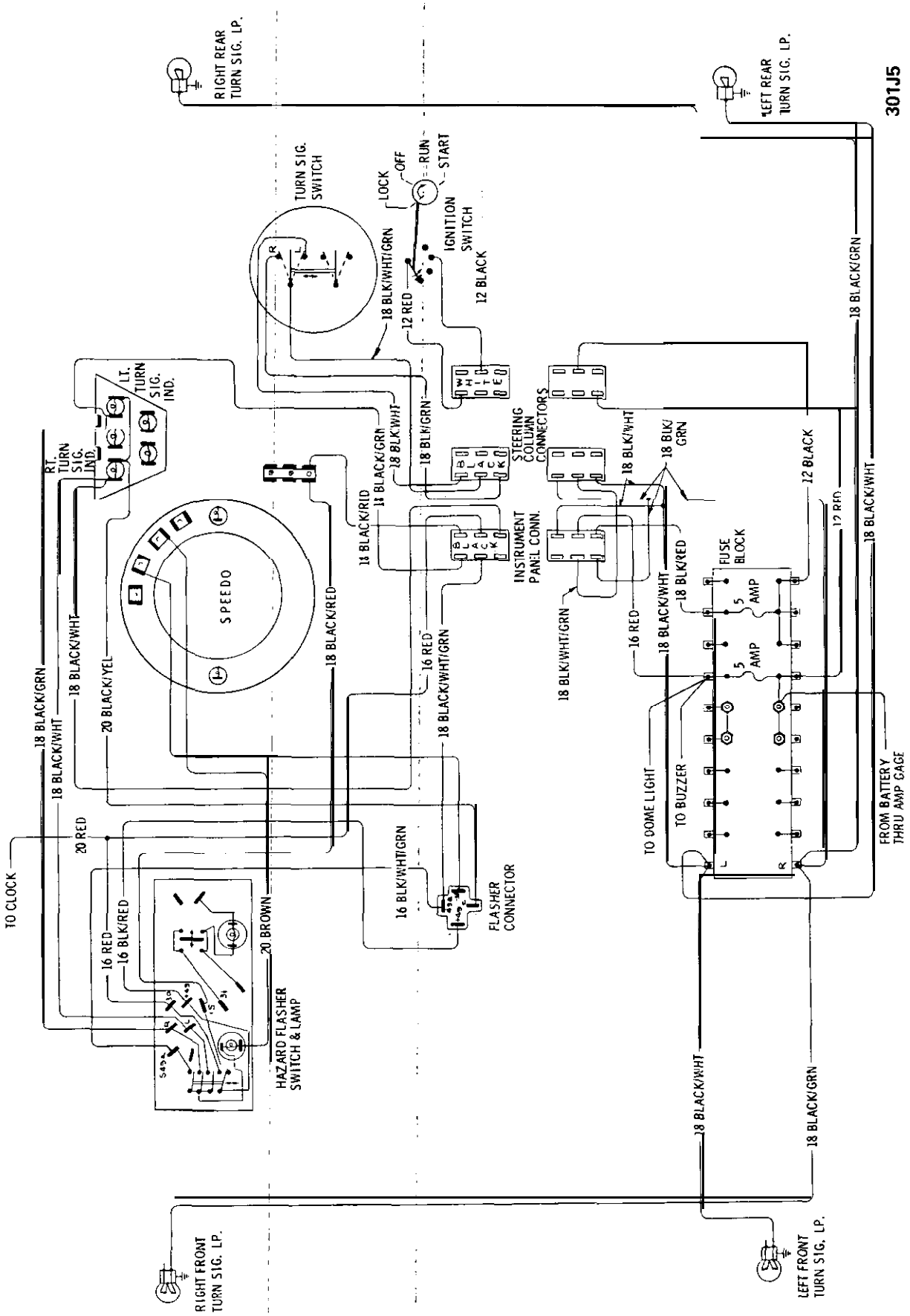

Figure 1J-5 Turn Signal and Hazard Flasher - GT

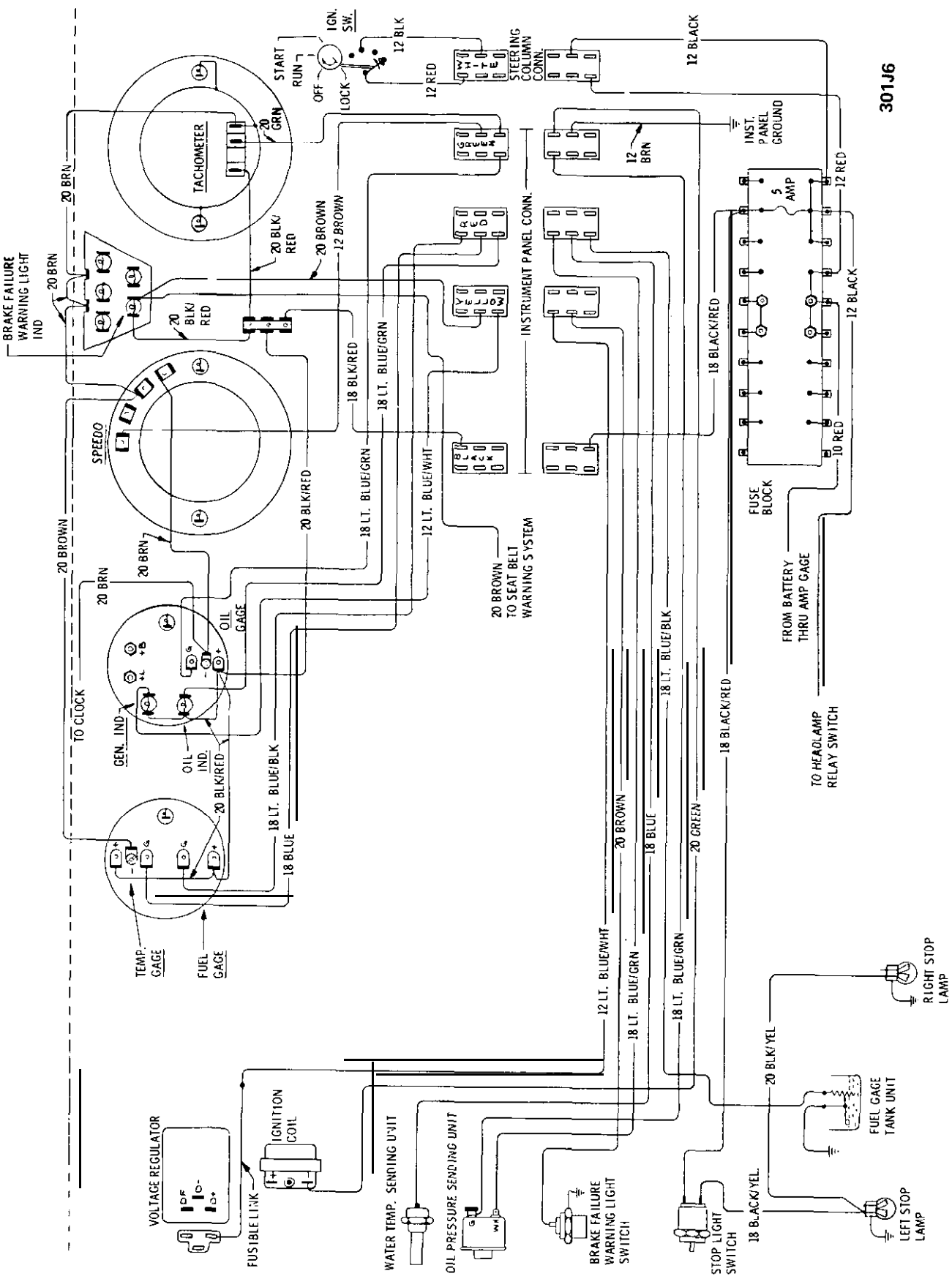

Figure 1J-6 Oil, Fuel, Temp. Tach, Stop and Brake Warning Light - GT

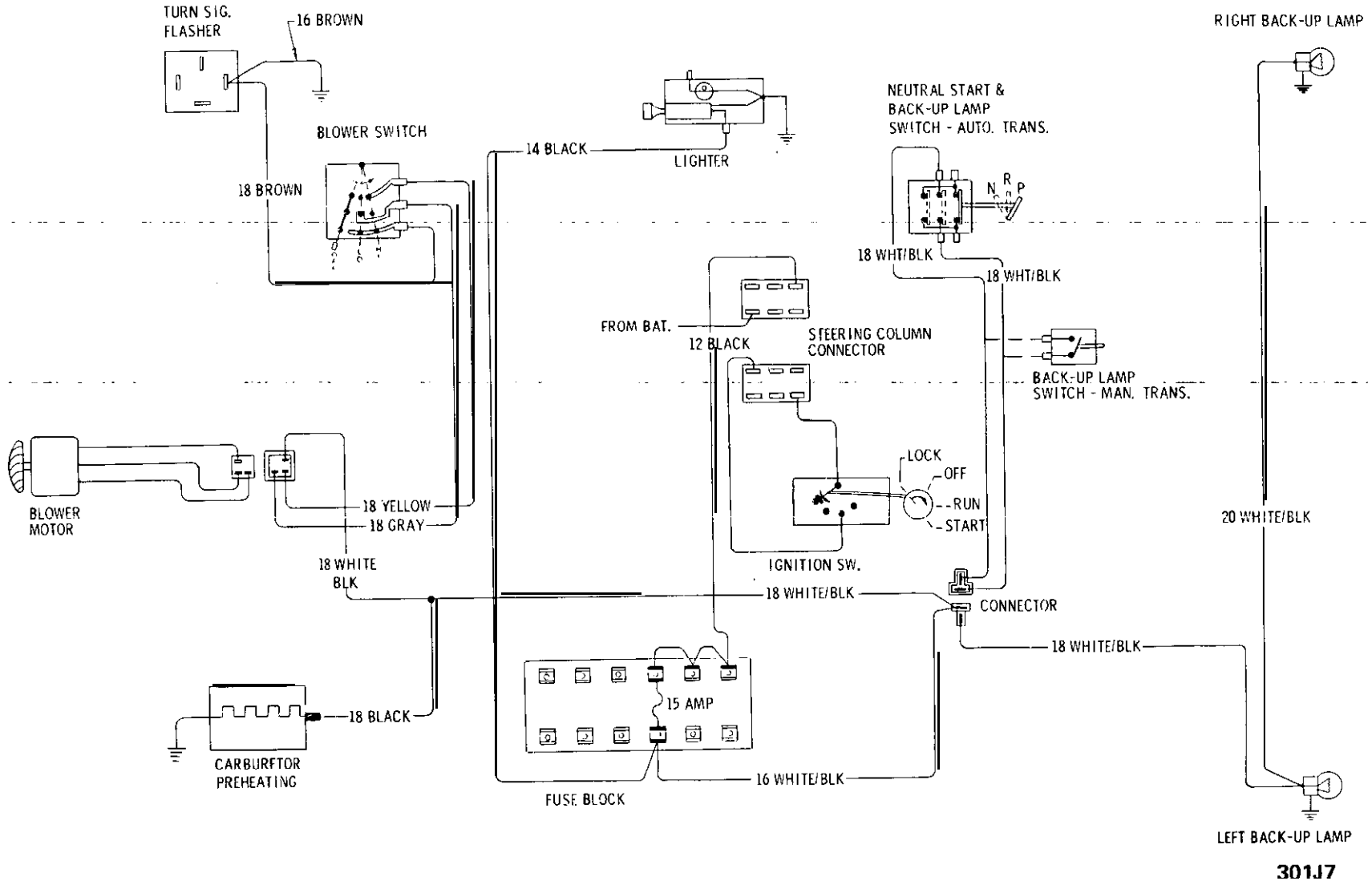

Figure 1J-7 Blower, Lighter and Backup Lights - Opel 1900 - Manta

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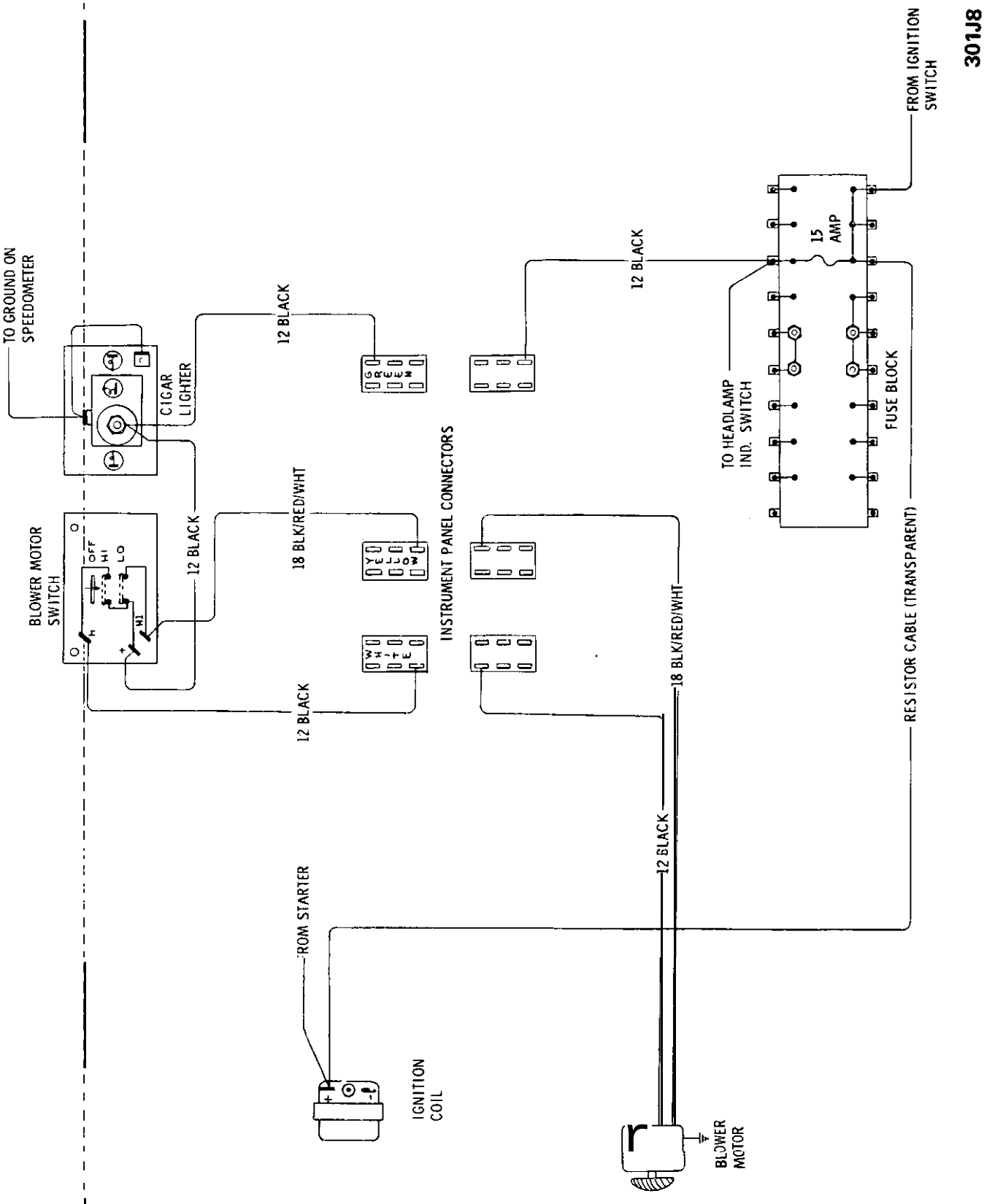

Figure 1 J-8 Blower and Lighter - GT

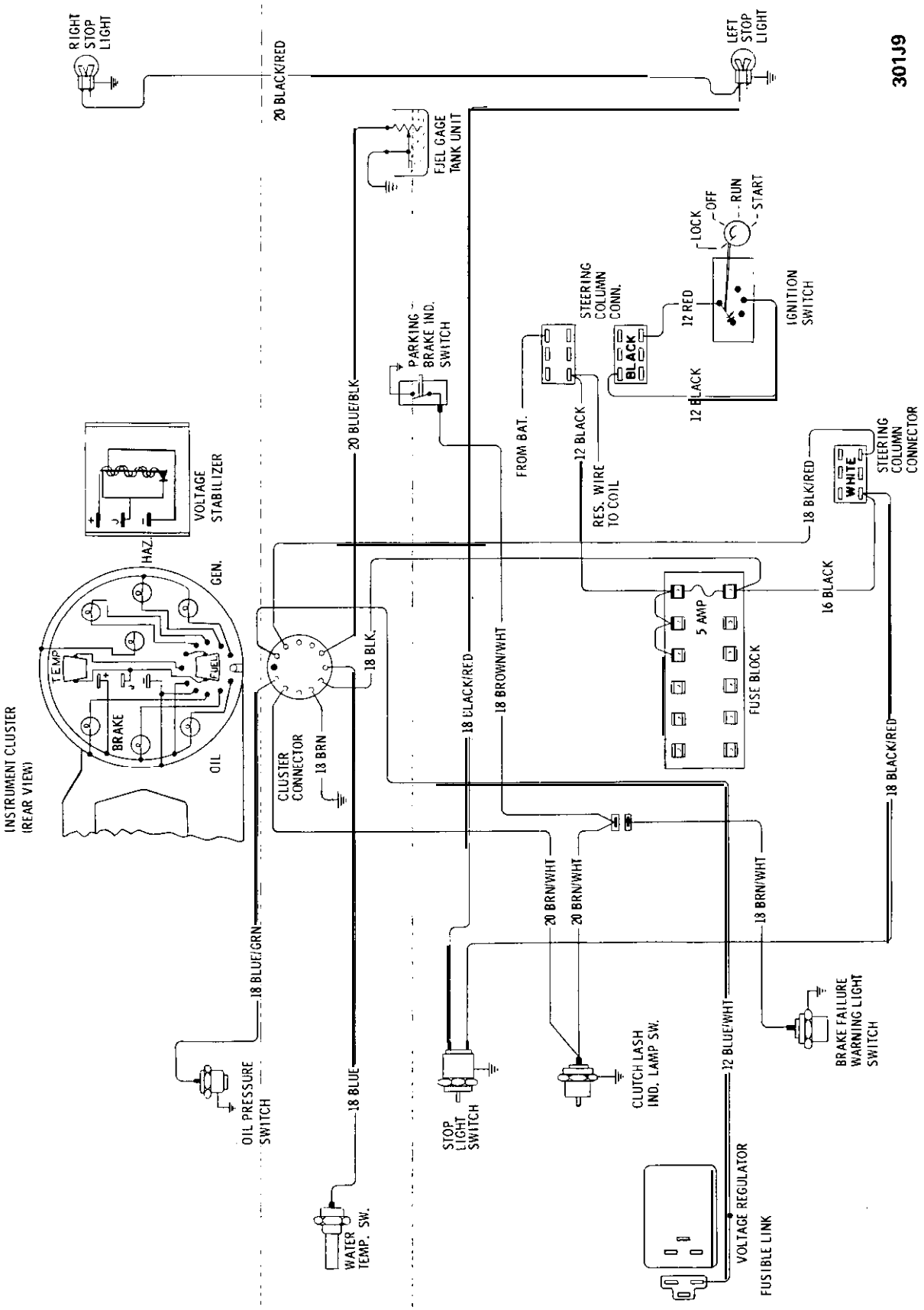

Figure 1J-9 Indicator Lights and Gauges - Opel 1900 Manta

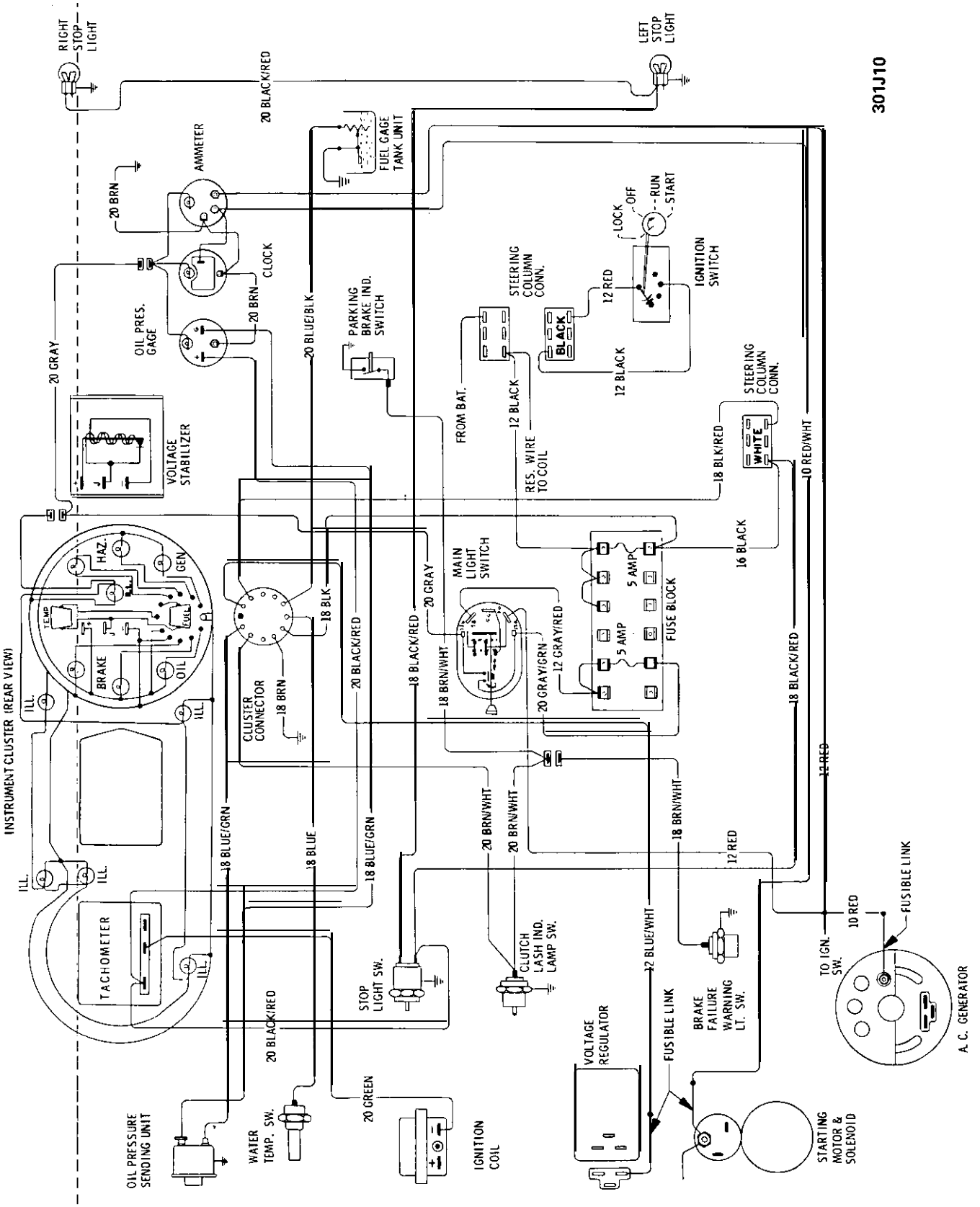

Figure 1 J-10 Indicator Lights and Gauges - Rallye

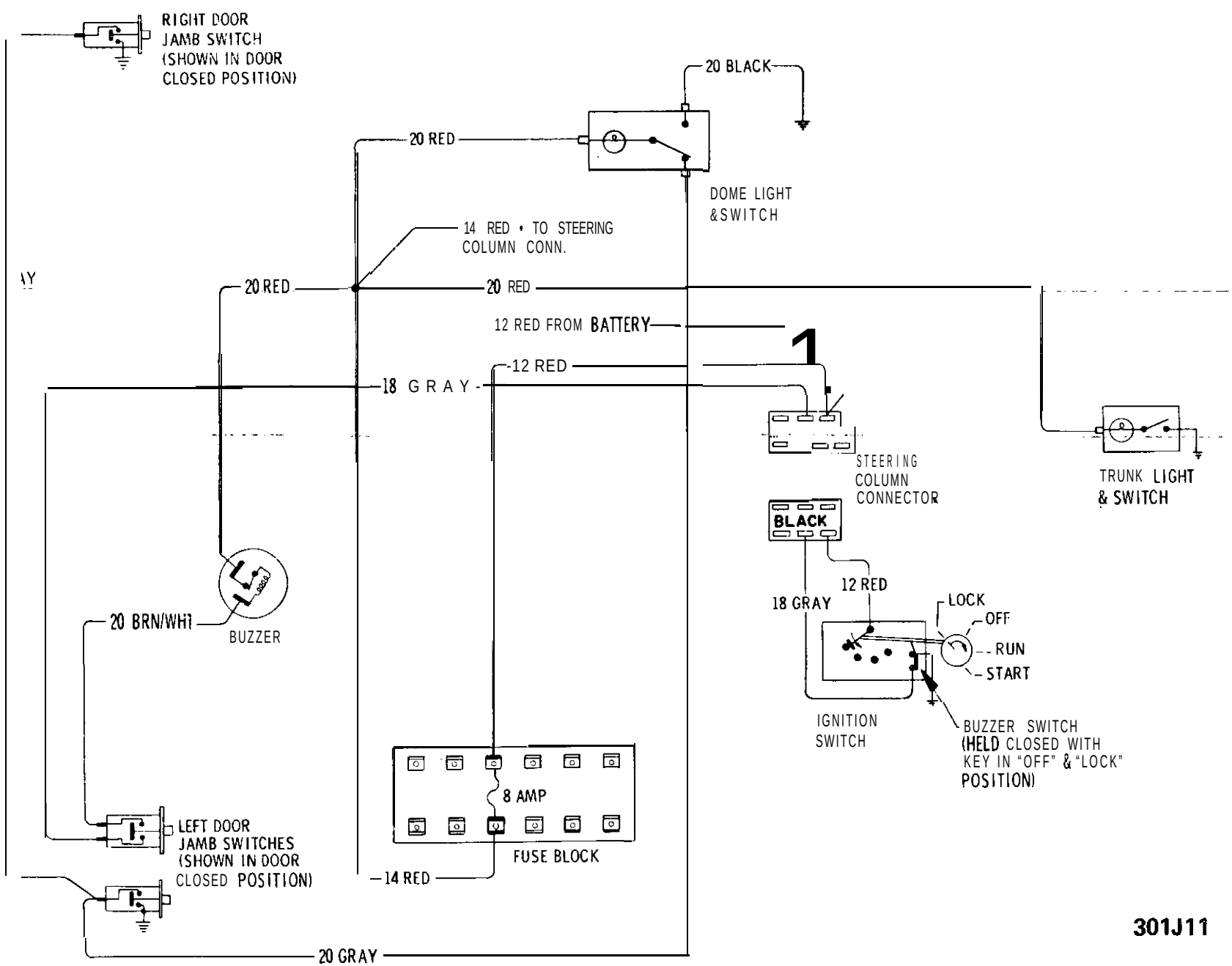

Figure 1J-11 Dome Light and Buzzer - Opel 1900 - Manta

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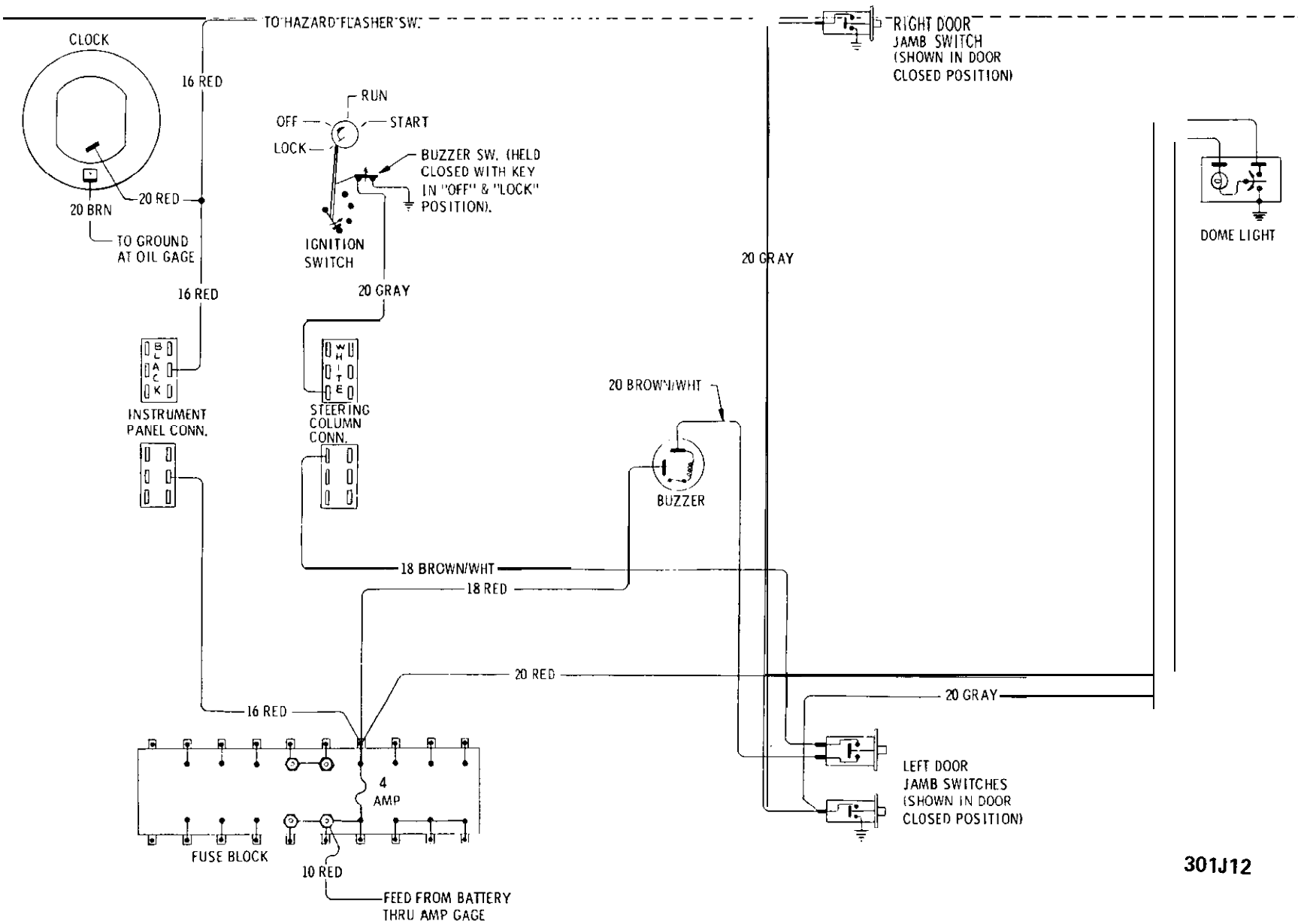

Figure 1J-12 Dome Light, Clock and Buzzer - GT

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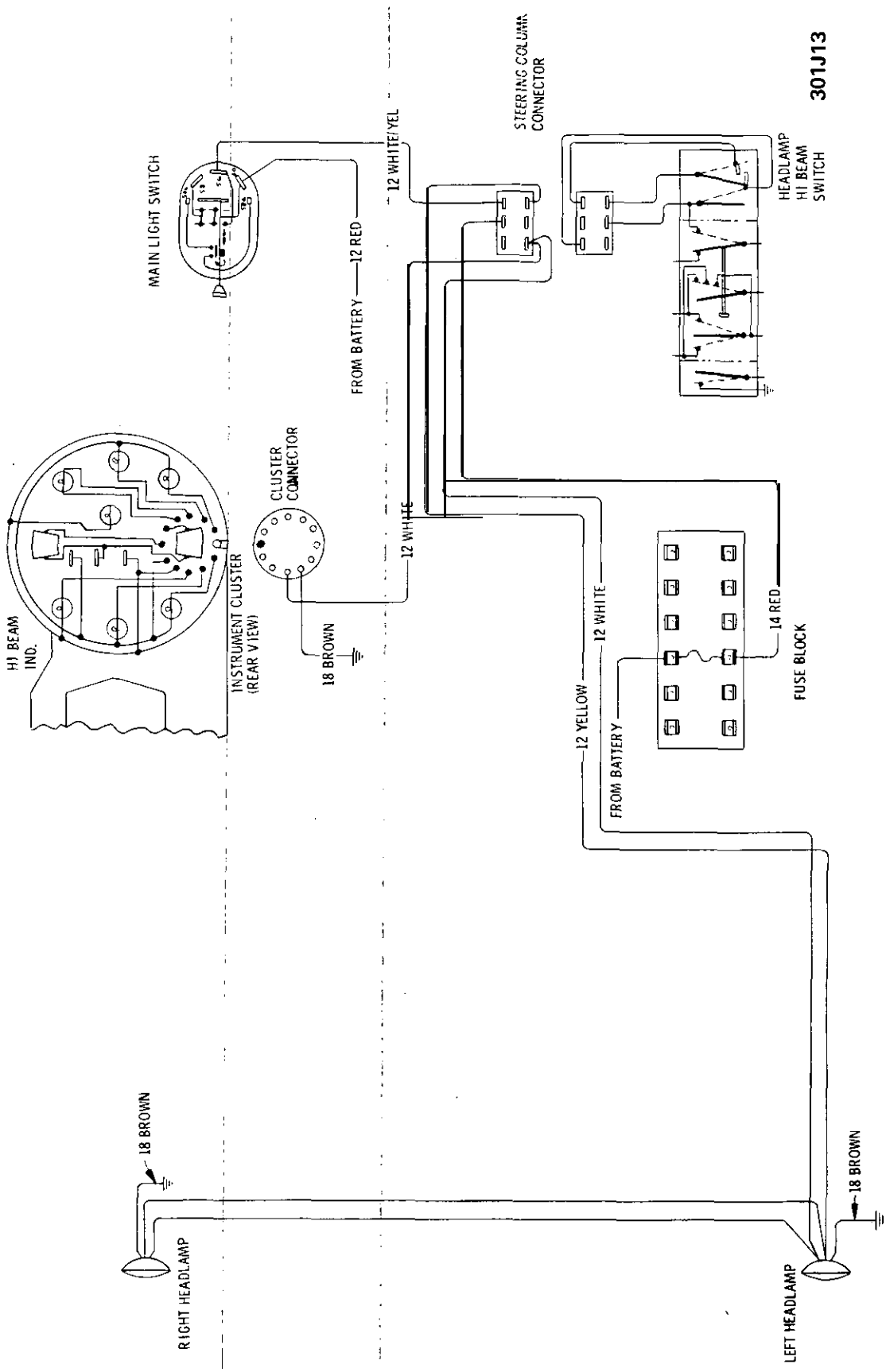

Figure 1 J-l 3; Headlamps ▪ Opel 1900

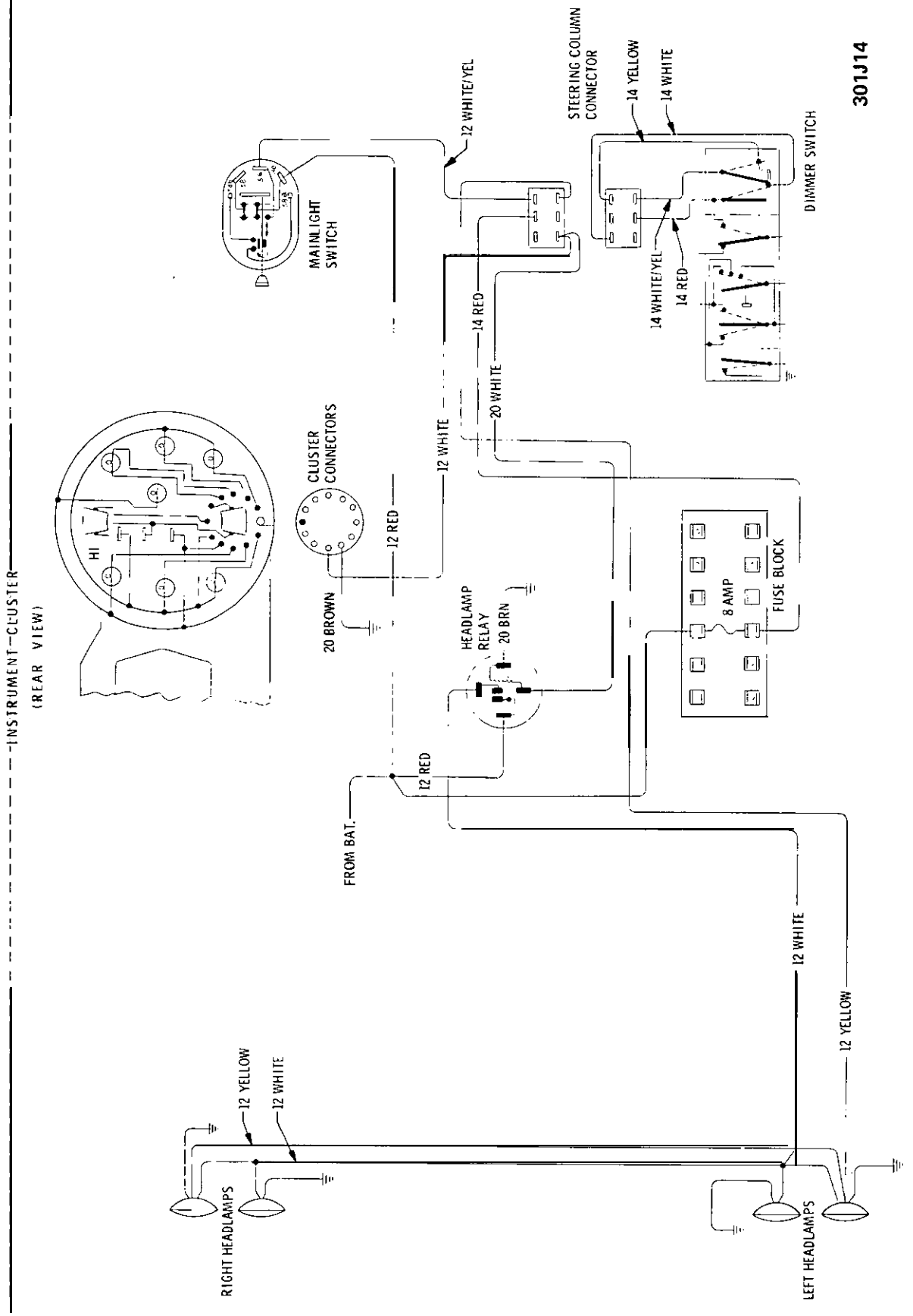

Figure 1J-14 Headlamps Manta

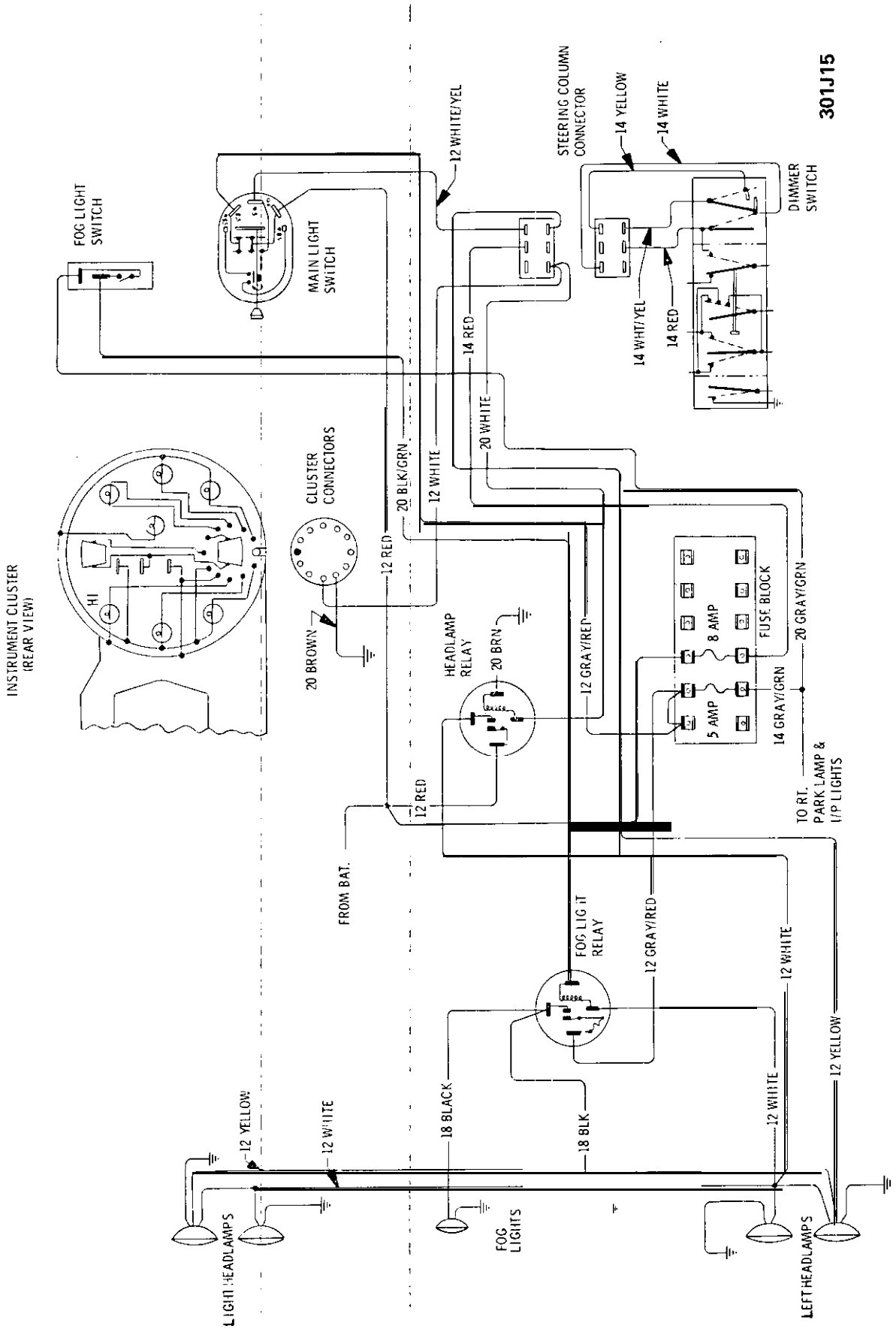

Figure 1J-15 Headlamp and Fog Lights - Rallye

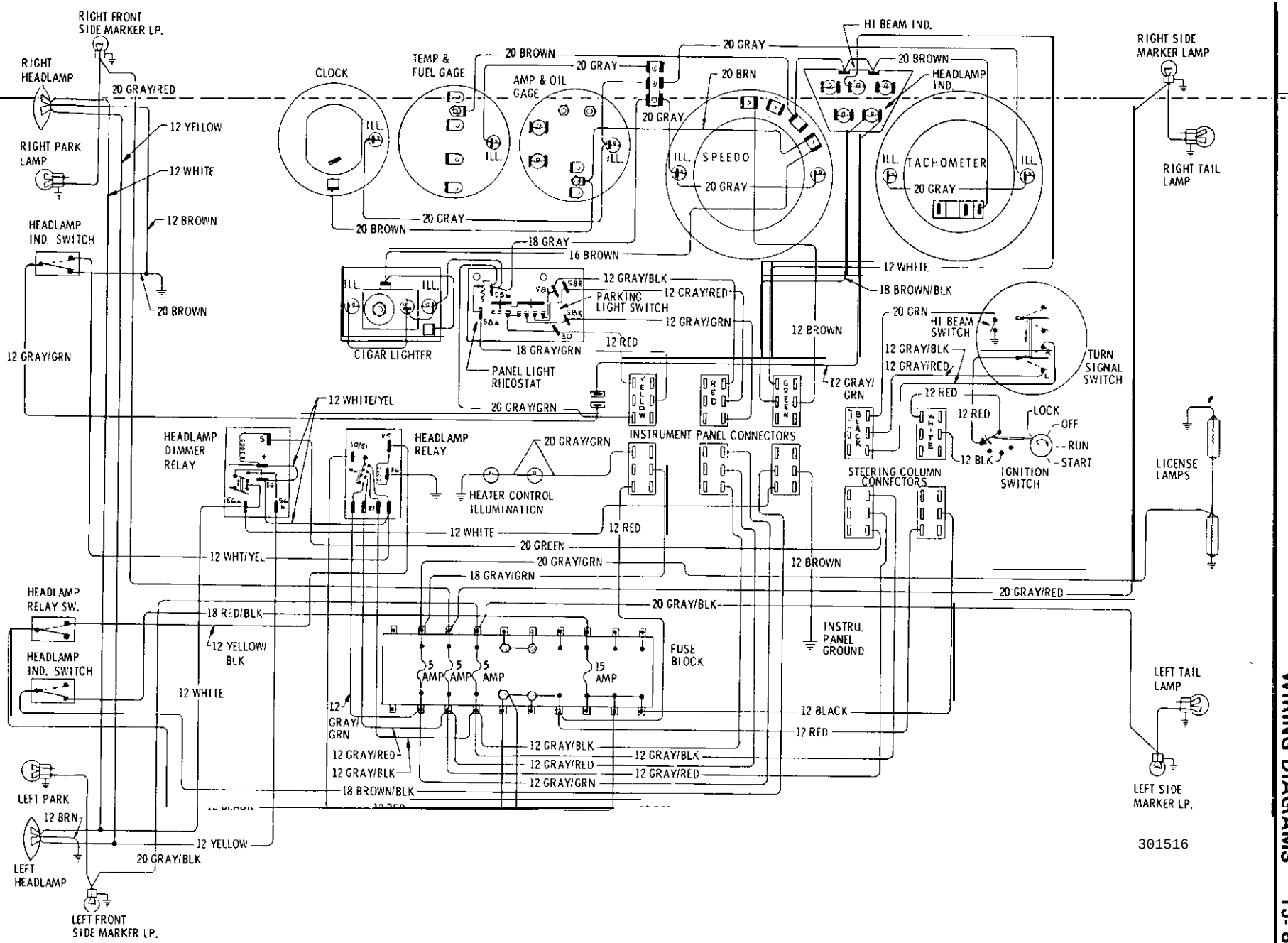

Figure 1J-16 Headlamps, Parking, Tail and Instrument Panel Lighting - GT

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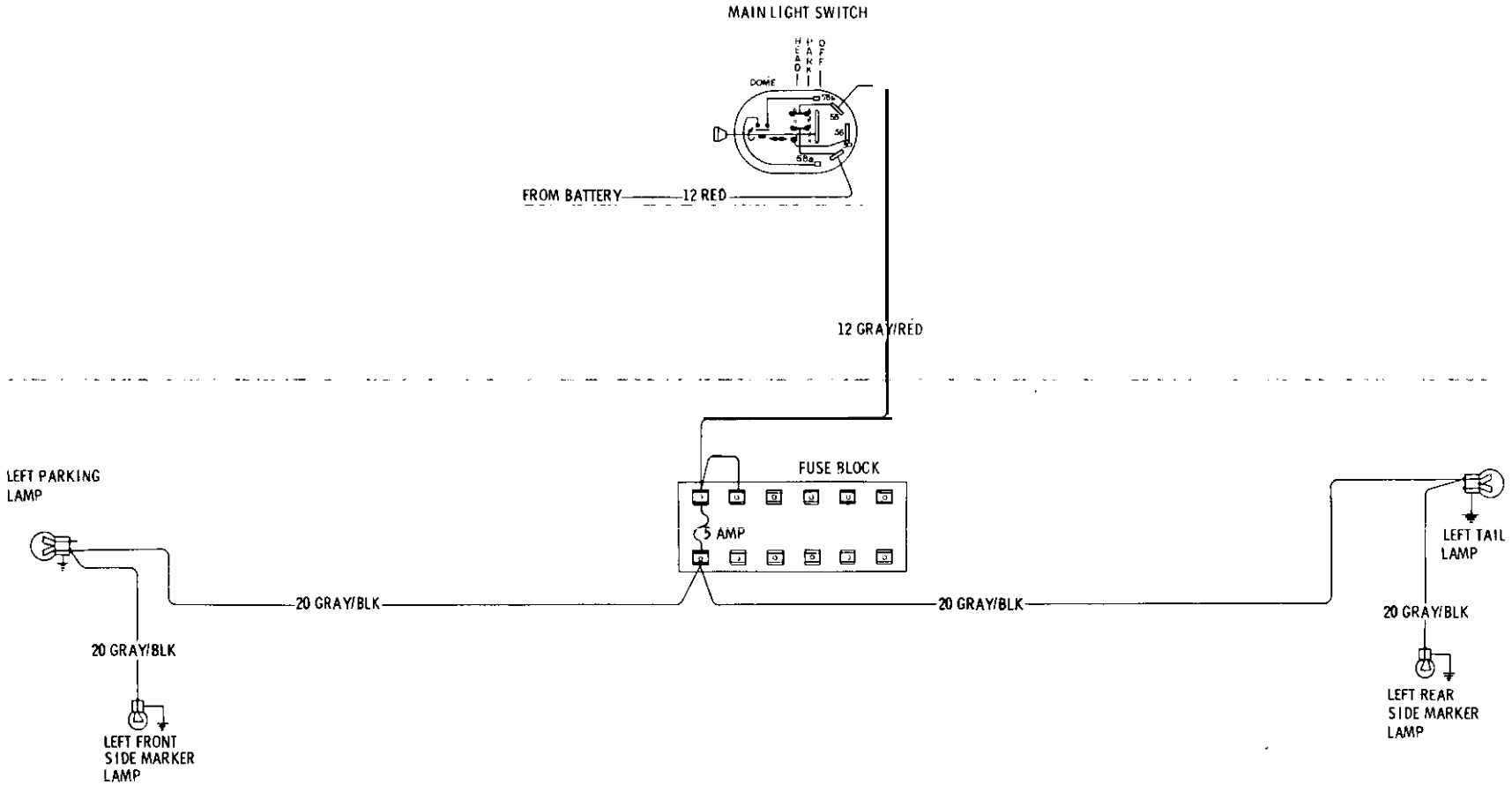

Figure 1J-17 Left Parking and Tail Lights - Opel 1900 - Manta

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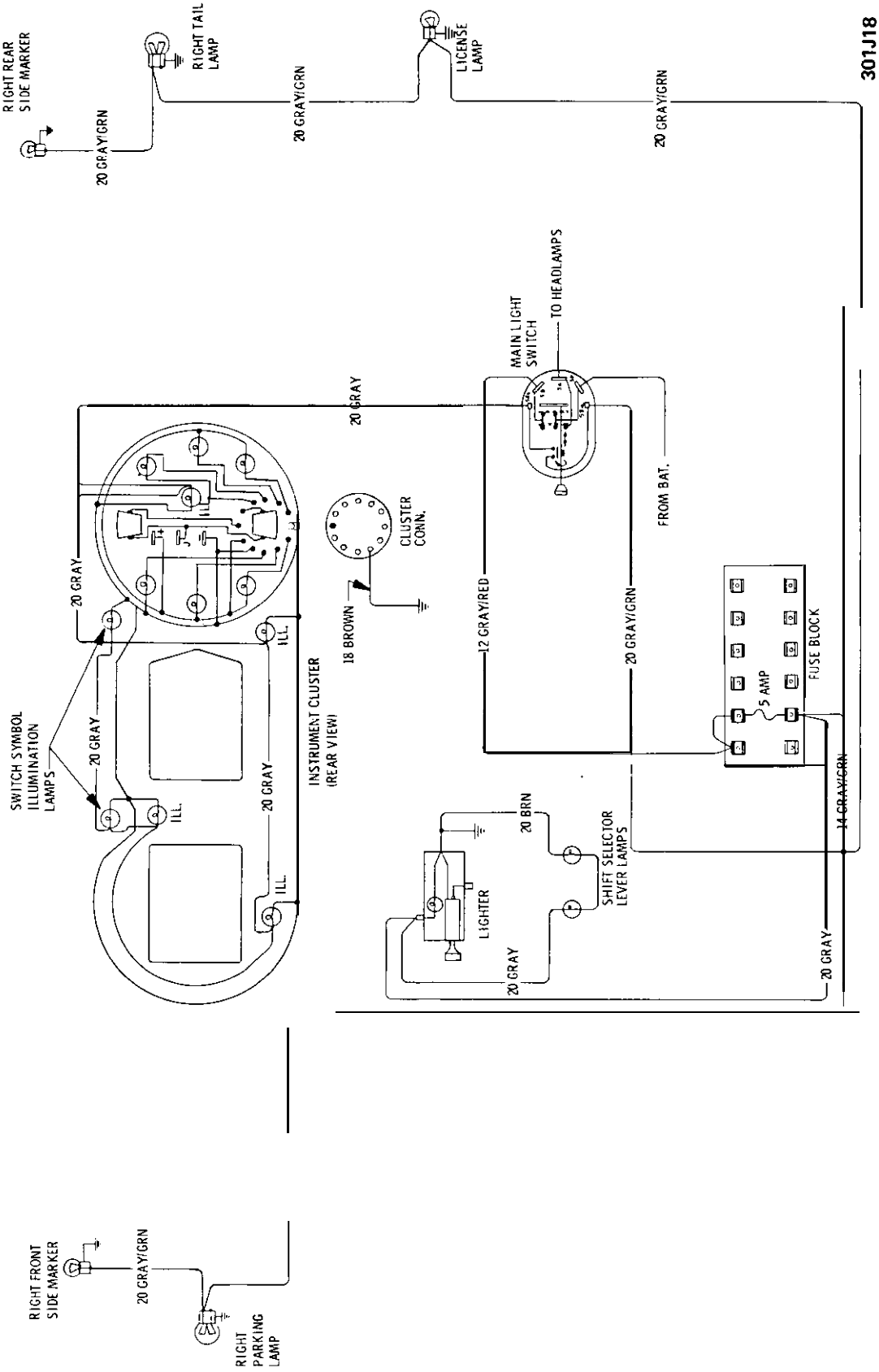

Figure 1J-18 Right Parking, Tail and Instrument Panel Lighting - Opel 1900 - Manta

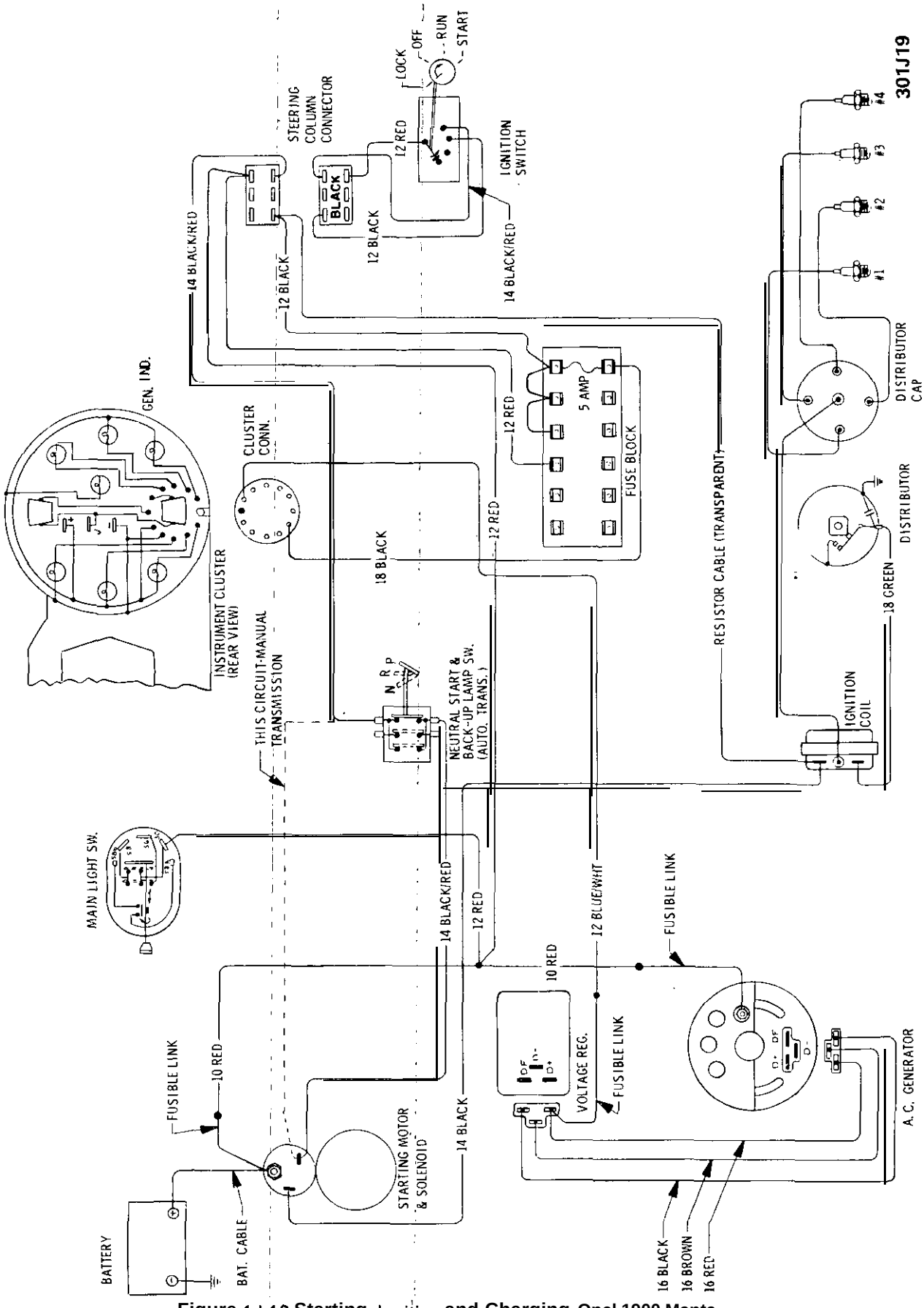

Figure 1J-19 Starting, Ignition and Charging Opel 1900 Manta

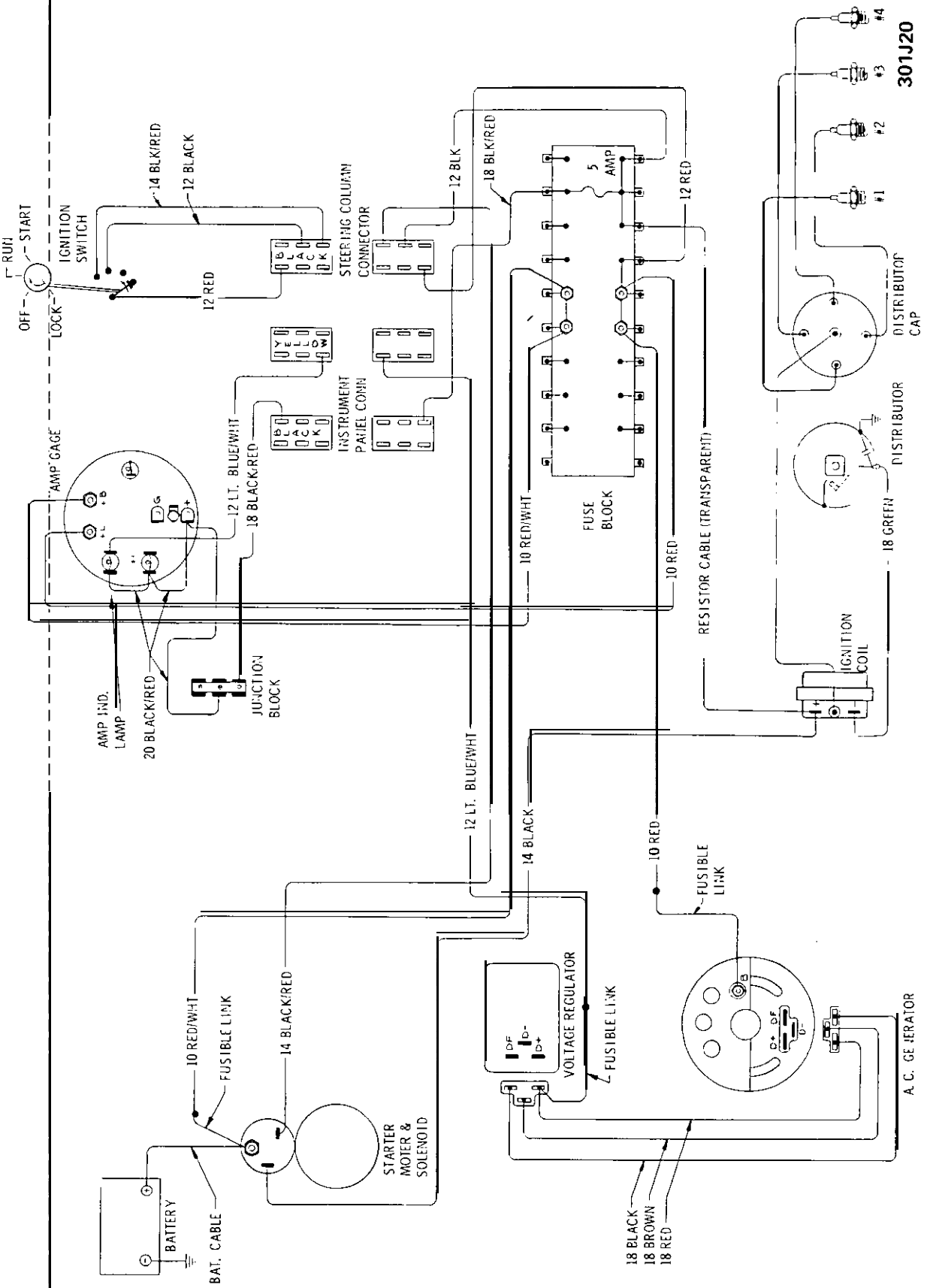

Figure 1J-20 Starting, Ignition and Charging GT

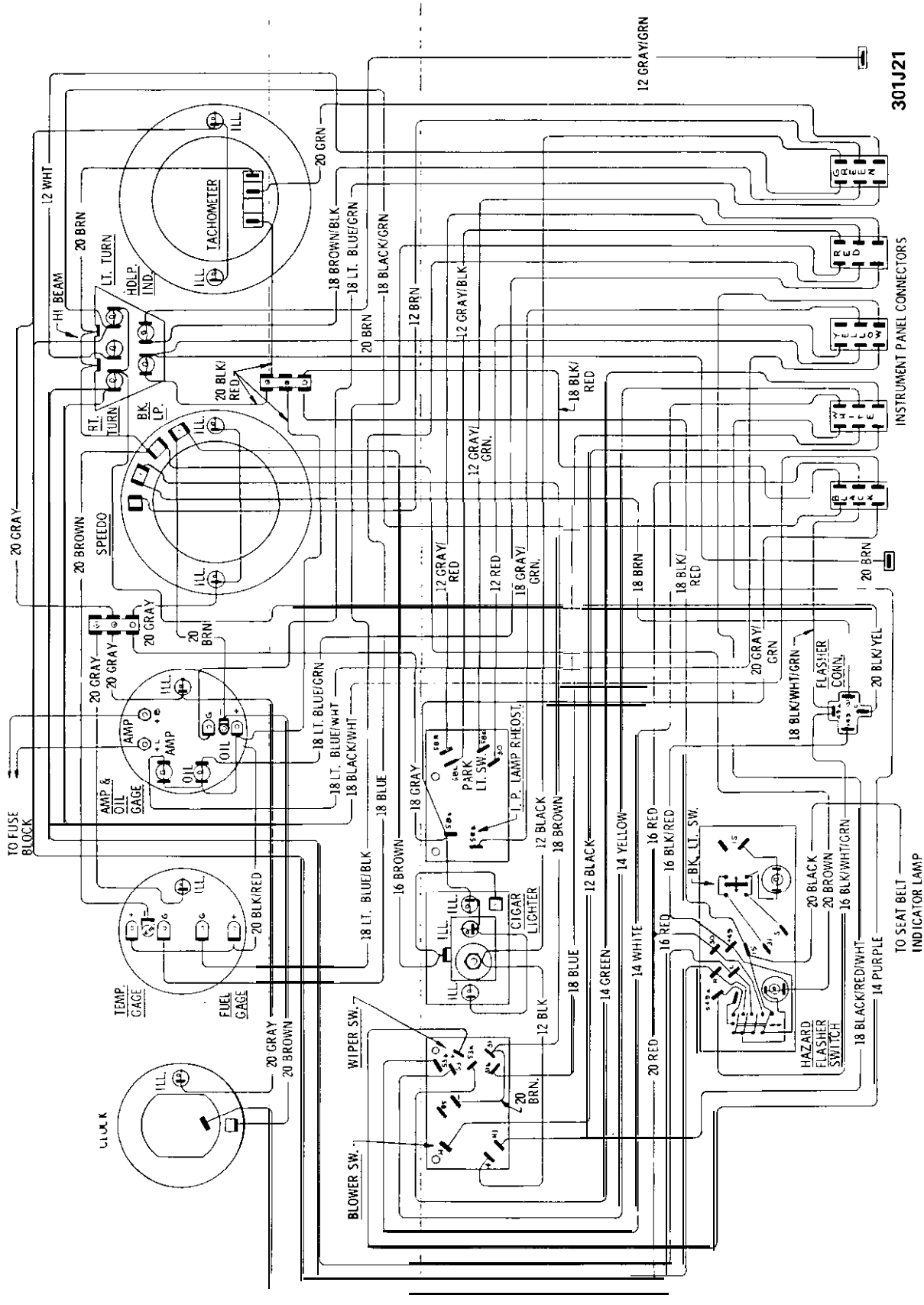

Figure 1J-21 Instrument Panel GT

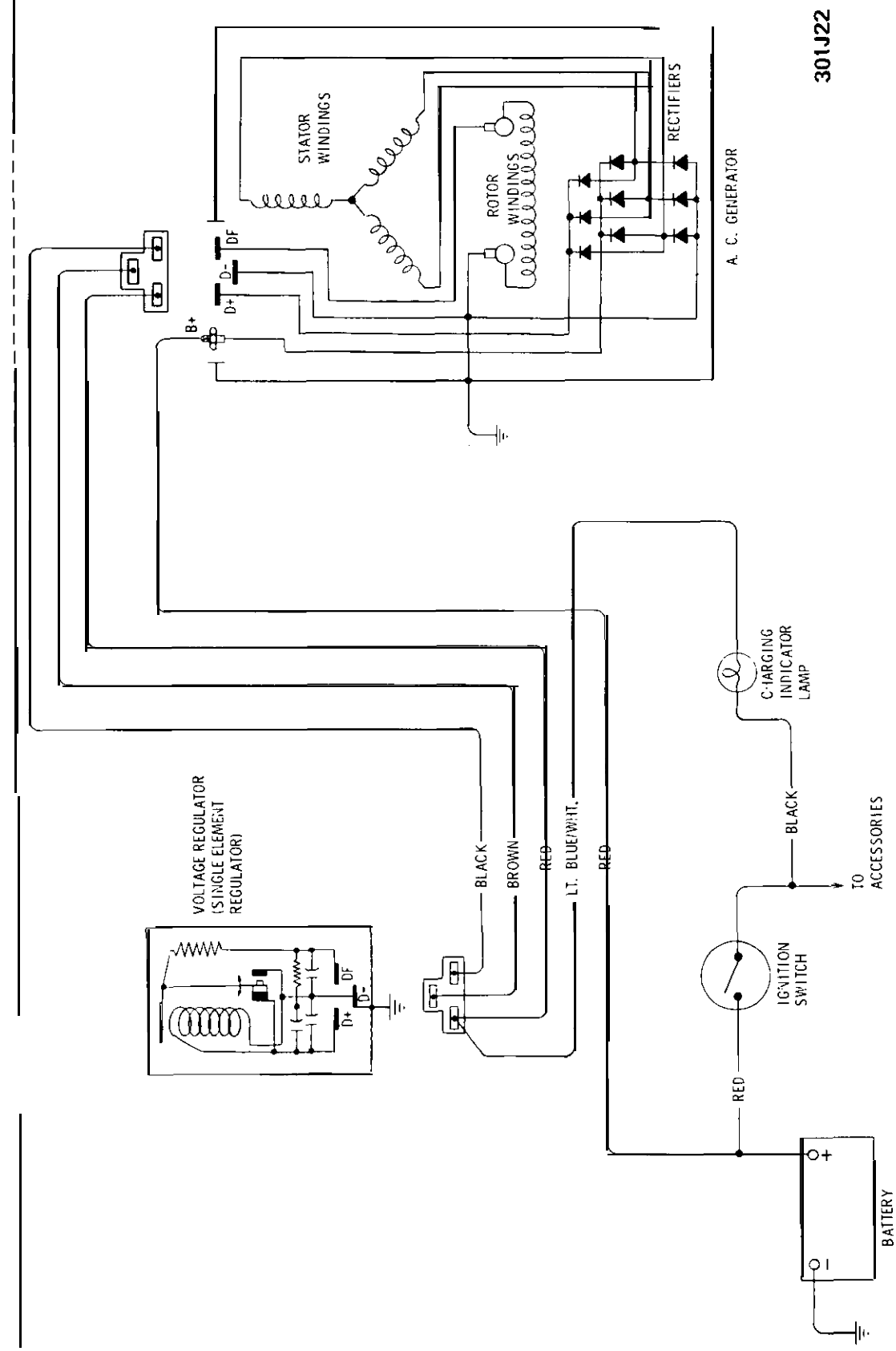

Figure 1J-22 A/C Generator and Regulator -All Models

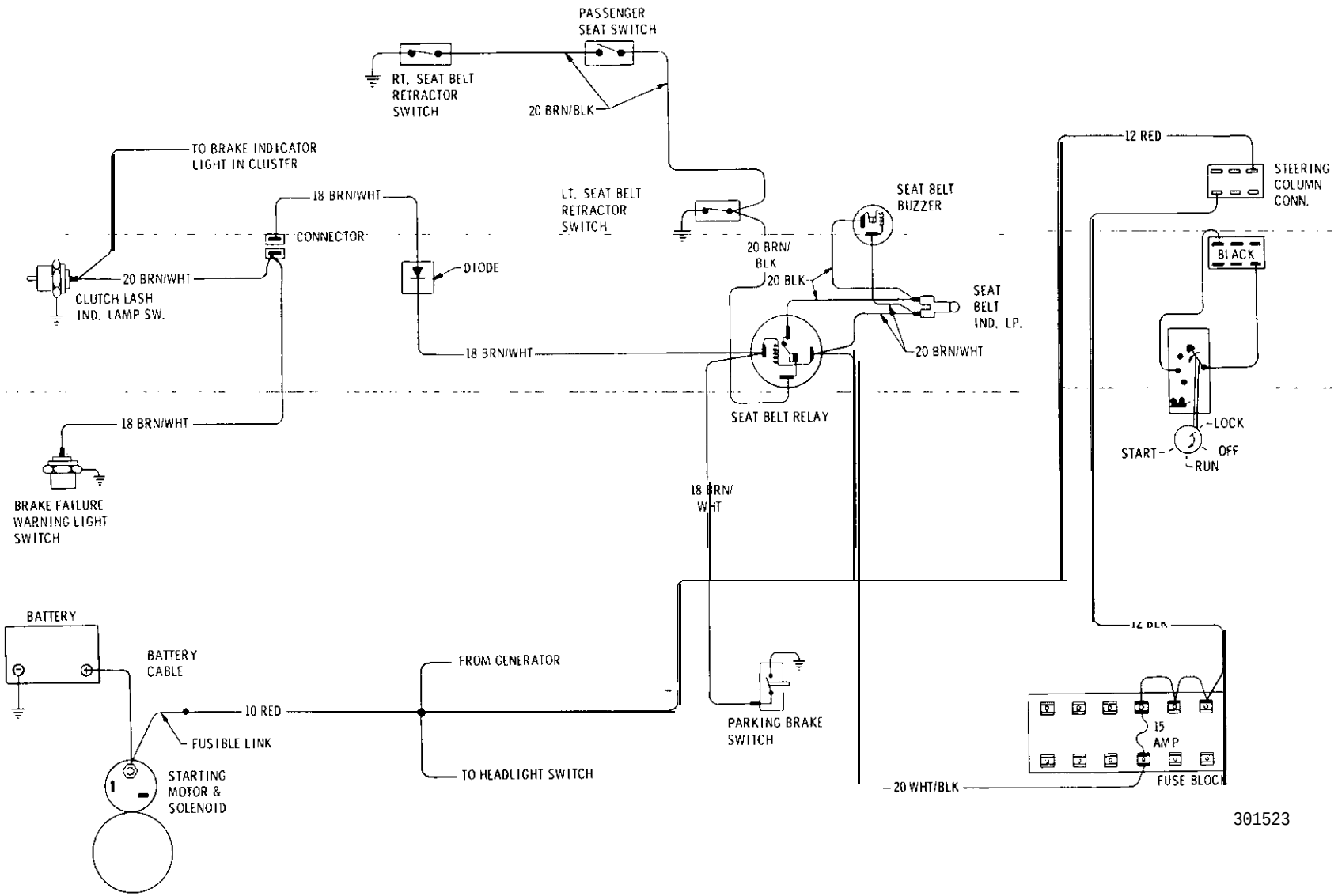

Figure 1J-23 Seat Belt Warning System (Manual Transmission) Opel 1900 - Manta

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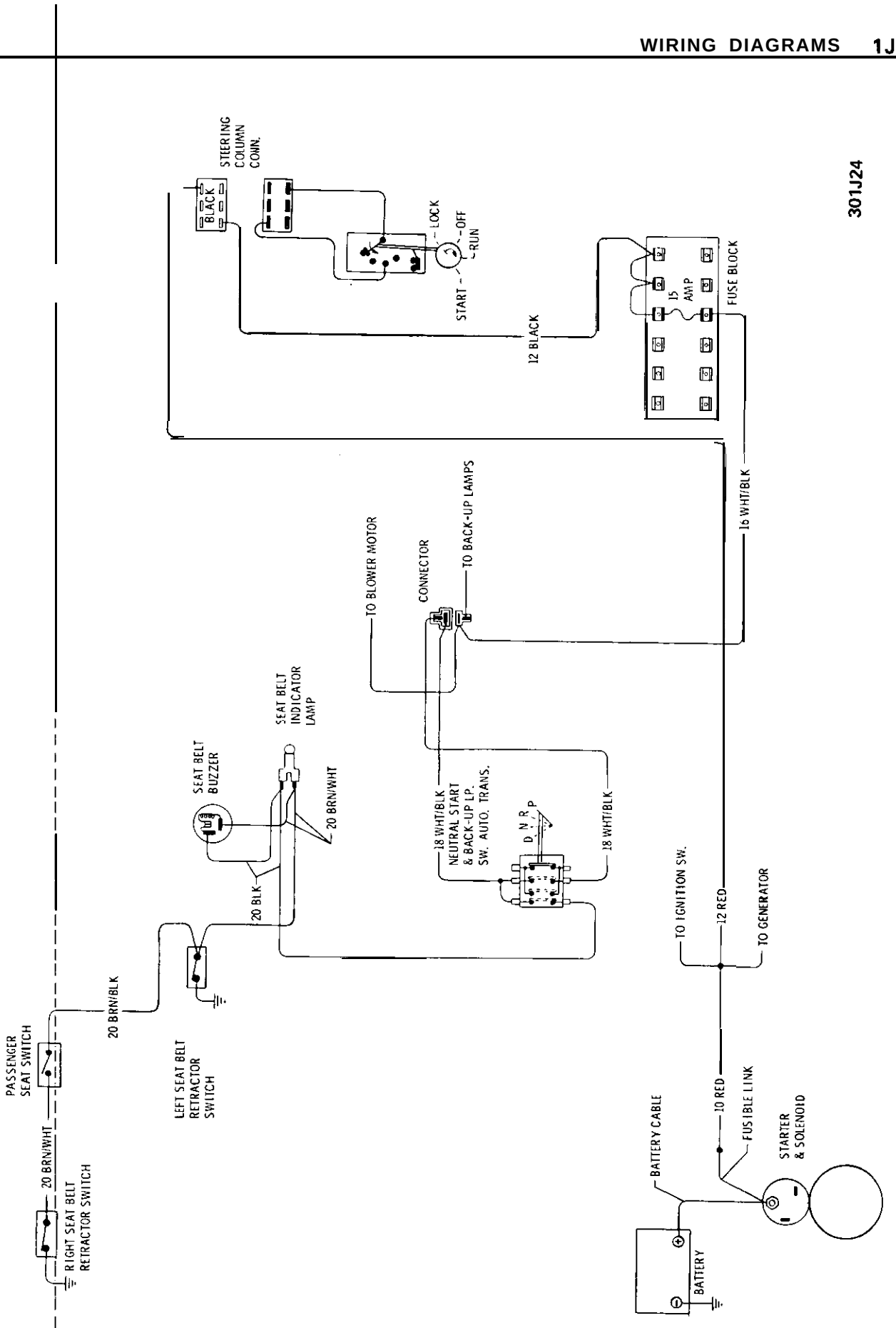

Figure 1 J-24 Seat Belt Warning System (Automatic Transmission) Opel 1900 Manta

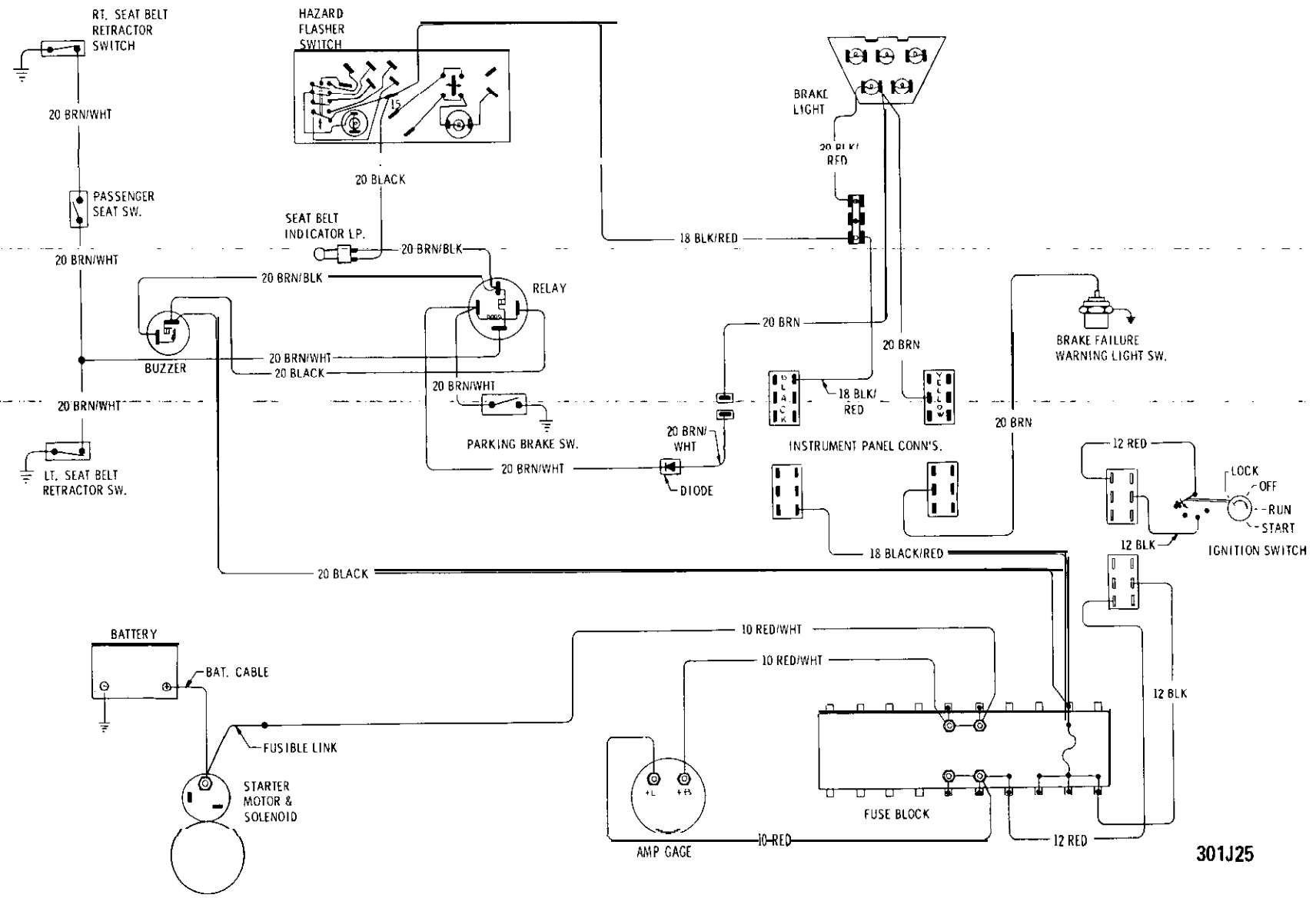

Figure 1J-25 Seat Belt Warning System (Manual Transmission) - GT

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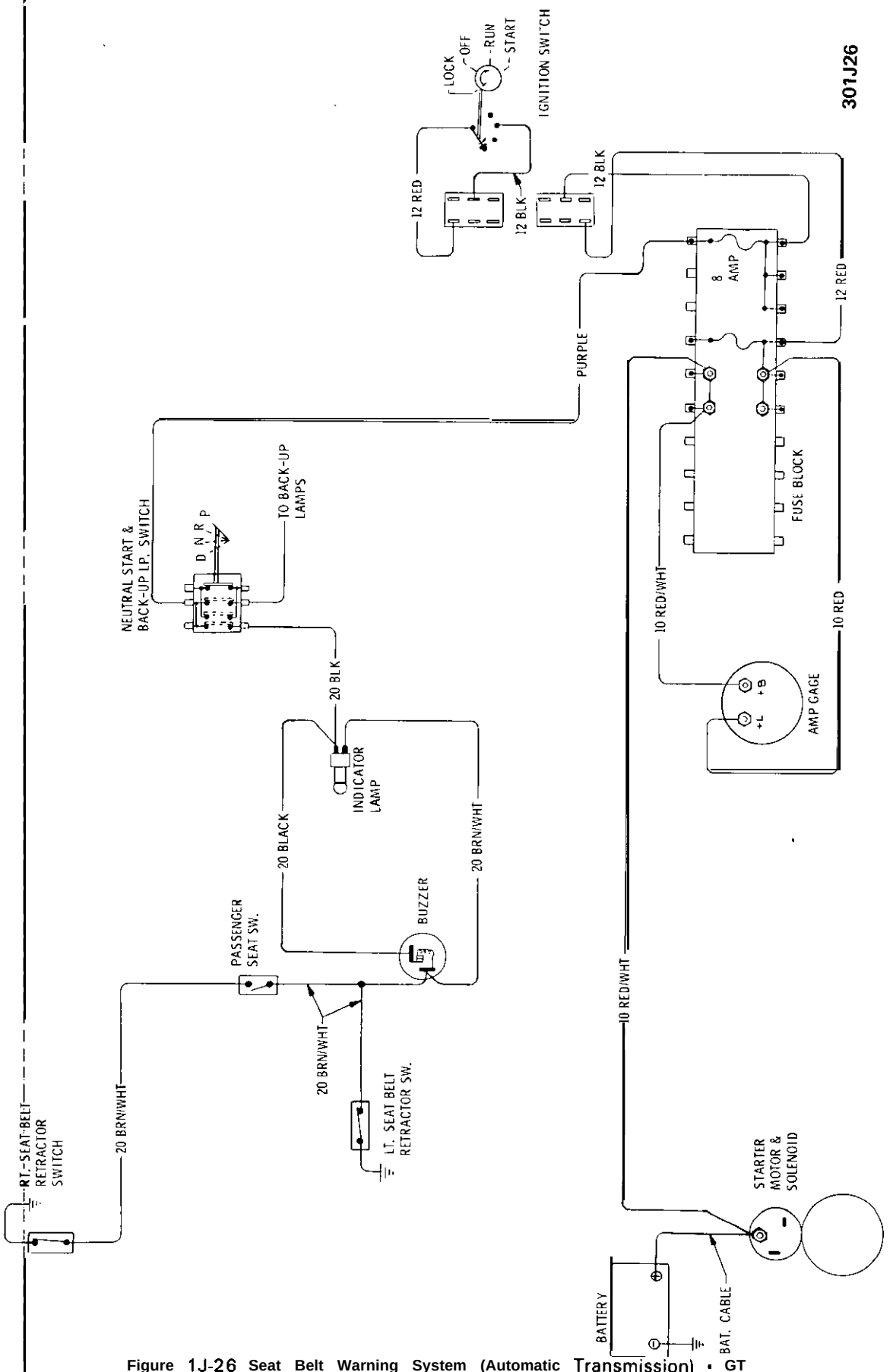

Figure 1J-26 Seat Belt Warning System (Automatic Transmission) - GT

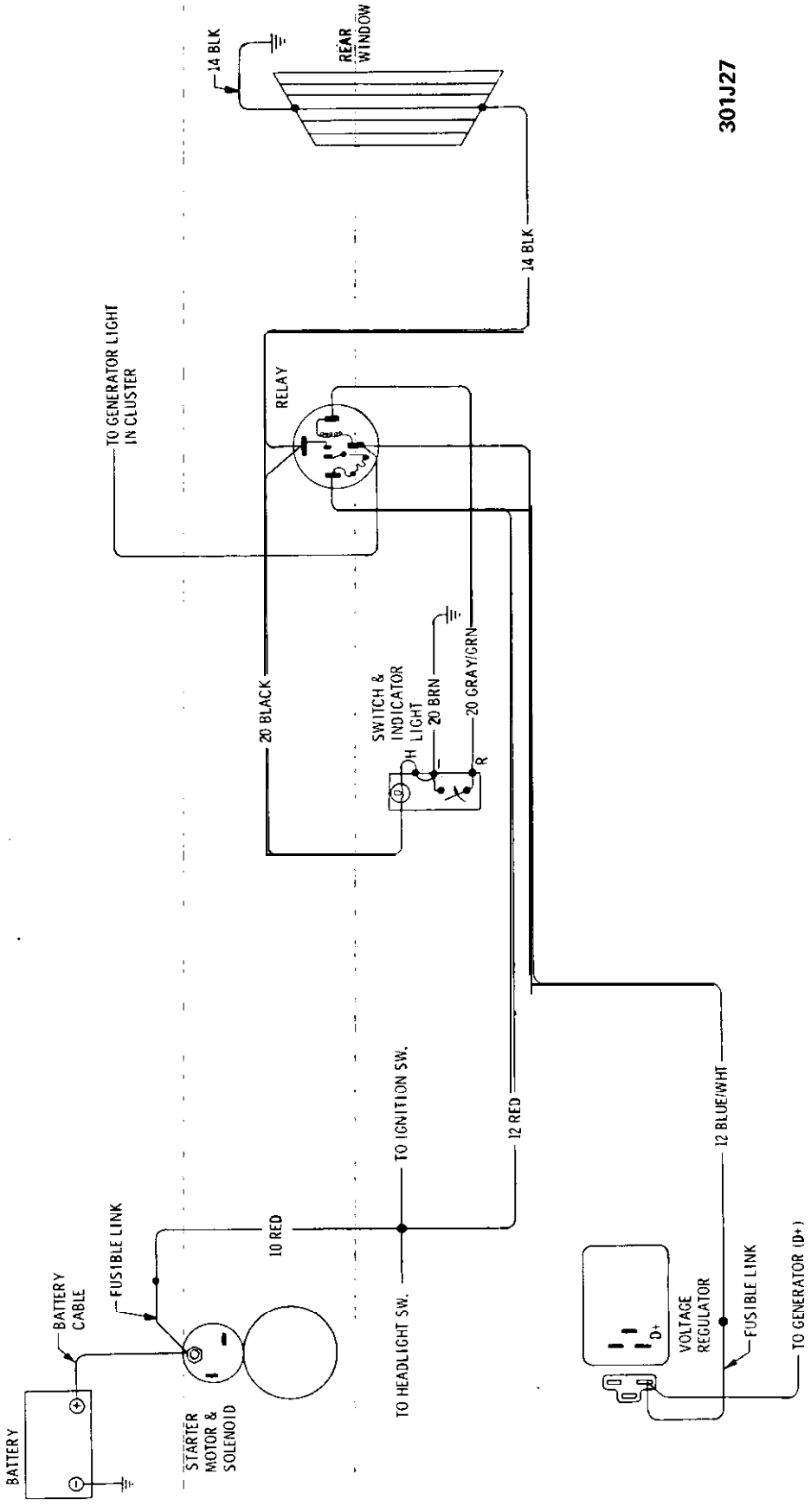

Figure 1 J-27 Heated Rear Glass · Opel 1900 · Manta

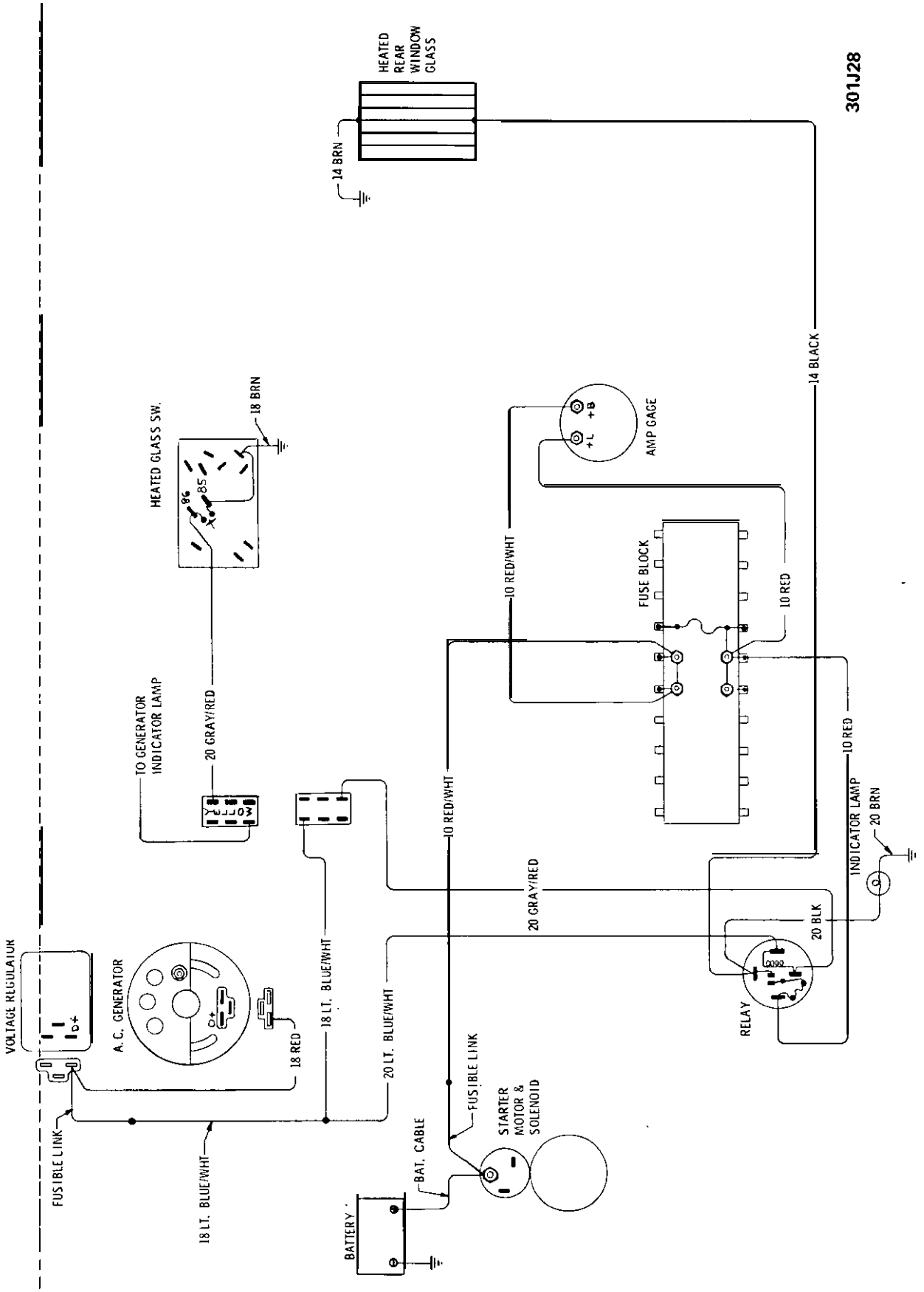

Figure 1J-28 Heated Rear Glass - GT