

Figure 17-3 — Power Circuit

## THE POWER CIRCUIT

The power circuit consists of the V-Glide wiper switch contacts, resistors, forward and reverse (F&R) switch, solenoid power contacts, motor, batteries and all connecting wires. The motor and batteries will be discussed in their own sections. (See Section 20 - Motor, and Section 18 - Batteries.)

When the control circuit is closed, the vehicle will start off in first speed. As the accelerator pedal is depressed further, the brush on the speed controller arm moves across the contacts until the last contact is reached and full speed is attained. The speed controller brush and contacts conduct the motor current through or around each resistor thus controlling the speed (Figure 17-3).

The resistors reduce voltage available to the motor in order to control the vehicle's speed. When current flows through a resistor, a voltage drop occurs which in turn supplies less voltage to the motor. The lower the voltage, the slower the motor will turn. In first speed, all of the resistors are in the circuit and the largest voltage drop is achieved. As second speed is engaged, the first speed resistor is bypassed and the current flows through the remaining resistors. Therefore, there is a smaller voltage drop and the motor turns faster. As each successive contact is reached, one less resistor is left in the circuit and a smaller voltage drop is noted and more voltage is supplied to the motor. In the last speed, all resistors are bypassed and full voltage is supplied to the motor (Figure 17-3).

The F&R switch changes the direction that the current flows through the motor armature thus changing the direction the motor turns causing the vehicle to go forward or reverse. The maximum speed in reverse is limited to one half of maximum forward speed by limiting maximum available voltage in reverse to one half of that in forward.

## THE CHARGE CIRCUIT

The charge circuit consists of the battery charger, charger plug, charger receptacle, on-board fuse link and batteries. The batteries and battery charger will be covered in their own section. (See Section 18 - Batteries and Section 19 - Battery Charger.)

The charger plug and receptacle are the main connection from the charger to the vehicle's battery circuit. The contacts in the receptacle must grip the plug blades sufficiently to create pressure or drag for an adequate electrical connection. If little or no drag is felt, the receptacle or plug must be replaced. If plug or receptacle are damaged or feel hot when charging, part(s) must be replaced. (See plug and receptacle, Section 19 - Battery Charger.)

The on-board fuse link provides additional protection to the vehicle's charging circuit. The fuse is rated for use with a Club Car supplied charger and if it is blown the cause should be determined before replacing. Under normal circumstances, the fuse should never blow. If fuse is blown, vehicle will not charge. (See on-board fuse link, Section 19 - Battery Charger.)

## TROUBLE-SHOOTING GUIDE

### WARNING:

**For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.**

**SEE SAFETY WARNINGS — PAGE 17-1**

SYMPTOM	PROBLEM	POSSIBLE CAUSES	REFER TO
1. Vehicle will not run - no "solenoid click"	Batteries	1) battery connections 2) discharged batteries	Test Procedure 1
	Key Switch	1) loose wires 2) failed switch	Test Procedure 2
	F&R Anti-Arcing Limit Switch	1) loose wires 2) failed switch 3) cam not activating switch	F&R Anti-Arcing Limit Switch, Section 17

SYMPTOM	PROBLEM	POSSIBLE CAUSES	REFER TO
1. Vehicle will not run - no "solenoid click"	Accelerator	1) accelerator rod disconnected	Brakes & Accelerator, Section 21
	Accelerator Pedal Limit-Switch	1) loose wire 2) disconnected or improperly connected wires 3) failed switch	Speed Controller Limit Switch, Section 17 Speed Controller Limit Switch, Section 17
	Solenoid	1) loose wires 2) failed coil	Solenoid, Section 17
2. Vehicle will not run - "solenoid clicks"	F&R Switch	1) loose wires 2) failed contacts	Test Procedure 7
	Solenoid	1) failed contacts	Test Procedure 10
	V-Glide Wiper Switch	1) loose or broken wire connections 2) brush or contacts are dirty, burned, corroded or worn 3) improperly wired	
	Motor	1) loose wires 2) open circuits 3) worn brushes	Test Procedure 8 & Motor, Section 20
3. Vehicle skips one or more speeds	V-Glide Wiper Switch	1) loose or broken wire connections 2) brush or contacts are dirty, burned, corroded, shorted or worn 3) improperly wired	Test Procedure 11 and Electrical Components, Section 17 Electrical Components, Section 17
	Resistors	1) loose or broken resistor	Test Procedure 6
4. Vehicle runs slow	V-Glide Wiper Switch	1) poor wire connections 2) dirty or worn contact points	Test Procedure 11
	Batteries	1) loose terminals or corrosion 2) improperly wired 3) batteries failed 4) batteries not fully charged	Test Procedure 1 & Battery, Section 18
	Accelerator Push Rod	1) accelerator rod improperly adjusted	Speed Controller, Section 17
	Motor	1) loose wires 2) worn or mis-aligned brushes 3) dirty or rough commutator	Motor, Section 20
	Brakes	1) dragging brakes	Brakes & Accelerator, Section 7

SYMPTOM	PROBLEM	POSSIBLE CAUSES	REFER TO
4. Vehicle runs slow	Tires	1) under-inflated or flat tires	Inflate or repair tire
5. Vehicle runs in first speed when F&R switch is put in forward or reverse with key switch <b>off</b>	Solenoid	1) solenoid contacts welded closed	Test Procedure 9
6. Vehicle runs in first speed when F&R switch is put in forward or reverse with key switch <b>on</b>	V-Glide Wiper Limit Switch	1) V-Glide wiper switch wired wrong 2) V-Glide wiper switch limit failed in closed position	V-Glide Wiper Limit Switch, Section 17 V-Glide Wiper Switch Limit Switch, Section 17
	Accelerator Rod	1) Accelerator rod bent or misadjusted	Brakes & Accelerator, Section 21
	V-Glide Wiper Switch	1) stuck brush or accelerator pedal 2) misadjusted	Brakes & Accelerator, Section 21 Brakes and Accelerator, Section 21
7. Vehicle goes forward but not in reverse or vice versa	F&R Anti-Arcing Limit Switch	1) loose or broke wires 2) Improper actuation of switch	Test Procedure 3 & Electrical Components, Section 17
	F&R Switch	1) poor continuity of switch contacts	Test Procedure 7
	Battery Wires	1) Improperly wired	
8. Vehicle not being fully charged	Charger Connections	1) loose wires at receptacle, battery or F&R switch 2) improper engagement of charger plug and receptacle	Charger, Section 19
	On-board Fuse Link	1) blown	Charger, Section 19
	Charger	1) incoming AC voltage (115 volts, 15 amps) 2) charger output low 3) charger cord & plugs	Charger, Section 19

## CIRCUIT TESTING

The entire circuit of this vehicle can be tested without disassembly in the following manner:

- NOTES: 1) Refer to **Figure 17-4** for testing the control circuit and **Figure 17-6** for testing the power circuit.
- 2) The red (+) probe symbol and the black (-) probe symbol as shown on the wiring diagrams (**Figure 17-4** and **Figure 17-6**) indicate points where the probes should be placed for each test. The number on the probe symbol indicates the test procedure number.
- 3) Test equipment required is a Volt-Ohm Meter (VOM) (CLUB CAR part # 1011480) or a continuity tester (CLUB CAR part # 1011273).
- 4) Continuity or a closed circuit is indicated by zero ohms on the VOM or a lighted light on the continuity tester. No continuity or an open circuit is indicated by infinite ( $\infty$ ) ohms or no light.
- 5) The tests in this section are made to check the component and the wires to and from that component. Therefore the probes will often be placed at points removed from the component being tested.

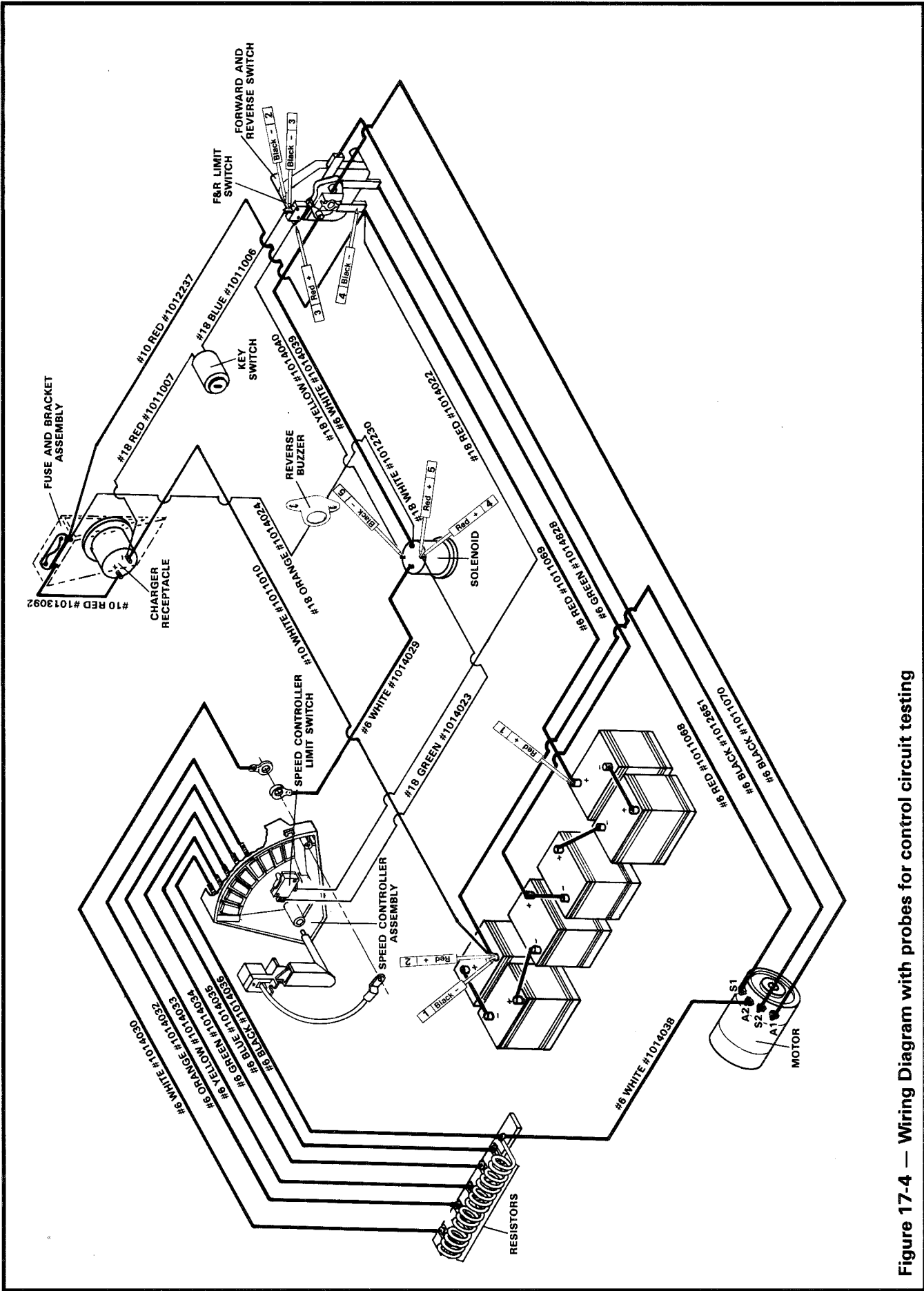


Figure 17-4 — Wiring Diagram with probes for control circuit testing

## CONTROL CIRCUIT

### Test Procedure 1 - Batteries - Voltage Check

#### **WARNING:**

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

With VOM set at Volts D.C., place red (+) probe on the positive post of battery #1 and the black (-) probe at the negative terminal of #6 battery. If you do not read at least 36 volts with batteries fully charged, check for loose battery connections or perhaps a battery installed in reverse polarity. Refer to Battery, Section 18 for further details on battery testing.

### Testing Procedure 2 - Key Switch

#### **WARNING:**

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

With VOM set at  $\Omega$ , place red (+) probe of meter or continuity tester on forward terminal lug of F&R switch and black (-) probe on upper terminal of F&R anti-arcing limit switch. (Figure 17-4). With key in the "OFF" position, reading should be no continuity. Insert key and turn to the "ON" position, reading should be continuity. If reading is incorrect, check wires and terminals, then replace switch. See key switch, page 17-13.

### Test Procedure 3 - F&R Anti-Arcing Limit Switch

#### **WARNING:**

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

Set VOM at  $\Omega$ , place red (+) probe of meter or continuity tester on the common terminal of the limit switch and the black (-) probe on the (NO) normally open terminal (Figure 17-4). Reading should show continuity when lever is depressed and no continuity when lever is released. If not, check wires and terminals, then replace limit switch. See F&R Anti-Arcing Limit Switch, page 17-14.

### Test Procedure 4 - Accelerator Pedal Limit Switch

#### **WARNING:**

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

With VOM set at  $\Omega$ , place red (+) probe of meter on the green wire terminal on the activating coil stud of the solenoid. Place the black (-) probe on the driver's side contact of the F&R switch (Figure 17-5). Depress the accelerator pedal. The reading should be continuity with the accelerator pedal depressed and no continuity with the accelerator pedal in the rest position. If the readings are not correct, remove the V-Glide wiper switch housing cover and check for proper activation of the limit switch by the wiper arm. Also be sure the green #18 wire is connected to the normally closed (NC) terminal of the limit switch, and the red #18 wire is connected to the common (COM) terminal. The normally open (NO) terminal of the limit switch should not have any wires connected to it.

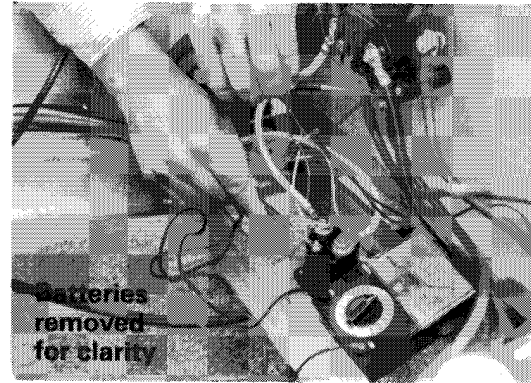


Figure 17-5

#### Test Procedure 5 - Solenoid Activating Coil

### WARNING:

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

Set VOM at  $\Omega$  and place the red (+) probe on one of the small activating coil studs of the solenoid. Place the black (-) probe on the other small activating coil stud of the solenoid. A reading of 55-60 ohms should be obtained at the solenoid. If not, replace the solenoid.

#### POWER CIRCUIT (Figure 17-6)

#### Test Procedure 6 - Resistors

### WARNING:

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

### WARNING:

Hot Resistors can Cause Severe Burns. DO NOT TOUCH.

Visually inspect resistors. If there are not apparent problems, set VOM at  $\Omega$ . Place red (+) probe of meter or continuity tester at the first resistor connection and black (-) probe at the last resistor connection. Meter reading should be continuity or approximately .6 ohms. If not, check for broken resistors or loose connections.

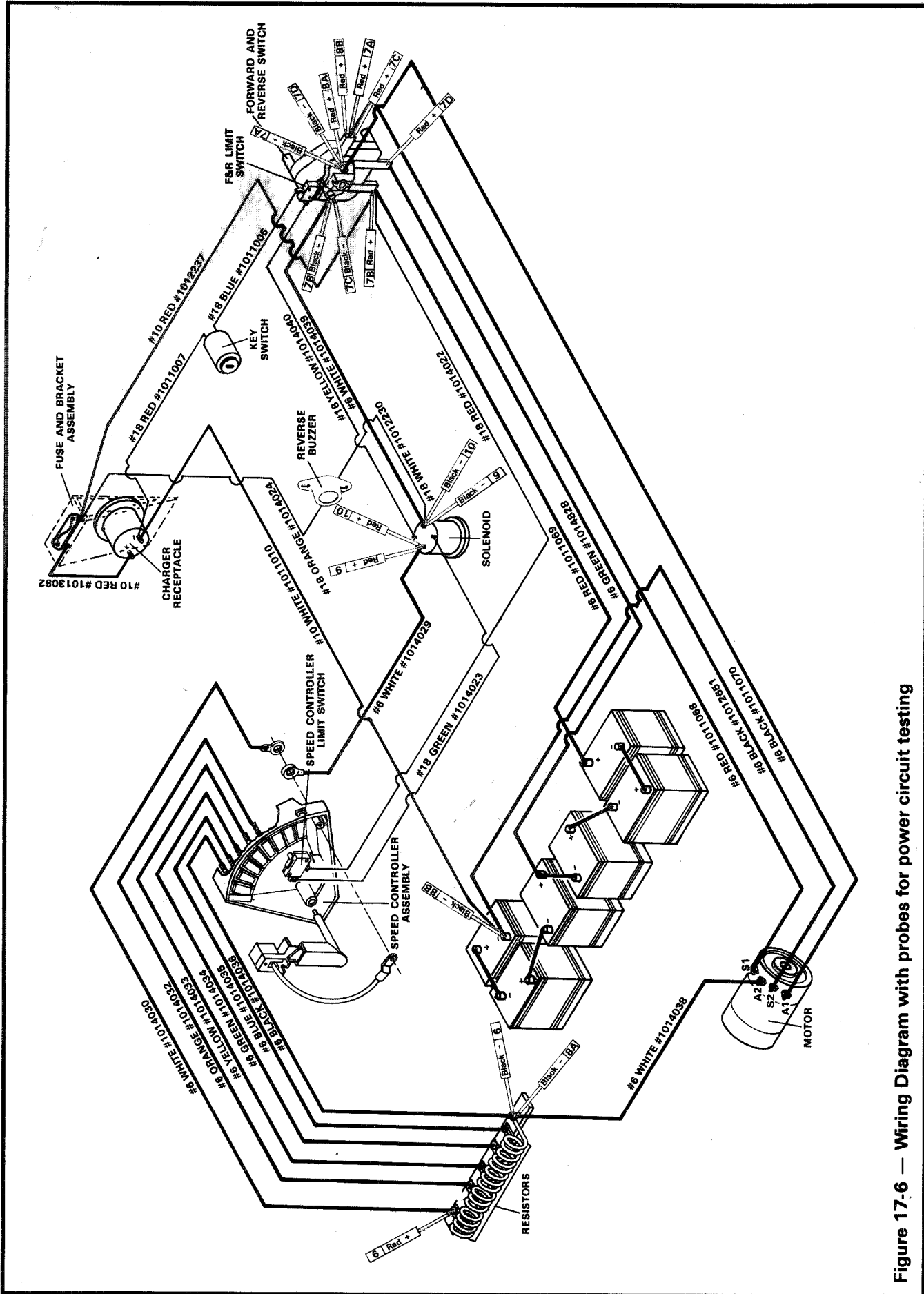


Figure 17-6 — Wiring Diagram with probes for power circuit testing



## Test Procedure 7 - Forward and Reverse Switch

### WARNING:

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

With VOM set at  $\Omega$ , place probes as specified in steps 7A through 7D. Check continuity of the F&R switch in both directions as follows: (Figure 17-7)

- 7A With F&R selector in the forward position, place red (+) probe of meter or continuity tester on the "common" terminal lug (upper passenger's side) of the F&R switch and place the black (-) probe on the heavy purple wire terminal of the F&R rotor. Meter reading should be continuity.
- 7B With F&R selector in the forward position, place red (+) probe on the "forward" terminal lug (bottom driver's side) of the F&R switch and place the black (-) probe on the heavy white wire terminal of the F&R rotor. Meter reading should be continuity.
- 7C With F&R selector in the reverse position, place red (+) probe on the "common" terminal (upper passenger's side) of the F&R switch and place the black (-) probe on the heavy white wire terminal of the F&R rotor. Meter reading should be continuity.
- 7D With F&R selector in the reverse position, place red (+) probe on the "reverse terminal lug (bottom passenger's side) of the F&R switch and place the black (-) probe on the heavy purple wire terminal of the F&R rotor. Meter reading should be continuity.

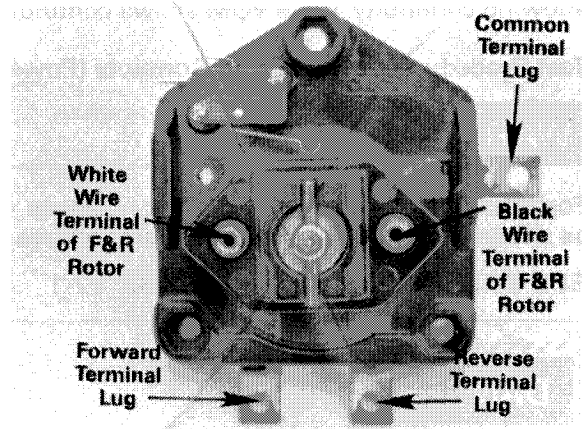


Figure 17-7

If continuity reading cannot be obtained, see F&R switch, page 17-25.

## Test Procedure 8 - Motor

### WARNING:

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

With VOM set at  $\Omega$ , check continuity of motor as follows:

- 8A Motor Armature  
With F&R selector in the neutral (straight up) position, place red (+) probe of meter or continuity tester on the heavy purple wire terminal of the F&R rotor and the black (-) probe on the last speed resistor coil connection. Meter reading should be continuity.
- 8B Motor Stator  
With F&R selector in the neutral (straight up) position, place red (+) probe on the "common" terminal lug (upper passenger's side) of the F&R switch and place the black (-) probe on the negative (-) post of the battery No. 6. Meter reading should be continuity.

If continuity readings are not obtained, check for loose wires or terminals. Then refer to Motor, Section 20 for motor repair and further testing.

Test Procedure 9 - Solenoid Contacts (Power Off)

**WARNING:**

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

If the vehicle runs in first speed as soon as the F&R lever is placed in forward or reverse the solenoid is probably welded closed. Set VOM on  $\Omega$  and place the red (+) probe of the meter on one of the large studs of the solenoid and the black (-) probe of the meter on the other large stud of the solenoid. It should show no continuity. If the VOM shows continuity, replace solenoid.

Test Procedure 10 - Solenoid Contacts (Power On)

**WARNING:**

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

**DANGER:**

Before connecting batteries, disconnect white wire from resistor board to A2 motor terminal. Remove white wire from vehicle to avoid arcing or accidentally reconnecting. Raise rear end of vehicle so rear wheels clear the ground and block securely with jack stands under the axle tube. With white wire removed, solenoid can be actuated without supplying power to rear wheels. Failure to disconnect wire can cause the vehicle to start abruptly.

- 10A Reconnect the battery cables and check continuity between battery #1 positive terminal and forward (driver side) terminal lug on F&R switch. If no continuity, with F&R in neutral check wire between battery #1 positive terminal and F&R forward (driver side) terminal lug, and if defective replace wire assembly.
- 10B Check continuity between battery #6 negative terminal and charger receptacle negative post. If no continuity, check wire assembly and replace wire assembly.
- 10C With the key switch in the on position and the F&R switch in forward, depress the accelerator pedal to the floor. (Should be able to hear the solenoid click.) Set the VOM on  $\Omega$  and check continuity across the large studs on the solenoid. The VOM should read continuity. If a no continuity reading is obtained, replace the solenoid.

**WARNING:**

Remove key, place forward and reverse lever in neutral and disconnect batteries as shown on inside front cover before replacing solenoid or reinstalling the white wire from resistor board to A2 motor terminal.

Test Procedure 11 - V-Glide Wiper Switch

**WARNING:**

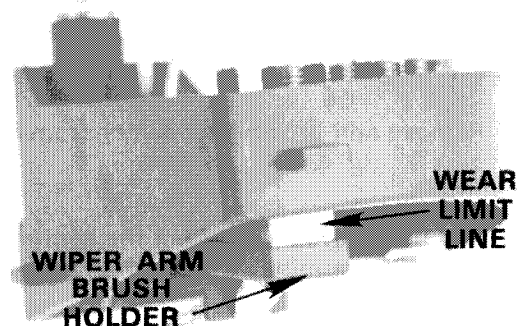
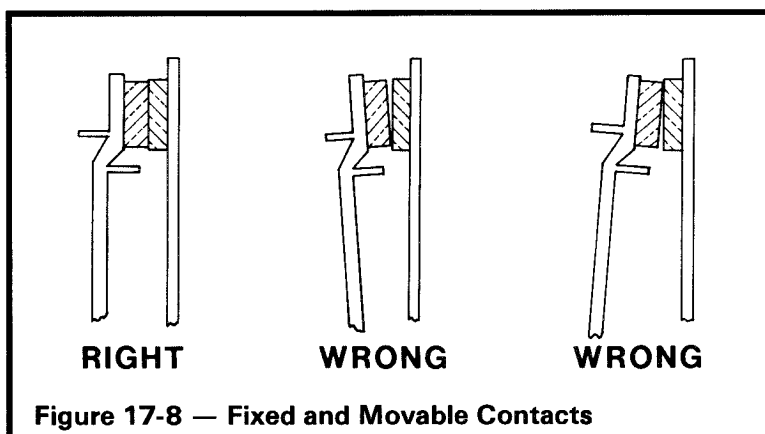
For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

## DANGER:

Disconnect the two battery cables as shown in Figure 17-1, turn the key switch to the off position, and put the F&R in neutral or the vehicle will engage in forward or reverse speed and run over you causing severe personal injury or death.

Follow procedures exactly as outlined in DANGER above. With cover removed, inspect the V-Glide wiper switch by observing the wiper arm brush as it moves across the fixed contacts. There should be sufficient spring pressure in the arm to keep the wiper arm brush firmly against each of the fixed contacts. There should also be sufficient contact between all of the fixed contacts and the wiper arm brush (Figure 17-8). Inspect both the wiper arm brush and fixed contacts for excessive pitting, burns or wear. Check to be sure all of the contacts are tight and the V-Glide wiper switch housing is not melted or burned around the contacts. The nuts holding the wires on the back of the fixed contacts must be torqued to 4/5 N-m (35-45 in.-lbs.). If the wiper arm brush has worn to the wear limit line (Figure 17-9), the wiper arm brush must be replaced. If the wiper arm brush must be replaced, it may require adjustment. (See Wiper Arm Adjustment.) If the V-Glide wiper switch housing or fixed contacts are damaged, the entire V-Glide wiper switch housing with contacts must be replaced.



## ELECTRICAL COMPONENTS - REMOVAL, TESTING AND INSTALLATION

### THE KEY SWITCH

The key switch is mounted just to the right of the steering column on the center section removable dash panel.

## WARNING:

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

### Removal

1. Loosen the two screws on each side of the dash center panel.
2. Slide center dash panel up the steering column by snapping out at the top and then rotating the panel out and up. There is sufficient slack in the wiring to allow for this.
3. Remove the wires from the key switch, do not allow wires to touch.
4. Remove key switch from dash by holding the key switch and turning the nut on the outside of the dash with key switch tool (CLUB CAR part # 1012801).

## Testing

With the key off, place continuity meter or VOM set on  $\Omega$  across key switch terminals. Reading should be no continuity. With key switch on, reading should show continuity (Figure 17-10).

## Installation

Coat the terminals with Battery Protector Spray (CLUB CAR part # 1014305) to ward off corrosion. Reinstall in reverse order of removal. Be sure that key switch terminals do not touch the frame and the panel is properly seated and snapped in place.

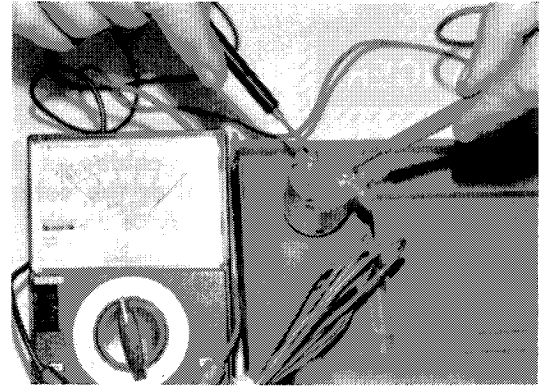


Figure 17-10

## THE F&R ANTI-ARCING LIMIT SWITCH

The F&R anti-arcing limit switch is located on the F&R switch and is activated by a cam on the F&R switch rotor.

## WARNING:

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

1. Remove anti-arcing limit switch from F&R switch by removing two screws, lockwashers and nuts.

## Testing

1. With the alligator clip from the continuity meter on the common terminal and the probe on the normally open (NO) terminal, switch lever not depressed, reading should be no continuity (Figure 17-11).
2. Depress the lever. Reading should show continuity.

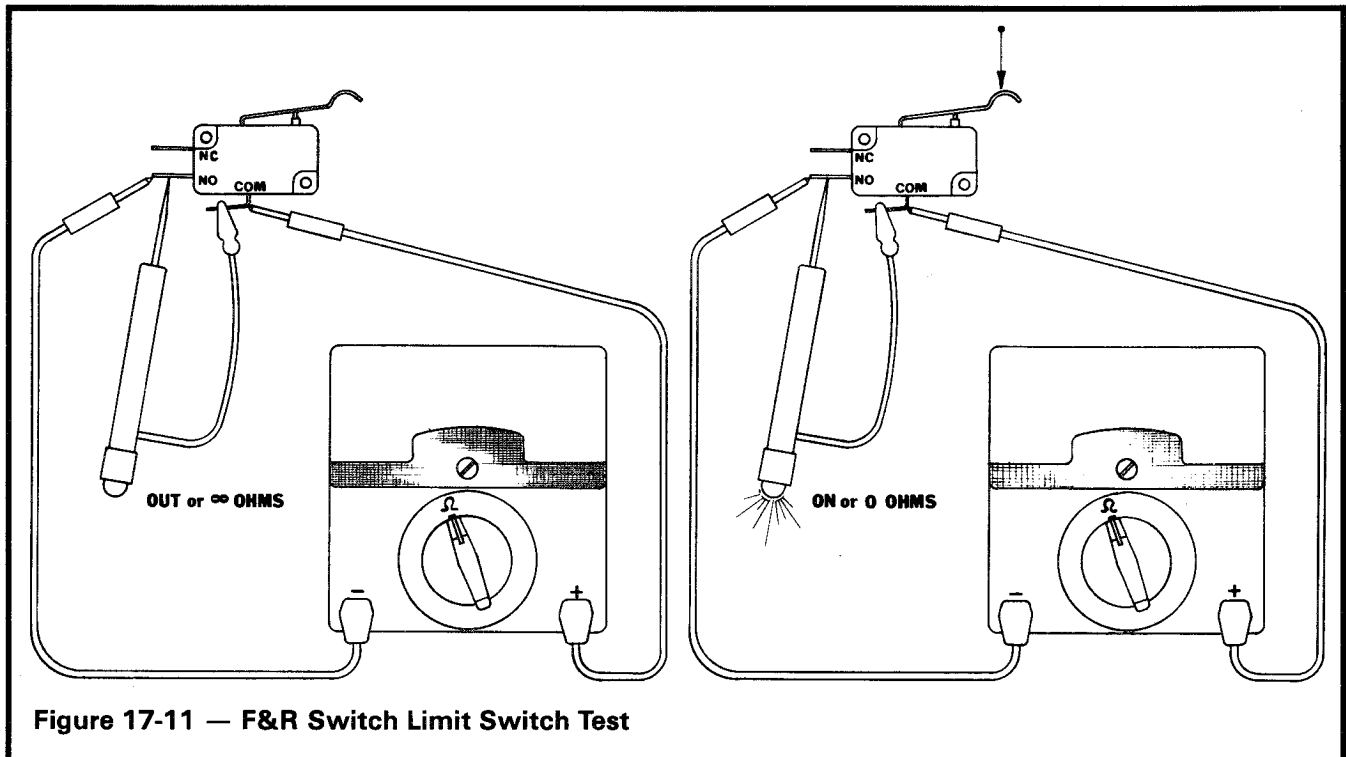


Figure 17-11 — F&R Switch Limit Switch Test

## Installation

Install in reverse order of disassembly. Insert blue wire on the common (COM) terminal and yellow wire on the normally open (NO) terminal. Torque screws to 0.6 N-m (5 in.-lbs.).

After installation, be sure that the switch "clicks" (makes and breaks contact) when the rotor is turned. If it does not "click", inspect the F&R rotor and limit switch for damage.

### THE ACCELERATOR PEDAL LIMIT SWITCH

## WARNING:

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

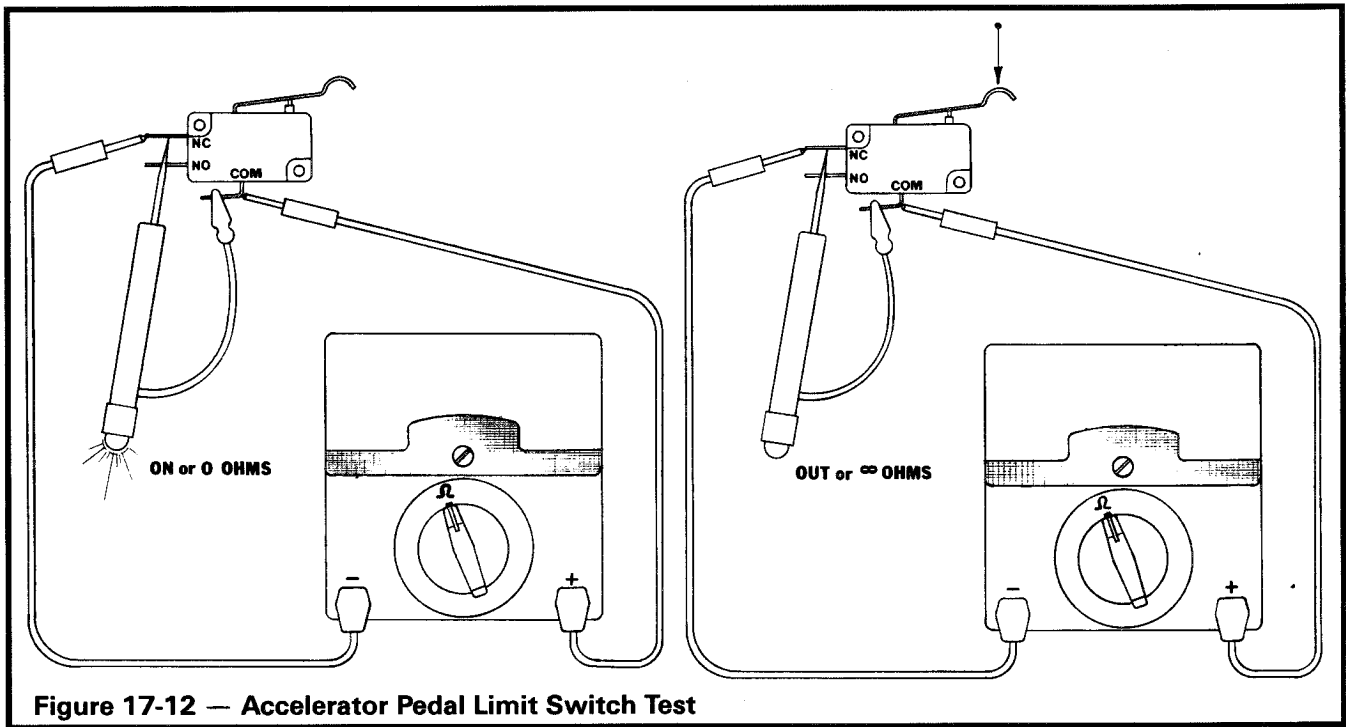


Figure 17-12 — Accelerator Pedal Limit Switch Test

### Removal

1. Remove the #5 and #6 batteries from the vehicle (Figure 17-1).
2. Remove the cover from the speed controller housing.
3. Disconnect accelerator rod from ball stud on speed controller.
4. Remove the screws and lockwashers from the limit switch. Be sure to retain the nuts for reassembly.
5. Remove the green and red wires from the limit switch.

### Testing

1. Place the black (-) probe on the normally closed (NC) terminal and the red (+) probe on the common (COM) terminal. With the switch lever not depressed the reading should show continuity (Figure 17-12).
2. Depress the lever with the probes in the same position as in step 1 and the reading should be no continuity.
3. If the readings are not correct as stated in steps 1 and 2, the limit switch must be replaced.

## Installation

1. Install the screws, lockwashers and nuts to the limit switch. Torque the screws to 0.6 N-m (5 in.-lbs.).
2. Install the accelerator rod ball joint to the ball stud on speed controller.
3. Install the green wire to the normally closed (NC) terminal and the red wire to the common (COM) terminal. The normally open (NO) terminal should not have a wire attached to it.
4. Install the cover on to the speed controller housing. All three tabs should snap into place.
5. Install the #5 and #6 batteries into the vehicle and reconnect the battery wires as shown in Figure 17-1.

## THE REVERSE BUZZER

The reverse buzzer is located under the front body on the rear of the center dash panel (Figure 17-13).

### WARNING:

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

## Removal

1. Remove center dash panel.
2. Remove orange and white wires from buzzer terminals (Figure 17-13).
3. Remove screws (2) to remove buzzer.

## Installation

1. Install screws (2) through buzzer bracket tab.
2. Connect orange wire to buzzer positive (+) terminal and white wire to buzzer negative (-) terminal.
3. Install center dash panel.

## THE SOLENOID

The solenoid is located just in front of the #3 and #4 batteries (Figure 17-1). The solenoid has two sets of studs. Two large 5/16 inch studs (power contact studs) and two small No. 10 studs (activating coil studs).

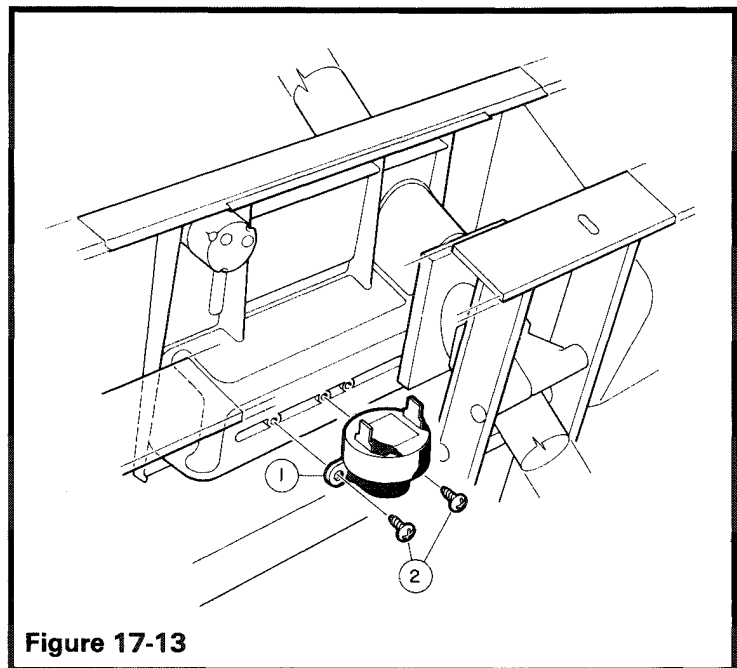


Figure 17-13

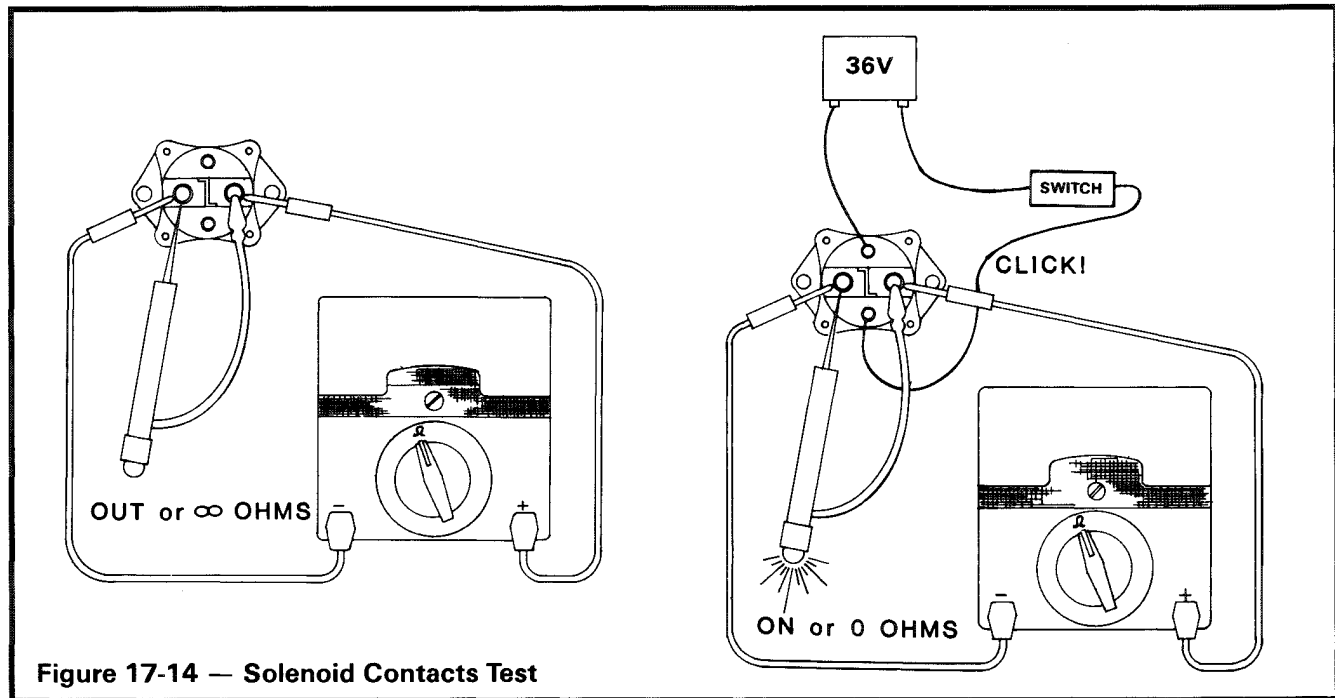
### WARNING:

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

## Removal

1. Disconnect all wires from solenoid.
2. To test solenoid contacts, place VOM or continuity meter across contacts. Reading should be no continuity (**Figure 17-14**).
3. Activate the coil by running 36 volts across the activating coil studs. (Car batteries or any spare set wired 36 volts in series can be used.) Reading across solenoid contacts should show continuity (**Figure 17-14**).
4. If any test yields an incorrect reading, replace solenoid.



**Figure 17-14 — Solenoid Contacts Test**

## Installation

1. Install the solenoid to the mounting place and torque to 7.5 N-m (66 in.-lbs.). The solenoid does not have to be oriented in any particular manner.
2. Install wires as shown in wiring diagram (**Figure 17-6**).

### CAUTION:

Be sure the wires have been routed so that the wire from the F&R rotor does not pull on other wires as the F&R handle is shifted.

## RESISTORS

### WARNING:

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

The resistors are mounted to the resistor mounting board which is mounted behind the batteries.

**Removal**

1. Loosen the nuts (1) which hold the particular resistor to the mounting board and slide the resistor out from underneath the washer (3). The nut does not have to be removed (Figure 17-15).

**Testing**

Visually inspect each resistor for broken wire or excessive corrosion. If damaged or broken - replace.

**Installation**

1. Install the resistor ends under the washers and tighten nut to 10/11 N-m (90-100 in.-lbs.).

**CAUTION:**

Be sure the motor wires have been routed through the wire ties to avoid contact with the resistors.

Be sure the resistors are no closer than one inch from resistor shield.

If the resistors are closer than one inch to the resistor shield, readjust resistors.

NOTE: Be sure that each resistor coil does not touch an adjacent coil or one of the other resistors. The vehicle will not operate properly if the resistor coils touch one another.

Refer to the circuit diagram (Figure 17-15) and note that R1 has the smallest wire and largest number of coils. R5 has the largest wire and smallest number of coils (see Chart 1). Be sure that the resistors are installed in proper sequence.

**CAUTION:**

If a 3½ horsepower motor is being used in conjunction with a V-Glide wiper switch, the fourth and fifth speed resistor coils must be replaced with resistor coil part numbers 1014654 and 1014655.

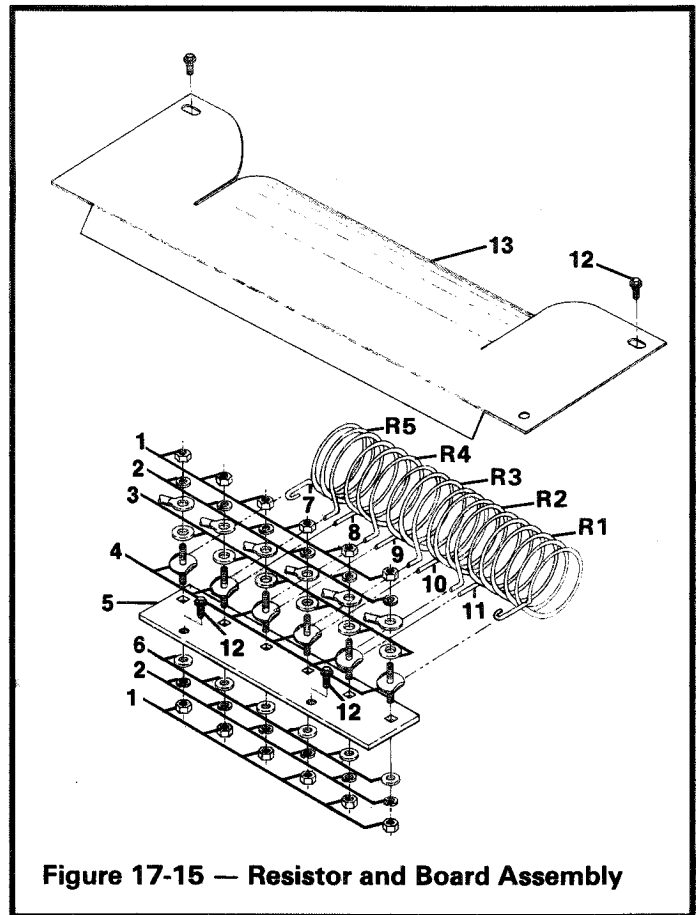


Figure 17-15 — Resistor and Board Assembly

Resistor Number	# of Coils	Diameter
R-1	6	.128"
R-2	4	.128"
R-3	3	.144"
R-4	3	.162"
R-5	3	.182"

NOTE: For 3½ horsepower motor

R-4	4	.182"
R-5	4	.204"

Chart 1

**V-GLIDE WIPER SWITCH**

**General**

The V-Glide wiper switch is located in the battery compartment next to the #6 battery. The wiper switch arm adjustment needs to be checked if the brush on the V-Glide wiper switch is replaced. The pedal group adjustments (see Section 21, Brakes & Accelerator) need to be checked if any of the pedal group or accelerator rod has been adjusted, removed, or replaced.

The V-Glide wiper switch assembly should be inspected on a monthly basis for cracks or damage. It should also be inspected on a monthly basis to be sure it is securely fastened to the frame.



## CAUTION:

Inspect the V-Glide wiper switch housing for cracks or damage prior to installation of V-Glide wiper switch housing to frame. If housing is cracked or damaged, the entire housing with fixed contacts must be replaced.

When washing the vehicle, do not direct water stream at V-Glide wiper switch.

Do not operate vehicle without V-Glide wiper switch cover in place.

## WARNING:

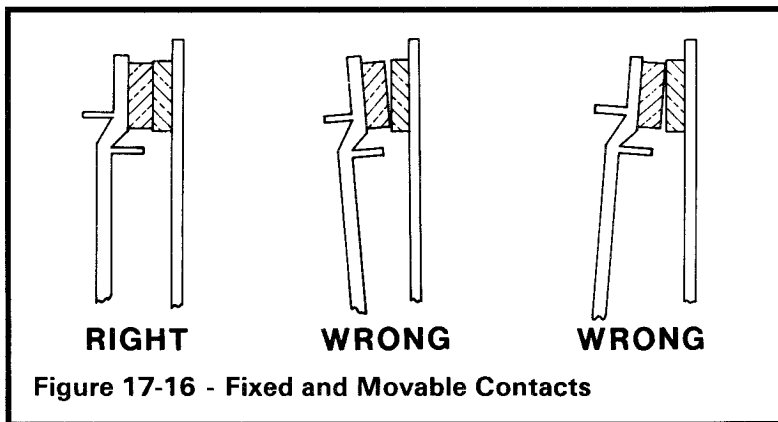
Be sure V-Glide wiper switch arm shaft rotates freely in housing. If wiper switch arm shaft binds or sticks, wiper switch arm must be replaced.

Be sure the V-Glide wiper switch assembly is securely fastened to the frame after installation.

### V-Glide Wiper Switch Arm Adjustment

The brush on the wiper switch arm and the contact on the fixed contacts must be parallel (Figure 17-16) to ensure the efficient operation of the V-Glide wiper switch.

1. Remove the #5 and #6 batteries (Figure 17-1) and remove the cover of the V-Glide wiper switch.
2. To test the contacts for parallelism, cover the entire surface of all contacts with removable ink.
3. Sweep the V-Glide wiper switch arm brush back and forth across the contacts. Adjust the wiper arm to obtain a minimum of 30% wipe on all contacts.
4. To adjust, remove spring cotter pin (25). Turn the adjustment screw (14) until the surfaces are parallel. The adjustment screw is located in the center of the V-Glide wiper switch arm (Figure 17-17).
5. After adjustment has been made, apply one drop of thread-locking compound, Loctite® 290, to adjustment screw (14) at hex nut (20) and install spring cotter pin (25) through hole in adjustment screw (Figure 17-17).



NOTE 1: If the wiper switch arm brush is worn to or beyond the wear limit line, the brush should be replaced. If any of the fixed contacts are excessively worn, pitted or burned, the entire housing with contacts must be replaced.

NOTE 2: A thread-locking compound has been placed on the threads of the contact studs to prevent removal of the fixed contacts. If removal of the contact studs is attempted, the stud will break or the housing will break before the nut comes loose.

### V-Glide Wiper Switch Adjustment

## WARNING:

To properly set your pedal group and accelerator system, check the adjustments in the following order:

- 1) Brake Pedal and Cable Adjustment — Page 7-3
- 2) Accelerator Rod Adjustment — Page 21-1
- 3) Accelerator Pedal Stop Adjustment — Page 21-3
- 4) Park Brake Adjustment — Page 7-4

If any of the above require adjustment, the other adjustments must also be checked in the order listed above.

## WARNING:

E

Failure to check all adjustments in the order listed could result in improper vehicle operation, property damage or severe personal injury.

### V-Glide Wiper Switch Wiper Arm Brush Replacement

1. Remove the #5 and #6 batteries (Figure 17-1) from the vehicle.
2. Remove the accelerator rod from the V-Glide wiper switch ball stud and place the wiper switch arm on the eighth contact.
3. Remove the brass nut (48) and lockwasher (8) from brass bolt (43) and remove the two #6 white wires (34 & 35) (Figure 17-17).
4. Remove the second brass nut (48) from brass bolt (43) and remove the brass bolt (43) from the V-Glide wiper switch housing (1).
5. Remove the third brass nut (48) from the brass bolt (43).
6. Remove the screw (21) and lockwasher (5) to replace the wiper switch arm brush (12). Pull the arm assembly away from the fixed contacts and remove the wiper switch brush (12) by pulling the wire through the hole in the wiper switch arm.
7. Install the new wiper switch arm brush (12) into the wiper switch arm assembly.
8. Install the screw (21) and lockwasher (5) through the wiper switch arm and into the brush (12). Torque to 0.7/0.9 N-m (6-8 in.-lbs.).
9. Install the arm brush wire terminal (12) to the bolt (43) and install the brass nut (48) up against the arm brush wire terminal. Torque to 4/5 N-m (35-45 in.-lbs.).
10. Install the brass bolt (43) through the V-Glide wiper switch housing (1), and install the brass nut (48). Torque to 4/5 N-m (35-45 in.-lbs.).
11. Install the #6 white wire from the first resistor and the #6 white wire from the solenoid to the brass bolt (43) and install lockwasher (8) and brass nut (43). Torque nut to 4/5 N-m (35-45 in.-lbs.).
12. Check the surface contact adjustment for proper alignment.
13. Reconnect the accelerator rod to the V-Glide wiper switch ball stud.
14. Reinstall V-Glide wiper switch cover.
15. Reinstall the #5 and #6 batteries (Figure 17-1) in the vehicle.

### Removal

## WARNING:

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

17

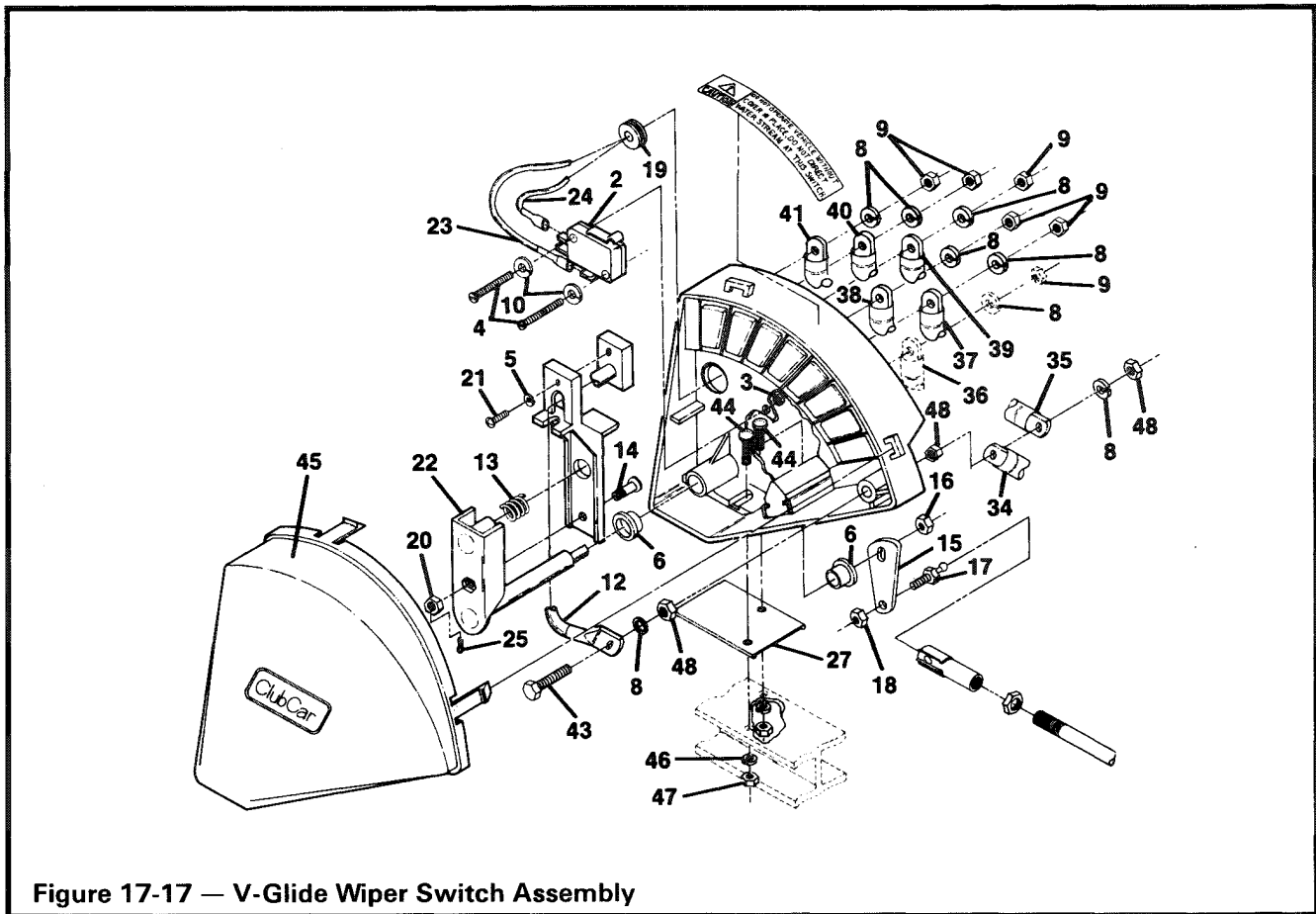


Figure 17-17 — V-Glide Wiper Switch Assembly

1. Remove the #5 and #6 batteries (Figure 17-1) from the vehicle.
2. Remove the nuts (9) and lockwashers (8) (Figure 17-17) at the V-Glide wiper switch to remove the resistor wires from the V-Glide wiper switch.
3. Remove the cover (45) from the V-Glide wiper switch.
4. Disconnect the red wire (23) from the bottom driver's side contact of the F&R switch.
5. Disconnect the green wire (24) from the small post of the solenoid.
6. Remove the nuts (47) and lockwashers (46) from underneath the I-beam and remove the V-Glide wiper switch assembly from the frame. Remove shim plate (27).
7. Remove brass nut (48) and lockwasher (8) and remove the #6 white wires (34 and 35). Remove V-Glide wiper switch assembly from vehicle.

#### Disassembly

1. Remove brass nut (48) and slide brass bolt (43) out of V-Glide wiper switch housing.
2. Remove the nut (16) and bell crank (15).
3. Slide the wiper switch arm assembly out of the V-Glide wiper switch housing (1).
4. Remove spring cotter pin (25) and disassemble wiper switch arm assembly, unscrew the adjustment screw (14) and retainer nut (20) and spring (13). Remove all thread-locking compound from the threads using a gasket remover.
5. To replace bearings (6), use a punch from the other side of the V-Glide wiper switch housing and tap lightly. Bearing will slide out.

#### Assembly

1. Install bearings (6) by tapping lightly with a plastic hammer. Be sure the collar of the bearing is up against the V-Glide wiper switch housing (1).
2. Hold the V-Glide wiper switch (11) and arm shaft and carrier (22) together with the spring (13) in place.

## CAUTION:

**Be sure the spring is in the groove on the V-Glide wiper switch or the arm may break if the spring is not in place and the arm is forced.**

Install the adjustment screw (14) and nut (20). This will have to be adjusted after the V-Glide wiper switch is fully assembled.

3. Slide the wiper switch arm assembly into the V-Glide wiper switch housing and install the bell crank with the ball stud down and away from the housing.
4. While holding the bell crank to prevent the arm from exerting a load on the V-Glide wiper switch housing, install the nut (16) and torque to 11/13 N-m (8-10 ft.-lbs.).
5. If the ball stud (17) was removed, install the ball stud facing away from the V-Glide wiper switch housing and install the locknut (18). While holding the ball stud with a wrench, torque the locknut (18) to 5/7 N-m (4-5 ft.-lbs.).
6. Install the brass bolt (43) with the wire terminal and brass nut (48) through the V-Glide wiper switch housing.
7. Install the brass nut (48) to the brass bolt (43) and torque to 4/5 N-m (35-45 in.-lbs.).

## WARNING:

**Be sure wiper switch arm shaft rotates freely in housing. If wiper switch arm shaft binds or sticks, wiper switch arm must be replaced.**

8. See V-Glide Wiper Switch Adjustment to properly adjust the contacts. (See page 17-20.)

### Installation

## CAUTION:

**Inspect the V-Glide wiper switch housing for cracks or damage prior to installation of V-Glide wiper switch housing to frame. If housing is cracked or damaged, the entire housing with fixed contacts must be replaced.**

1. Place the shim plate (27) on to the I-beam and install the V-Glide wiper switch assembly on to the shim plate using bolts (44), lockwashers (46) and nuts (47). Be sure the square shoulders on the bolts (44) fit squarely into V-Glide wiper switch housing. Torque nuts to 2.0/2.5 N-m (18-22 in.-lbs.).

## WARNING:

**Be sure the V-Glide wiper switch assembly is securely fastened to the frame after installation.**

2. Install the accelerator rod to the ball stud.
3. Install the small #18 green wire to the rear small stud of the solenoid (**Figure 17-6**).
4. Install the small #18 red wire to the bottom driver's side contact of the F&R switch.

5. Install the #6 white wire (35) from the first resistor coil and the #6 white wire (34) from the solenoid to the brass bolt (43) (Figure 17-18). Install the lockwasher (8) and brass nut (48) to the brass bolt (43) and torque to 4/5 N-m (35-45 in.-lbs.).
6. Install the #6 orange wire (37) to the fourth contact from the bottom. Torque to 4/5 N-m (35-45 in.-lbs.). The first three contacts do not have any wires connected to them.
7. Install the #6 yellow wire (38) to the fifth contact from the bottom. Torque to 4/5 N-m (35-45 in.-lbs.).
8. Install the #6 green wire (40) to the sixth contact from the bottom. Torque to 4/5 N-m (35-45 in.-lbs.).
9. Install the #6 blue wire (40) to the seventh contact from the bottom. Torque to 4/5 N-m (35-45 in.-lbs.).
10. Install the #6 black wire (41) to the eighth contact from the bottom. Torque to 4/5 N-m (35-45 in.-lbs.).

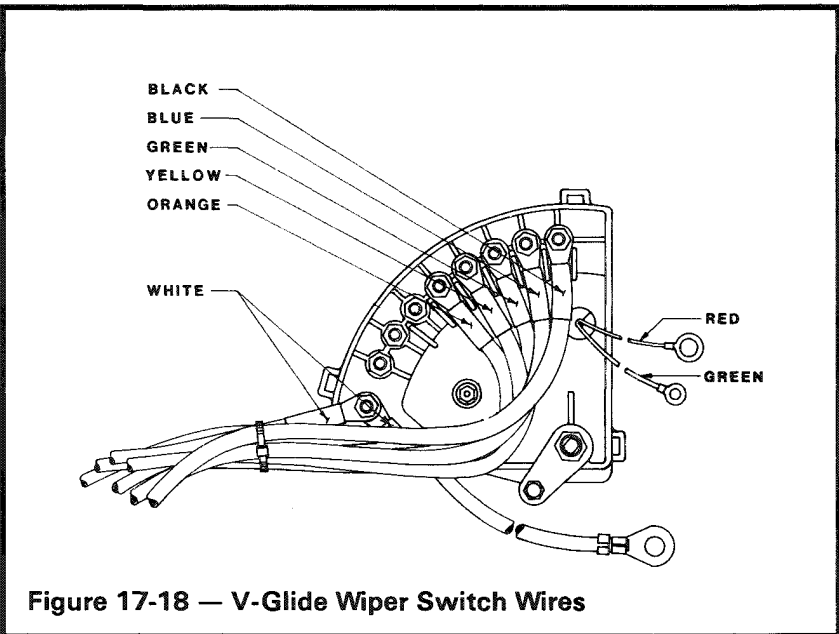


Figure 17-18 — V-Glide Wiper Switch Wires

**WARNING:**

Be sure the wires are connected to the V-Glide wiper switch contacts exactly as stated above or the vehicle may start off in a speed other than first.

**CAUTION:**

Do not operate vehicle without V-Glide wiper switch cover in place. Operating the vehicle without the cover allows dirt, dust and water to get into the operating components of the V-Glide wiper switch and could cause a premature failure and/or a malfunction.

11. See Accelerator Pedal and Rod Adjustment, Section 21, for proper pedal group adjustment.

**WARNING:**

To properly set your pedal group and accelerator system, check the adjustments in the following order:

- 1) Brake Pedal and Cable Adjustment — Page 7-3
- 2) Accelerator Rod Adjustment — Page 21-1
- 3) Accelerator Pedal Stop Adjustment — Page 21-3
- 4) Park Brake Adjustment — Page 7-4

If any of the above require adjustment, the other adjustments must also be checked in the order listed above.

Failure to check all adjustments in the order listed could result in improper vehicle operation, property damage or severe personal injury.

12. Ride the vehicle and inspect it for proper operation.

## FORWARD AND REVERSE SWITCH (Figure 17-19)

### WARNING:

For electrical repairs - Wear safety glasses - Remove key - Put F&R in neutral - Disconnect batteries as shown, Page 17-1, - Follow all procedures exactly as listed.

SEE SAFETY WARNINGS — PAGE 17-1

The forward and reverse (F&R) switch is mounted on the body in front of the two center batteries.

#### Removal

1. Remove F&R handle (2) by removing screw (1) (Figure 17-19).
2. Remove screws (18) and nuts (14) that mount the F&R to the body.
3. Pull the F&R switch away from body and out of battery compartment for ease of service.
4. If wires must be disconnected from F&R switch, label them upon removal so they will be reconnected properly.

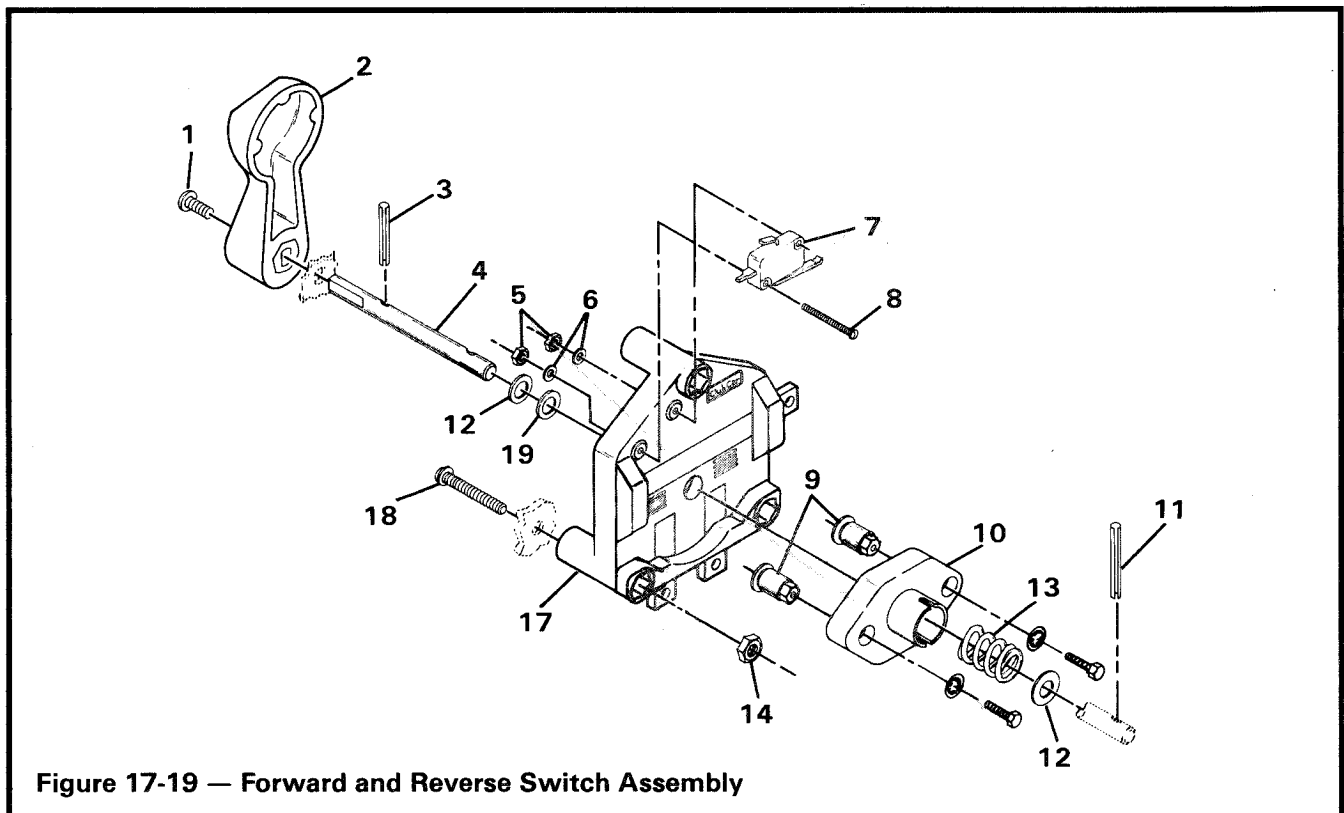


Figure 17-19 — Forward and Reverse Switch Assembly

#### Testing

1. Refer to Power Circuit Testing - Test Procedure 7.
2. Visually inspect rotor and bar contacts; be sure bar contacts are in good condition. If not, replace the whole F&R assembly. If severe arcing has occurred, check F&R anti-arcing limit switch for proper operation. See F&R anti-arcing limit switch.

#### Rotor Contact Replacement

1. Remove F&R switch as described above.
2. Remove wires from rotor. Label wires upon removal so they will be reconnected properly.
3. Remove roll pin (11) from F&R switch shaft and rotor by using a small punch and hammer. Be careful not to damage the pin or switch.

**CAUTION:**

Be careful when removing rotor, as the F&R shaft spring is compressed and may release suddenly when roll pin is removed.

4. Slide rotor off shaft.
5. Replace contacts.
6. Reassemble in reverse order of disassembly.

**Service**

1. Keep switch clean.

**WARNING:**

Do NOT grease contacts. This could cause switch to malfunction or burn.

2. If the F&R switch is stiff or binds in operation, the contact face of the switch may be lubricated with WD-40 brand spray lubricant.

**Installation**

Install switch in reverse order of disassembly. If wires were not labeled, see **Figure 17-6**, page 17-10.





# SECTION 17B — SOLID STATE SPEED CONTROL (V-GLIDE WIPER SWITCH WITH DISCRETE RESISTORS)

## ELECTRICAL SYSTEM WARNINGS

### WARNING:

Only trained people should repair or service this vehicle. All people doing simple repairs or service should have some knowledge of electrical repair to avoid injury. Follow all procedures exactly and obey the warnings listed in this manual.

Always wear safety glasses or approved eye protection when servicing the vehicle to prevent eye injuries. Wear a full face shield when working with batteries.

Remove key from vehicle to avoid unintentional starting of the vehicle.

Place forward and reverse in neutral (straight up position) to avoid unintentional starting of the vehicle.

Do not wear loose clothing and remove jewelry, such as rings, watches, chains, etc., before servicing vehicle.

Always use insulated tools when working around batteries or electrical connections.

Disconnect the two battery cables as shown in Figure 17-20 to prevent injury.

### DANGER:

Battery — Releases explosive gases; keep all ignition sources away such as sparks, flames and cigarettes. Ventilate when charging or using in an enclosed space to prevent explosive gas build-up.

When using tools, wires or metal objects around batteries, use extreme caution to prevent causing a short circuit and/or a spark which can create an explosion.

Batteries contain acid which is poisonous and can cause severe burns, therefore avoid contact with skin, eyes or clothing.

#### Antidotes:

External — Flush with water. Call physician immediately.

Internal — Drink large quantities of milk or water, follow with milk of magnesia or vegetable oil. Call physician immediately.

Eyes — Flush with water for 15 minutes. Call physician immediately.

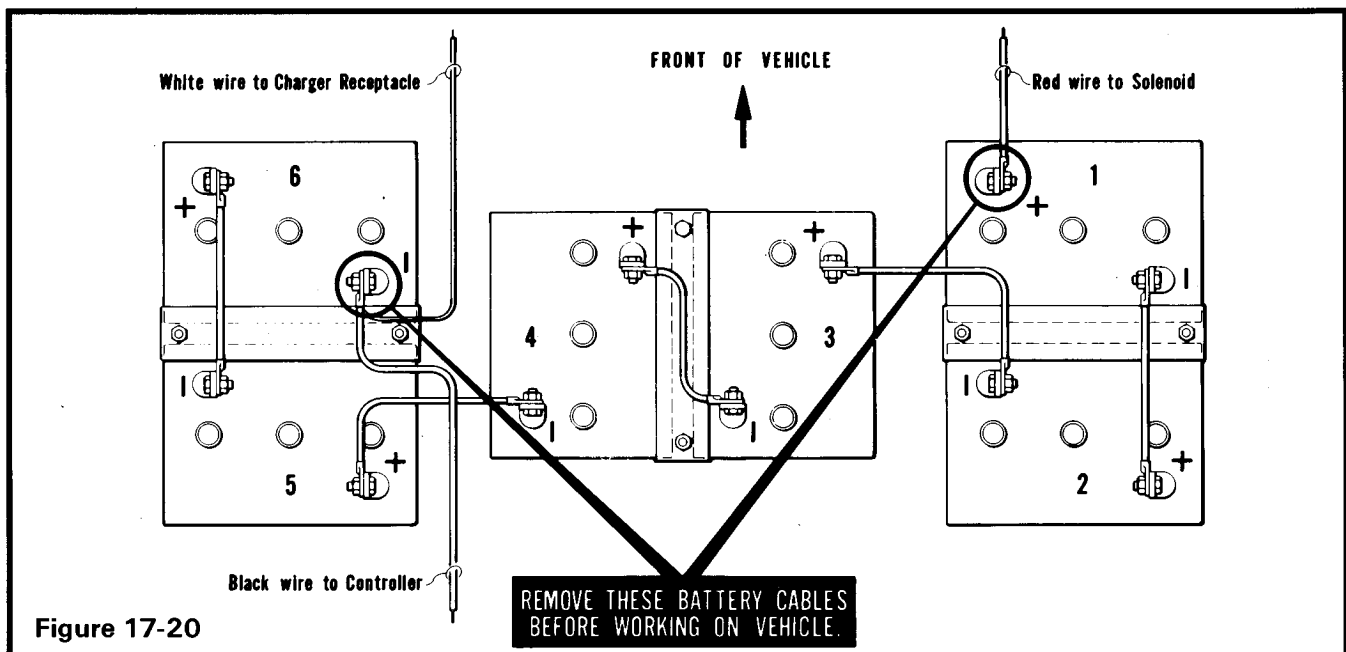


Figure 17-20

## GENERAL INFORMATION

In order to properly service and maintain this electric vehicle, it is necessary to understand the electrical circuitry and the functions of all components in this system. There are four separate circuits that make the vehicle operate: the control circuit, the speed control circuit, the power circuit and the charge circuit. Refer to the electrical wiring diagram and schematic for additional clarification while working on the electrical system.

**NOTE:** It is necessary to have the following equipment to service the electrical system; an ohm meter or a continuity meter and a volt meter capable of reading from 0-36 volts D.C. The VOM and continuity tester are available from CLUB CAR, part # 1011480 and # 1011273.

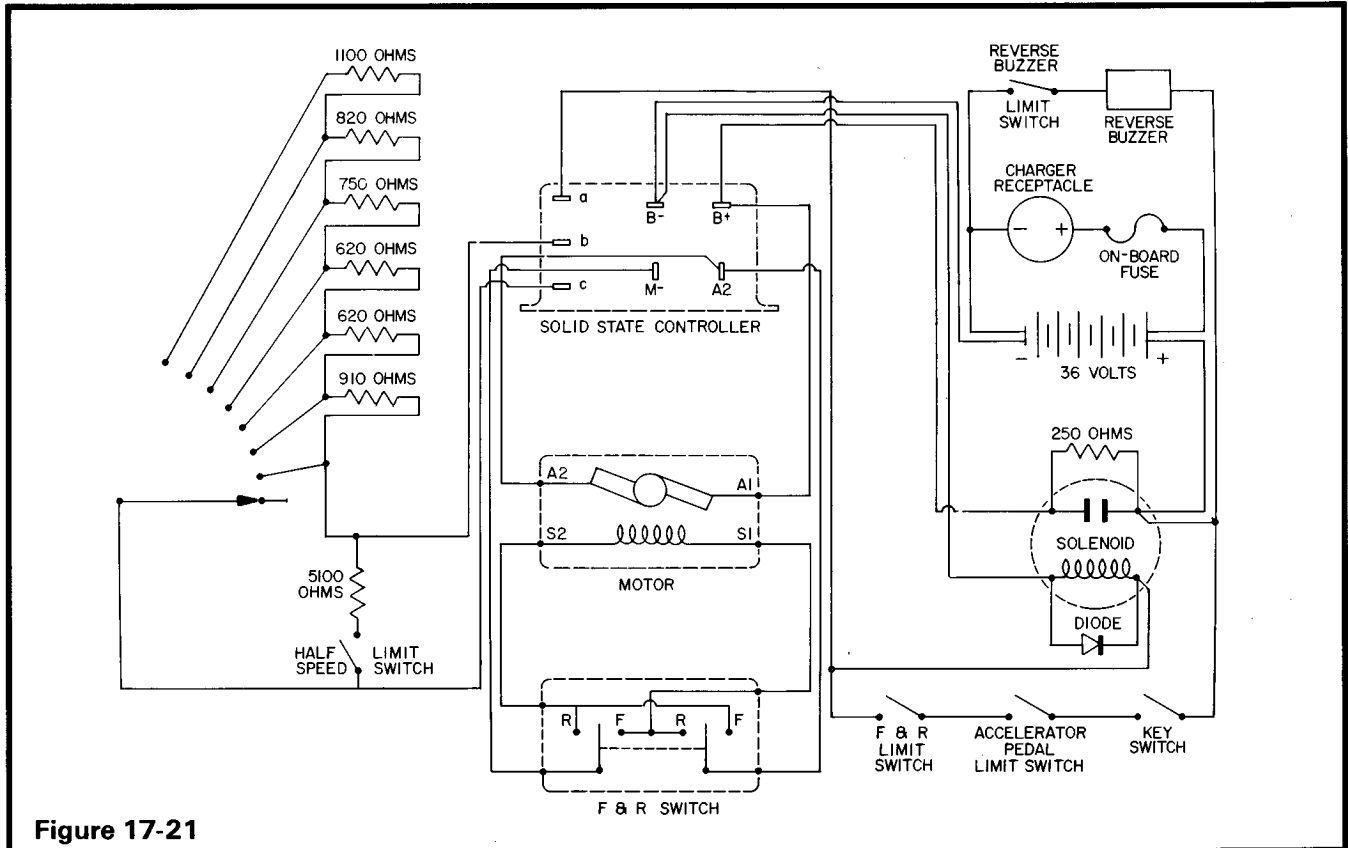


Figure 17-21

## THE CONTROL CIRCUIT

The control circuit consists of the key switch, F&R anti-arcing limit switch, accelerator limit switch, solenoid activating coil and connecting wires. A reverse warning buzzer is also included on every vehicle.

The key switch is an on-off switch, the function of which is to disable or open the control circuit when the vehicle is not in use. With the key in the off position, the vehicle will not run.

The F&R anti-arcing limit switch's function is to prevent arcing on the F&R contacts. When the vehicle is in neutral, the limit switch is open. The F&R anti-arcing limit switch closes only after full contact has been made on the F&R switch. As the F&R switch is being disengaged, the F&R anti-arcing limit switch opens the power circuit by opening the control circuit before the contacts are separated. By using the F&R anti-arcing limit switch to control power through the F&R switch, arcing is prevented on the F&R contacts.

When the accelerator is depressed which closes the wiper switch limit switch, and the F&R switch is in forward or reverse which closes the F&R anti-arcing limit switch, and the key is in the on position, the control circuit is complete. The solenoid coil (enclosed in solenoid) will then be activated and the solenoid power contacts will close while providing the key switch input to the solid state speed controller.

The reverse buzzer is a warning device activated by the forward and reverse switch when the vehicle is placed in reverse. The reverse buzzer will sound continuously until the vehicle is shifted to neutral or forward.

## THE POWER CIRCUIT

The power circuit consists of the solid state speed controller, solenoid contacts, forward and reverse (F&R) switch, motor, batteries and all power wires. The motor and batteries will be discussed in their own sections. See Section 20 - Motor and Section 18 - Batteries.

As the accelerator pedal is pressed, the solid state control varies the vehicle speed smoothly from zero to full by precise control of the amount of voltage to the motor.

The F&R switch changes the direction that the current flows through the motor field thus changing the direction the motor turns causing the vehicle to go forward or reverse.

## THE SPEED CONTROL CIRCUIT

The speed control circuit consists of the wiper switch with discrete resistors, a 5100 ohm resistor and some internal circuitry in the controller. With the car in forward, the wiper switch resistance varies from 0 ohms with the accelerator pedal up (at rest position) to approximately 5000 ohms at full pedal down. (For full speed operation, resistance must be above 4600 ohms and below 7000 ohms.) With the car in reverse, a limit switch is engaged which brings a 5100 ohm resistor in parallel into the circuit. This limits the reverse speed to one half of full forward speed. The resistance in reverse varies from 0 ohms at rest to approximately 2500 ohms at full pedal down reverse speed.

## THE CHARGE CIRCUIT

The charge circuit consists of the battery charger, charger plug, charger receptacle, on-board fuse link and batteries. The batteries and battery charger will be covered in their own section. (See Section 18 - Batteries and Section 19 - Battery Charger.)

The charger plug and receptacle are the main connection from the charger to the vehicle's battery circuit. The contacts in the receptacle must grip the plug blade sufficiently to create pressure or drag for an adequate electrical connection. If little or no drag is felt, the receptacle or plug must be replaced. If the plug or receptacle are damaged or feel hot when charging, replacement of one or both is necessary. (See plug and receptacle, Section 19 - Battery Charger.)

The on-board fuse link provides additional protection to the vehicle charging circuit. The fuse is rated for use with a CLUB CAR supplied charger and if it is blown, the cause should be determined before replacing. Under normal circumstances, the fuse should not blow. If fuse is blown, vehicle will not charge. (See on-board fuse link, Section 19 - Battery Charger.)

## TROUBLE-SHOOTING GUIDE

### CIRCUIT TESTING

The entire circuit of this vehicle can be tested without disassembly in the following manner:

1. Refer to **Figure 17-22** for testing the control circuit and **Figure 17-23** for testing the power circuit.
2. The red (+) probe symbol and the black (-) probe symbol as shown on the wiring diagrams (**Figure 17-22** and **Figure 17-23**) indicates points where the probes should be placed for each test. The number on the probe symbol indicates the test procedure number.
3. Test equipment required is a volt-ohm meter (VOM) (CLUB CAR part # 1011480) or a continuity tester (CLUB CAR part # 1011273).
4. Continuity or a closed circuit is indicated by zero ohms on the VOM or a lighted light on the continuity tester. No continuity or an open circuit is indicated by infinite ohms or no light.
5. The tests in this section are made to check the component and the wires to and from that component. Therefore the probes will often be placed at points removed from the component being tested.

### **WARNING:**

**For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.**

**SEE SAFETY WARNINGS - PAGE 17-27.**

SYMPTOM	PROBLEM	POSSIBLE CAUSES	REFER TO
1. Vehicle will not run - no "solenoid click"	Batteries	1) battery connections 2) discharged	Test Procedure 1
	Key Switch	1) loose wires 2) failed switch	Test Procedure 2
	F&R Anti-Arcing Limit Switch	1) loose wires 2) failed switch 3) cam not activating switch	F&R Anti-Arcing Limit Switch, Electrical Components, Section 17C
	Accelerator	1) accelerator rod disconnected	Accelerator, Pedal & Rod Adjustment Section 21
	Accelerator pedal (wiper switch) Limit Switch	1) loose wires 2) failed switch 3) miswired	Test Procedure 4
	Diode	1) failed diode	Diode, Electrical Components, Section 17C
	Controller Electrical Leakage	1) dirt or acid residue on controller	Test Procedure 9
2. Vehicle will not run - "solenoid clicks"	Batteries	1) battery connections 2) discharged batteries	Test Procedure 1
	Solenoid	1) loose wires 2) failed coil	Test Procedure 5
	F&R Switch	1) loose wires 2) failed contacts	Test Procedure 6
	Wiper Switch	1) loose wires 2) improperly wired 3) short or open circuit	Test Procedure 8
	Controller	1) loose wires 2) defective controller	Test Procedure 9
	Motor	1) loose wires 2) open/shorted windings	Motor, Section 20
	3. Vehicle runs slowly	Wiring	1) improperly wired solenoid to B+ terminal or controller
Batteries		1) loose terminals or corrosion 2) improper wiring 3) failed batteries 4) discharged batteries	Test Procedure 1 & Battery Section 18 Battery Charger, Section 19
Motor		1) loose wires 2) low motor current 3) excessive motor current	Motor, Section 20
Wiper Switch		1) improperly adjusted 2) defective switch	Accelerator Pedal & Rod Adjustment and Test Procedure 8
Brakes		1) dragging brakes	Brakes, Section 7

SYMPTOM	PROBLEM	POSSIBLE CAUSES	REFER TO
3. Vehicle runs slowly	Half Speed Reverse Limit Switch	1) failed in close position	Wait for controller to cool-remove part of load Test Procedure 9
	Controller	1) vehicle overload 2) defective controller	
4. Vehicle runs full speed in reverse	Tires	1) under-inflated or flat tires	Inflate or repair tires
	F&R Half Speed Reverse Speed Limit Switch	1) loose or disconnected wires 2) failed switch	
5. Vehicle goes forward but not in reverse or vice versa	5100 ohm Resistor	1) resistor disconnected or failed	Forward and Reverse Switch, F&R Limit Switch, Electrical Components, Section 17C
	F&R Anti-Arcing Limit Switch	1) loose or broken wires 2) improper actuation of switch	
6. Vehicle not being fully charged	F&R Switch	1) poor continuity of switch contacts	Test Procedures 3, F&R Switch and F&R Limit Switch, Electrical Components, Section 17C Test Procedure 6
	Charger Connections	1) loose wires at receptacle, battery or F&R switch 2) improper engagement of charger plug and receptacle	Charger, Section 19
7. Vehicle runs when F&R switch is put in forward or reverse with key switch on without depressing accelerator.	On-board Fuse Link	1) blown	Charger, Section 19
	Charger	1) incoming AC voltage 2) charger output low 3) charger cord & plugs	Charger, Section 19
	Accelerator	1) misadjusted	Accelerator Pedal & Rod Adjustment, Section 21

**CONTROL CIRCUIT**

**Test Procedure 1 - Batteries - Voltage Check**

**WARNING:**

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

**SEE SAFETY WARNINGS - PAGE 17-27.**

- A. With VOM set at Volts D.C., place red (+) probe on the positive post of battery #1 and the black (-) probe at the negative terminal of #6 battery. If you do not read at least 36 volts with batteries fully charged, check for loose battery connections or a battery installed in reverse polarity. Refer to Battery, Section 18 for further details on battery testing.
- B. With red (+) probe remaining on positive (+) post of battery #1, connect the VOM (-) lead to the motor A<sub>1</sub> terminal. You should read a voltage of 1 to 5 volts. If this voltage is zero or close to it, the trouble is either a bad controller, a bad 250 ohm resistor across the power contacts, in the wires between batteries and solenoid power contacts, the wires between solenoid power contacts and controller or wires between controller and motor A<sub>1</sub> terminal. Trace wires to make sure they are properly connected. Remove and test the 250 ohm resistor with an ohm meter. If these check out, the controller is malfunctioning.

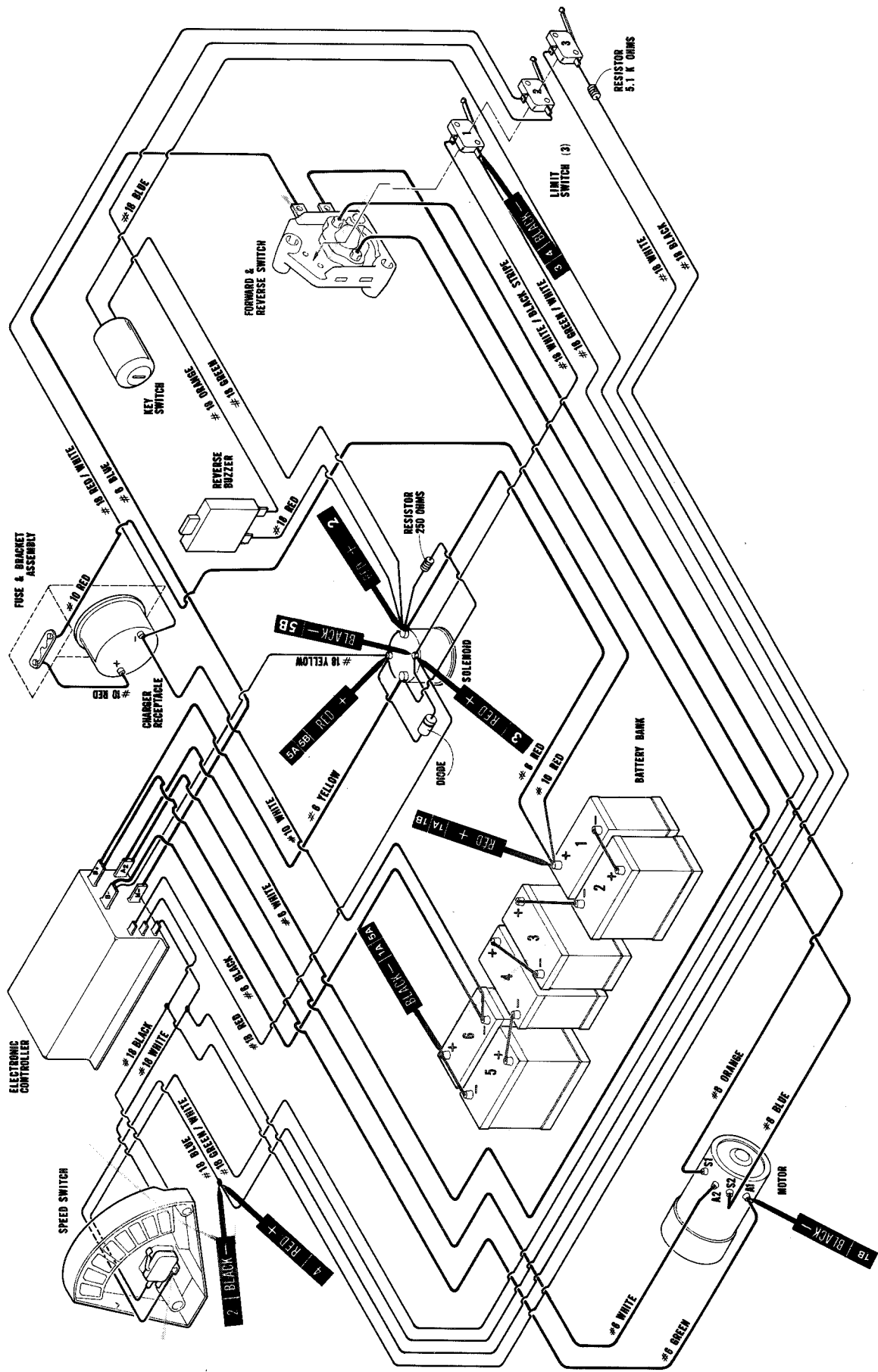


Figure 17-22 — Control Circuit

## Testing Procedure 2 - Key Switch

### **WARNING:**

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

SEE SAFETY WARNINGS - PAGE 17-27.

1. Place the red (+) probe of the VOM or continuity tester on the large terminal of the solenoid with the red wire attached and place the black (-) probe at the blue wire disconnect on the key switch side.
2. With key switch off, the reading should be no continuity.
3. Insert the key and turn the switch on, the reading should be continuity.
4. If the reading is incorrect, check the key switch, wires and terminals, and then replace defective parts.

## Test Procedure 3 - F&R Anti-Arcing Limit Switch

### **WARNING:**

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

SEE SAFETY WARNINGS - PAGE 17-27.

NOTE: The F&R anti-arcing limit switch is in the stack of three switches on the F&R and is the switch closest to the body of the car.

1. Place the red (+) probe of the VOM or continuity tester on the small activating coil stud of the solenoid with the white/black and red wires connected to it, and the black (-) probe on the #1 anti-arcing limit switch at the normally open (NO) terminal.
2. Reading should show continuity when the F&R handle is shifted to forward position and to reverse position (should show no continuity when in neutral and when in forward or reverse until the rotor contacts are in contact with contact bars). If not, check wires and terminals, then replace switch.

## Test Procedure 4 - Wiper Switch Limit Switch

### **WARNING:**

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

SEE SAFETY WARNINGS - PAGE 17-27.

1. Place the black (-) probe of the VOM on the normally open (NO) green/white wire terminal at the anti-arcing limit switch and the red (+) probe of the VOM on the wiper switch side at the blue wire disconnect (Figure 17-22).
2. With the accelerator pedal not depressed, the reading should be no continuity.
3. Depress the accelerator pedal and the reading should be continuity.
4. If these readings are not obtained, check to be sure the wires are connected properly to the normally closed (NC) and the common (COM) terminals. Check accelerator pedal adjustment. (See Section 21).
5. If wires were connected correctly and the accelerator pedal is properly adjusted but the readings are incorrect, replace switch.

## Test Procedure 5 - Solenoid Activating Coil

### **WARNING:**

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

SEE SAFETY WARNINGS - PAGE 17-27.

- A1. Place the red (+) probe of the VOM on the small actuating coil stud of the solenoid with the yellow wire attached and the black (-) probe to the negative (-) terminal of the #6 battery.
- A2. Reading should be continuity. If not, check wires, terminals, and connections.
- B1. Remove the diode assembly and the yellow wire from the small activating coil stud of the solenoid. Place the red (+) probe of the VOM on the small activating coil stud of the solenoid. Place the black (-) probe on the other small activating coil stud of the solenoid. A reading of 55 to 60 ohms should be obtained. If not, replace the solenoid.

NOTE: For CLUB CAR part # 8016, ohm reading is 55 to 60 ohms; for CLUB CAR part # 1016172, ohm reading is 180 to 200 ohms.

- B2. If ohm reading is correct, reconnect diode assembly and yellow wire.

## POWER CIRCUIT

### Test Procedure 6 - Forward and Reverse Switch

### **WARNING:**

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

SEE SAFETY WARNINGS - PAGE 17-27.

With VOM, place probes as specified in procedure 6A through 6D. Continuity reading should be obtained. Check continuity of the F&R switch in both directions as follows:

- 6A. With F&R selector in the forward position, place red (+) probe of VOM or continuity tester on the M-terminal lug of the speed controller and place the black (-) probe on the S1 motor terminal. Meter reading should be continuity.
- 6B. With F&R selector in the forward position, place red (+) probe on the A2 motor terminal lug and place the black (-) probe on the S2 motor terminal. Meter reading should be continuity.
- 6C. With F&R selector in the reverse position, place red (+) probe on the speed controller M-terminal and place the black (-) probe on the S2 motor terminal. Meter reading should be continuity.
- 6D. With F&R selector in the reverse position, place red (+) probe on the A2 motor terminal lug and place the black (-) probe on the S1 motor terminal. Meter reading should be continuity.

If continuity reading cannot be obtained and all wires and connections are correct, see F&R Switch, Section 17C.



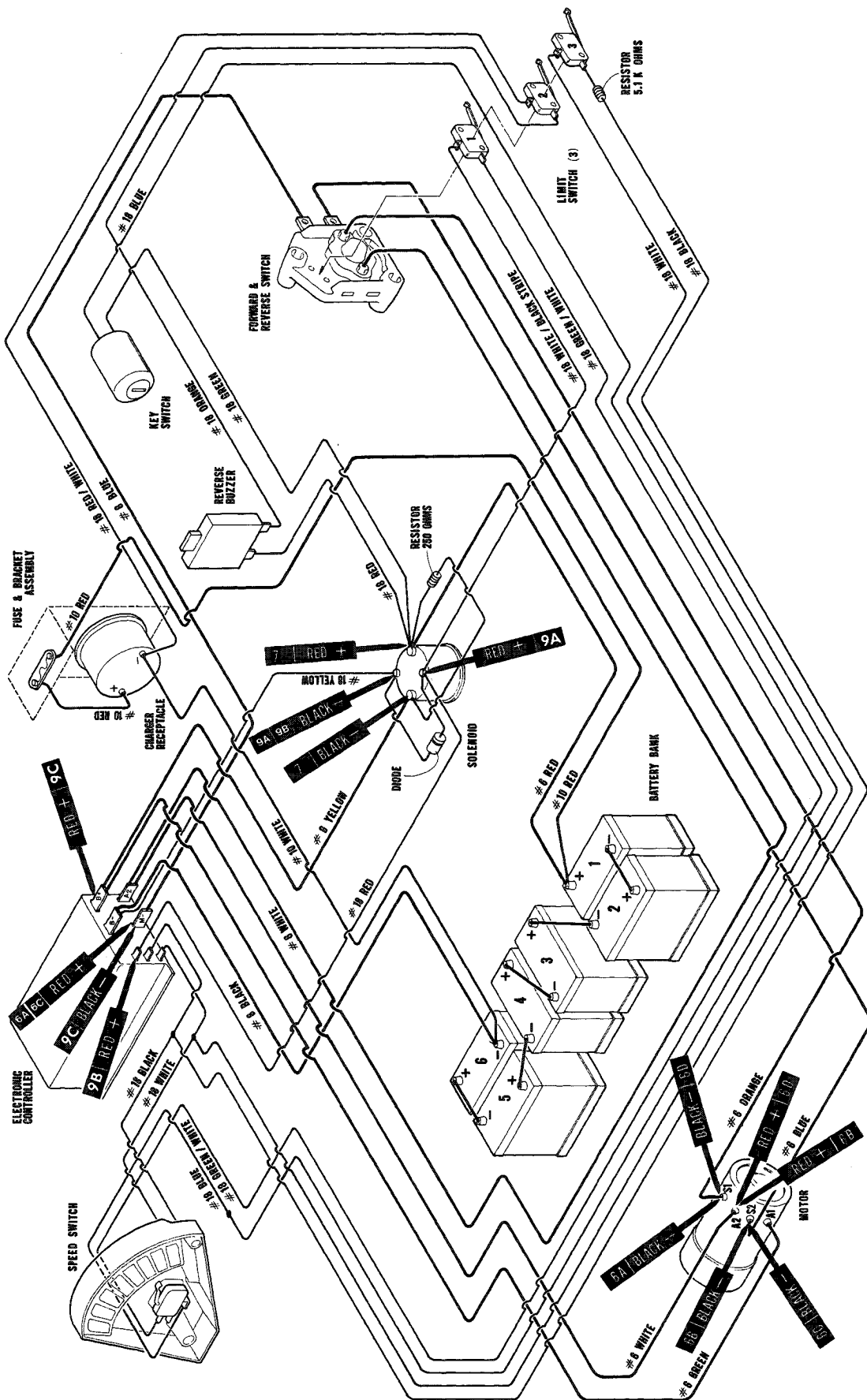


Figure 17-23 — Power Circuit

## Test Procedure 7 - Solenoid Contacts (Power Off)

### **WARNING:**

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

SEE SAFETY WARNINGS - PAGE 17-27.

Follow procedures exactly as outlined in the WARNING above. Remove the yellow wire and red wire from the large studs of the solenoid. Remove resistor assembly. Place the red (+) probe of the VOM on one of the large studs of the solenoid and the black (-) probe of the meter on the other large stud of the solenoid. It should show no continuity. If the VOM shows continuity, replace solenoid.

### **WARNING:**

Remove key, place forward and reverse lever in neutral and disconnect batteries as shown on inside front cover before replacing solenoid or reinstalling the white wire to A2 motor terminal.

## SPEED CONTROL CIRCUIT

### Test Procedure 8 - Wiper Switch with Discrete Resistors

1. Remove the two wires attached to controller terminals "b" and "c" (see schematic Figure 17-21 to identify these (a, b, c) terminals) and connect an ohm meter to these wires.
2. Disconnect "half speed reverse resistor" from the "half speed reverse" limit switch.
3. Measure resistance while pressing the accelerator pedal.

The measured resistance should go up in six steps.

1st Step:	910 ohms	(Approx.)
2nd Step:	1530 ohms	(Approx.)
3rd Step:	2150 ohms	(Approx.)
4th Step:	2900 ohms	(Approx.)
5th Step:	3720 ohms	(Approx.)
6th Step:	4820 ohms	(Approx.)

NOTE: It may be very difficult to detect these steps. However, if an increase in resistance from 0 to (approximately) 5000 ohms is obtained when the accelerator pedal is depressed from rest position to full speed position without exceeding (approximately) 7000 ohms during or at the end of accelerator travel, then the speed switch resistor assembly is O.K.

4. If the resistance steps were not correct and the accelerator pedal is properly adjusted then replace wiper switch with discrete resistors.
5. Attach black and white wires to terminals "b" and "c" as shown in Figure 17-21.
6. Reconnect half speed reverse resistor back to half speed reverse limit switch on the F&R switch.
7. Repeat the measurements of resistance steps with F&R in neutral position. These should be the same as the measurements had in step 3. If different, half speed reverse circuit limit switch is faulty. (See Electrical Components, Section 17C.)

### Test Procedure 9 - Solid State Speed Controller

### **WARNING:**

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

SEE SAFETY WARNINGS - PAGE 17-27.

## **DANGER:**

Disconnect the battery cables as shown in Figure 17-20, turn the key switch to the off position, and put the F&R in neutral or the vehicle will engage in forward or reverse speed and run over you causing severe personal injury or death.

The solid state speed controller, being a sealed, solid state unit, requires almost no maintenance. It is recommended, however, that the following items be checked occasionally, as required.

1. Make sure that the electrical connections to the controller (as well as those to the motor, batteries, etc.) are tight. When checking the controller bus bar connections for tightness, be sure to use the double-wrench technique to avoid stressing the bus bars which could crack the seals.
2. Remove from the terminal area any corrosion or accumulations of dirt, acids, fertilizers, etc. It is especially important that the controller terminal face be free of these substances since their presence may lead to electrical leakage and cause faulty operation.

PRIOR TO ATTEMPTING TESTS LISTED BELOW, THE VEHICLE MUST BE JACKED UP SO THAT THE DRIVE WHEELS ARE OFF THE GROUND.

## **WARNING:**

Lift only one end of unloaded vehicle at a time. Chock the wheels and lock brakes prior to lifting. Using a suitable lifting device (i.e., chain hoist, hydraulic floor jack) with 454 kilograms (1000 pounds) minimum lifting capacity. DO NOT use lifting device to hold vehicle in elevated position. Always use approved jack stand of proper weight capacity to support vehicle.

Reconnect batteries as shown, page 17-27.

### A. CHECK FOR SOLENOID INPUT

1. Remove white #6 wire from A<sub>2</sub> motor terminal and secure to avoid unintentional contact with any live components or connections. Connect battery wires. (See page 17-27.)
2. Place the forward/reverse switch in forward or reverse, turn key on and depress pedal until limit switches turn on.
3. This should cause the solenoid to operate with an audible click. Connect the VOM across the contactor coil terminals as shown. You should see full battery voltage.

### B. CHECK FOR KEYSWITCH INPUT

1. The controller keyswitch input terminal (terminal "a" Figure 17-21) should also be getting full battery voltage. Verify this with the VOM black probe (-) to the small actuating coil stud with the yellow wire affixed and the red probe (+) to keyswitch input terminal "a".
2. If the keyswitch input terminal is not getting full battery voltage, then check wire and connections between solenoid small stud and controller "a" terminal and replace defective parts.
3. Disconnect battery wires as shown in Figure 17-20. Reconnect white #6 wire to A<sub>2</sub> motor terminal.

### C. CHECK FOR CONTROLLER OUTPUT

1. Disconnect batteries (Figure 17-1).

## **WARNING:**

Failure to discharge the controller could result in an arc should the wrench or ratchet touch both the B<sup>+</sup> and B<sup>-</sup> terminals when performing the controller output test.

2. Discharge the speed controller's capacitors by placing the red probe on the B<sup>+</sup> terminal and the black probe on the B<sup>-</sup> terminal until the voltage reading stabilizes on the VOM.

3. Remove white #6 wire from A2 motor terminal and secure to avoid unintentional contact with any live components or connections. Connect battery wires. (See page 17-27.)
4. Connect the VOM (+) lead to the controller B+ terminal; connect the VOM (-) lead to the M- terminal.
5. Turn on the keyswitch, shift the forward/reverse switch to forward and watch the VOM as you depress the pedal. Depending on the accelerator pedal adjustment voltage reading, it may or may not start at zero with the pedal up, but it should continuously rise from zero or from a few tenths of a volt to full battery voltage with the pedal all the way down. If the VOM reading does not rise to full battery voltage and the wiper switch circuit test O.K. and accelerator pedal adjustment is proper, then the controller is faulty.

#### D. CHECK FOR DIODE OUTPUT

1. Remove wires from controller A2 and B+ terminal.
2. Remove power by opening the battery circuit as shown in **Figure 17-20** and place forward/reverse switch in neutral position. Use an ohm meter to check the resistance between the controller A2 and B+ terminals. You are testing for the presence of a diode inside the controller, so swap the two meter leads and look for a low resistance when the (+) lead is on controller A2 terminal and the (-) lead is on controller B+ terminal and a much higher resistance the other way. If your meter has a diode test function, use that. If you find the diode to be shorted, the controller is defective.
3. Attach the #6 white wire to motor A2 terminal.
4. Re-attach wires to controller A2 and B+ terminal (**Figure 17-23**).

# SECTION 17C — ELECTRICAL COMPONENTS (REMOVAL, TESTING AND INSTALLATION)

## ELECTRICAL COMPONENTS — REMOVAL, TESTING AND INSTALLATION

### THE KEY SWITCH

The key switch is mounted just to the right of the steering column on the center dash panel.

#### **WARNING:**

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

SEE SAFETY WARNINGS - PAGE 17-27.

#### Removal

1. Loosen the two screws on each side of the center dash panel.
2. Slide center dash panel up the steering column by snapping out the top and then rotating the panel out and up. There is sufficient slack in the wiring to allow for this.
3. Remove the wires from the key switch, do not allow wires to touch.
4. Remove key switch from dash by holding the key switch and turning the nut on the outside of the dash with the key switch tool (CLUB CAR part # 1012801).

#### Testing

With the key off, place continuity meter or VOM set on RX1 across key switch terminals. Reading should be no continuity. With key switch on, reading should show continuity (Figure 17-24).

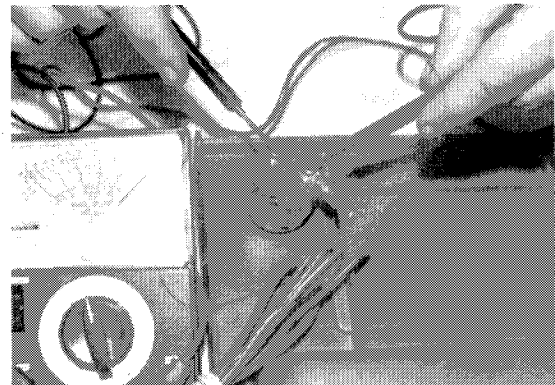


Figure 17-24

#### Installation

Coat the terminals with Battery Protector Spray (CLUB CAR part # 1014305) to ward off corrosion. Reinstall in reverse order of removal. Be sure that key switch terminals can touch the frame and the panel is properly seated and snapped in place.

### FORWARD AND REVERSE SWITCH (FIGURE 17-25)

#### **WARNING:**

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

Do NOT grease contacts. This could cause the F&R switch to malfunction or burn.

SEE SAFETY WARNINGS - PAGE 17-27.

The forward and reverse (F&R) switch is mounted to the body in front of the two center batteries.

#### Testing

1. Refer to Power Circuit Testing - Test Procedure 6.
2. Test for limit switch actuations per chart on page 17-42.
3. Visually inspect rotor and bar contacts; be sure bar contacts are in good condition. If not, replace the whole F&R assembly. If severe arcing has occurred, check F&R anti-arcing limit switch for proper operation. See Test Procedure 3 and F&R Limit Switches.

## Removal

1. Remove F&R handle (2) by removing set screw (1).
2. Remove screws (18) and nuts (14) that mount the F&R to the rear body.
3. Pull the F&R switch away from rear body and out of battery compartment for ease of service.
4. If wires must be disconnected from F&R switch, label them upon removal so they will be reconnected properly.

## Rotor Contact Replacement

1. Remove F&R switch as described above.
2. Remove wires from rotor. Label wires upon removal so they will be reconnected properly.
3. Remove roll pin (11) from F&R switch shaft (4) and rotor (20) by using a small punch and hammer. Be careful not to damage the pin or switch.

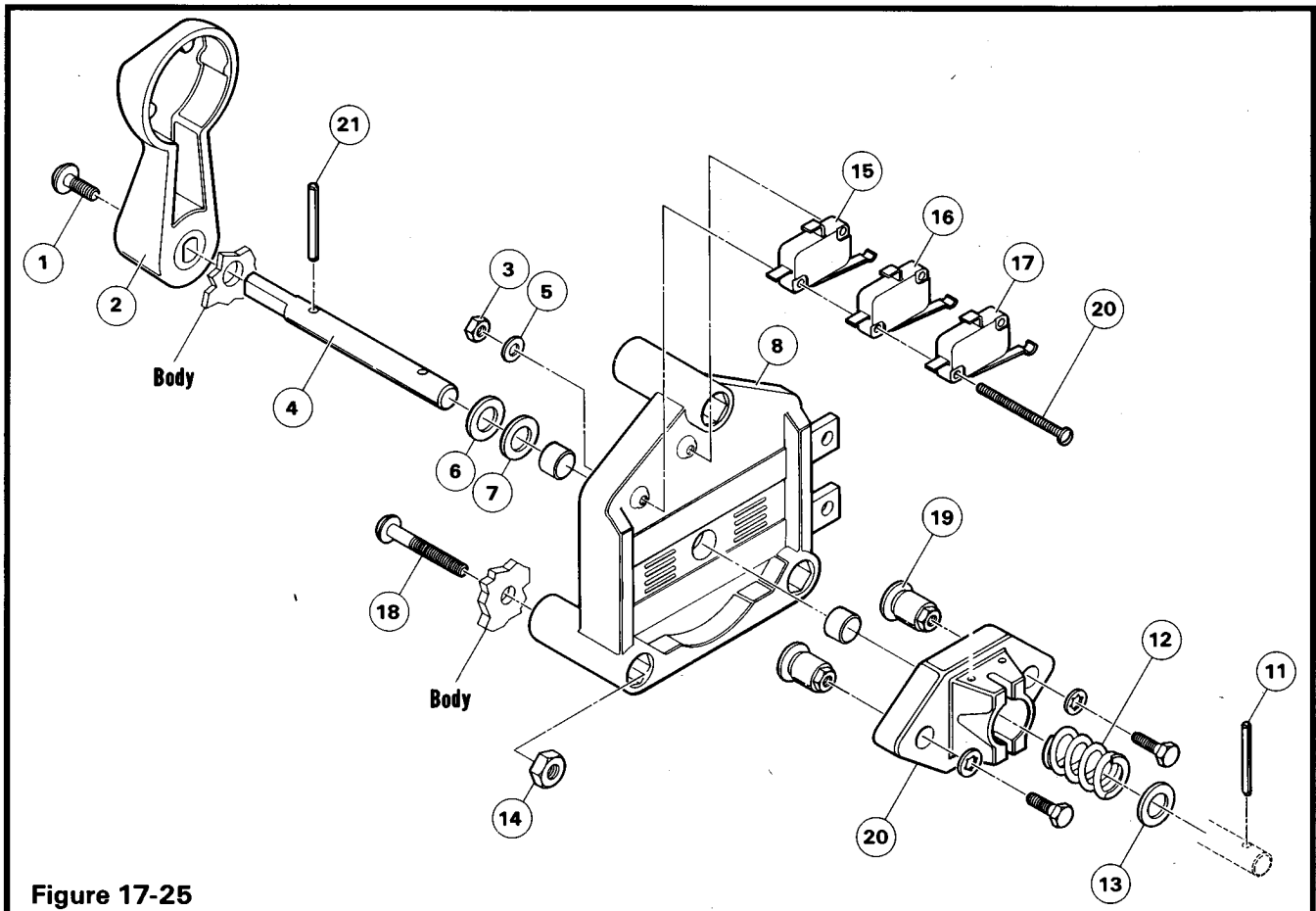


Figure 17-25

## CAUTION:

Be careful when removing rotor, as the F&R shaft spring is compressed and may release suddenly when roll pin is removed.

4. Slide rotor off shaft.
5. Replace contacts (19).
6. Reassemble in reverse order of disassembly.

## CAUTION:

Be sure the wires have been routed so that the wire from the F&R rotor does not pull on other wires as the F&R handle is shifted.

### Service

1. Keep switch clean.
2. If switch is hard to turn or sticks, a light spray of WD-40® may be applied to the contacts.

## WARNING:

Do NOT grease contacts. This could cause switch to malfunction or burn.

### Installation

Install switch in reverse order of disassembly.

### F&R LIMIT SWITCHES

The F&R anti-arcing limit switch, reverse buzzer limit switch, and reverse half speed limit switch are located on the F&R switch and are activated by a cam on the F&R switch rotor (Figure 17-25).

## WARNING:

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

SEE SAFETY WARNINGS - PAGE 17-27.

1. Remove all three limit switches from F&R switch by removing two screws (20), lockwashers (5) and nuts (3). Label each wire prior to disconnecting wire terminals from each switch.

### Testing

Check each switch as follows:

1. With the alligator clip from the continuity meter on the common terminal and the probe on the normally open (NO) terminal, switch lever not depressed, reading should be no continuity (Figure 17-26).
2. Depress the lever. Reading should show continuity,
3. If not, replace switch.

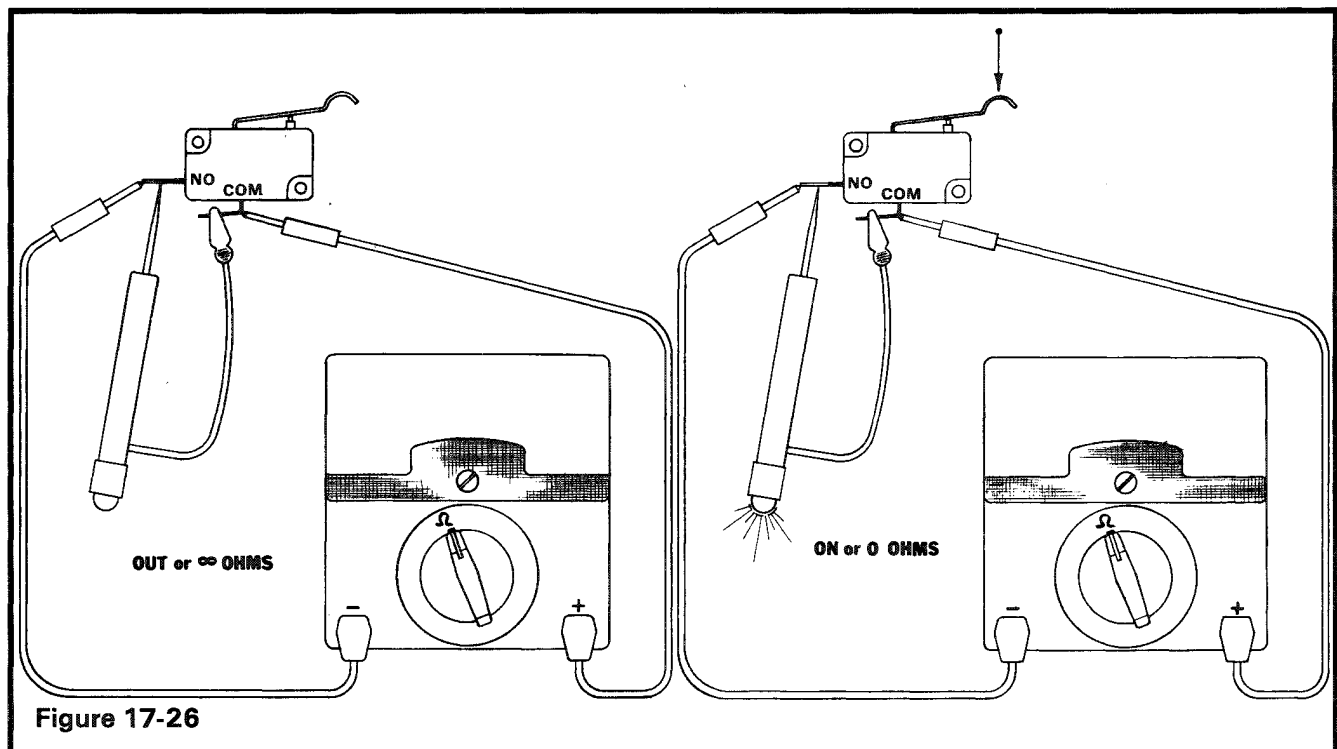


Figure 17-26

## Installation

E

Install in reverse order of disassembly. Insert labeled wires on the common (COM) terminal and labeled wires on the normally open (NO) terminal of each switch. Torque screws to 0.6 N-m (5 in.-lbs.). (If wires were not labeled during removal, see **Figure 17-22** for proper wiring.)

After installation, be sure that the lever arm of each switch is pressed and released per chart below when the rotor is turned. If not, inspect the F&R rotor and limit switches for damage.

Limit Switch	F&R Handle Position	
	Forward	Reverse
F&R Anti-Arcing	Depressed	Depressed
Half Speed Reverse	Released	Depressed
Reverse Buzzer	Released	Depressed

### THE REVERSE BUZZER

The reverse buzzer is located under the front body mounted on the rear of the center dash panel. See page 17-16 for removal and installation.

### THE SOLENOID

The solenoid is located on the passenger's side fender well behind the battery compartment. The solenoid has two sets of studs, two  $\frac{5}{16}$  inch studs (power contact studs) and two small No. 10 studs (activating coil studs).

## WARNING:

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

SEE SAFETY WARNINGS - PAGE 17-27.

17

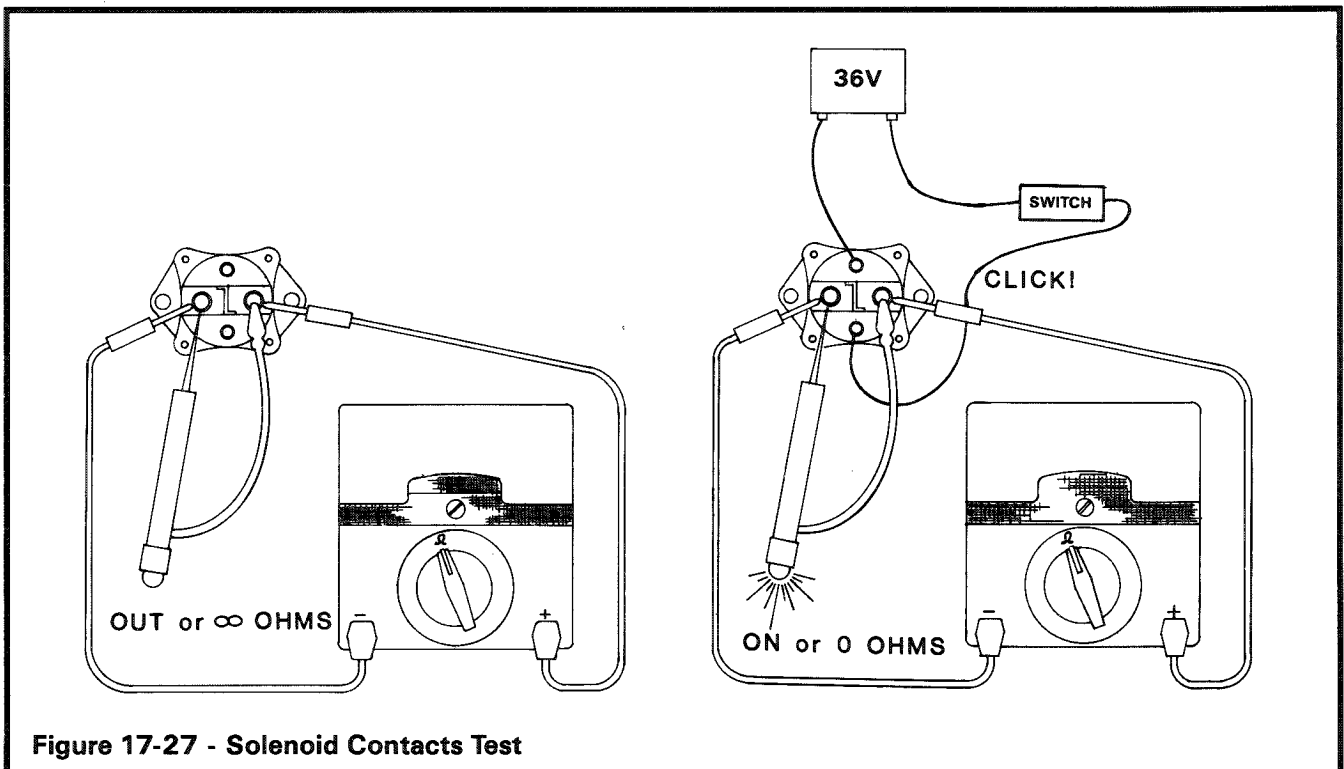


Figure 17-27 - Solenoid Contacts Test



## Removal

1. Disconnect batteries (Figure 17-1).

### **WARNING:**

Failure to discharge the controller could result in a short should the wrench or ratchet touch the large stud during removal or installation of the resistor or diode assembly.

2. Discharge the speed controller's capacitors by placing the red probe on the B+ terminal and the black probe on the B- terminal until the voltage reading stabilizes on the VOM.
3. Disconnect all wires from solenoid. Remove resistor assembly and diode assembly.
4. To test solenoid studs, place VOM or continuity tester across contacts. Reading should be no continuity (Figure 17-27).
5. Activate the coil by applying 36 volts across the activating coil studs. Reading across solenoid contacts should show continuity (Figure 17-27).
6. If any test yields an incorrect reading, replace solenoid.

## Installation

1. Install the solenoid to the mounting place and torque to 7.5 N-m (66 in.-lbs.). The solenoid does not have to be oriented in any particular manner.
2. Install wires as shown in wiring diagram (Figure 17-22).
3. Install diode and resistor as shown in wiring diagram (Figure 17-22).

## THE DIODE

A diode is placed across the solenoid activating coil to allow the field to collapse and prevent limit switch failures. If limit switches are failing, the diode should be checked for correct orientation.

### **WARNING:**

For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.

SEE SAFETY WARNINGS - PAGE 17-27.

## Removal

1. The diode assembly is connected between the two small No. 10 studs (activating coil studs) on the solenoid.
2. Disconnect batteries (Figure 17-1).

### **WARNING:**

Failure to discharge the controller could result in a short should the wrench or ratchet touch the large stud during removal or installation of the resistor or diode assembly.

3. Discharge the speed controller's capacitors by placing the red probe on the B+ terminal and the black probe on the B- terminal until the voltage reading stabilizes on the VOM.
4. Remove two nuts retaining diode assembly to solenoid.
5. Remove diode assembly.
6. Using a VOM, check for continuity between both diode terminals. Reverse the tester leads and again check for continuity.
7. A diode is designed to conduct current in one direction only. If a diode shows continuity in both directions, or does not show continuity in either direction, replace diode assembly.

## Installation

1. Install diode assembly to small No. 10 solenoid studs.
2. Insure that the correct direction of the diode is as illustrated in **Figure 17-22**.
3. Install remaining wires to studs as shown in **Figure 17-22**.
4. Install and tighten two No. 10 nuts to studs, torque 2.0/2.3 N-m (17-20 in.-lbs.).

## RESISTOR - SOLENOID

A 250 ohm resistor is placed across the contacts to keep the capacitors in the controller charged. This reduces arcing on the contacts of the solenoid. Whenever a solenoid fails, this 250 ohm resistor should be checked.

## WARNING:

**For electrical repairs — Wear safety glasses — Remove key — Put F&R in neutral — Disconnect batteries as shown, page 17-27. Follow all procedures exactly as listed.**

**SEE SAFETY WARNINGS - PAGE 17-27.**

## Removal

1. The half speed resistor assembly is connected to the half speed reverse limit switch on the F&R switch (**Figure 17-25**).
2. Perform Test Procedure 8 with F&R in reverse position but without disconnecting the half speed resistor as outlined in step 2 of Test Procedure 8. If the measurements do not agree with the values listed below, but the wiper switch half speed resistor limit switch tests O.K. and the accelerator pedal adjustment is proper, then the problem lies in the half speed resistor assembly or in the associated wiring.

NOTE: The measured resistance should go up in six steps.

1st Step:	770 ohms (approx.)
2nd Step:	1180 ohms
3rd Step:	1510 ohms
4th Step:	1850 ohms
5th Step:	2150 ohms
6th Step:	2480 ohms

It may be difficult to detect these steps. However, if an increase in resistance from 0 ohms to approximately 2500 ohms is obtained when the accelerator pedal is depressed from rest position to full speed position without exceeding approximately 3000 ohms during or at the end of accelerator pedal travel, then the wiper switch with discrete resistors and the half speed resistor circuit is O.K.

3. Shift F&R to neutral position and remove half speed resistor assembly from limit switch by disconnecting terminals.
4. Use a VOM to check resistance between the half speed resistor assembly terminals. A reading of 4845 to 5355 ohms is obtained, check wires and connections and replace as necessary.

**ACCELERATOR ADJUSTMENT — SEE SECTION 21.**

# BATTERIES

## WARNING:

Only trained people should repair or service this car. All people doing simple repairs or service should follow the correct procedures and obey the warnings listed in this manual.

## DANGER:

Wear a full face shield when working around batteries, because of the danger of an exploding battery.

**Battery — Explosive Gases.** Keep sparks, flames, cigarettes away. Tools, wires and metal objects can cause sparks when "shorted" across a battery or batteries. Insulated tools should be used. Extreme care should be taken when disconnecting or reconnecting batteries. When wires are disconnected, be sure to keep them away from battery posts and other wires. Ventilate when charging or using in an enclosed space to prevent explosive gas build up.

**Poison — Contains Acid — Causes severe burns — Avoid contact with skin, eyes or clothing.**

### Antidotes:

**External — Flush with water. Call physician immediately.**

**Internal — Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil. Call physician immediately.**

**Eyes — Flush with water for 15 minutes. Call physician immediately.**

## GENERAL INFORMATION

The batteries supplied with a golf car are different from those supplied with an automobile. The outward appearance of these two batteries is similar but the operating characteristics are very different. The golf car battery is known as a "deep cycle" battery and the automotive battery is known as a "starting, lighting and ignition" (SLI) battery and they should never be substituted for one another.

An automotive battery has to deliver high cranking currents of 300-400 amperes at a sufficient voltage for several seconds and maintain an accessory load of 10-25 amperes in stop and go driving. The energy removed from an automotive battery is immediately replaced by the alternator or generator of the car. As a result the automotive battery operates at 90 to 100% of full charge at all times.

The batteries supplied with a golf car must supply 100% of the energy required to move the vehicle. Therefore, these batteries receive deep discharges down to 30% to 40% of their full charge capacity. Then they must be recharged, hence their name "deep cycle." The average amperage draw is considered to be 75 amps, although it varies greatly depending on the vehicle and how it is operated. Golf car batteries are specifically designed to handle this type of service.

The rechargeable lead-acid battery is basically a device for turning chemical energy into electrical energy and vice versa. The main active elements within a battery are the positive plates, the negative plates and the electrolyte (sulfuric acid). Another very important element (but inactive) is the separator. The separator does exactly what its name implies — it keeps the material of the positive and negative plates from touching each other and creating electrical shorts. It must be porous enough to allow charged ions to pass through between the positive and the negative plates, but never allow the two materials to contact each other.

Basically, whenever two unlike metals are immersed in an acid solution, an electric current is generated.

In a "deep cycle" battery, the negative plates contain lead (Pb) and the positive plates contain lead dioxide (PbO<sub>2</sub>). These plates are immersed in a sulfuric acid solution (H<sub>2</sub>SO<sub>4</sub>) (Figure 18-1).

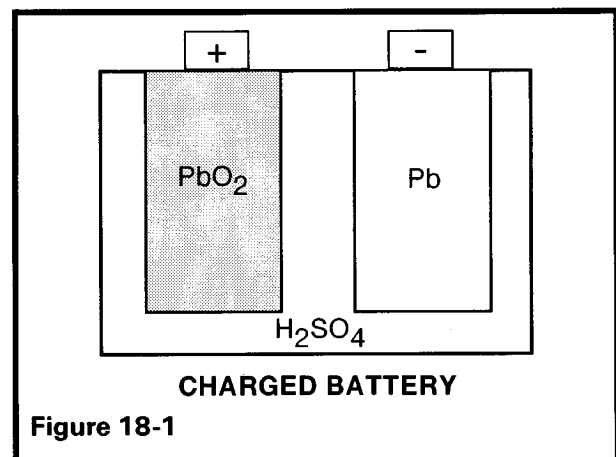


Figure 18-1

During discharge, the chemical reaction inside the battery causes the  $\text{SO}_4$  to break away from the  $\text{H}_2\text{SO}_4$  and the  $\text{O}_2$  to break away from the  $\text{PbO}_2$  (Figure 18-2).

The  $\text{SO}_4$  combines with the lead (Pb) on both plates forming lead sulphate ( $\text{PbSO}_4$ ). The oxygen ( $\text{O}_2$ ) from the positive plates combines with the hydrogen (H) from the electrolyte to form water ( $\text{H}_2\text{O}$ ) (Figure 18-3).

The result is two similar metals (lead sulphate,  $\text{PbSO}_4$ ) immersed in water ( $\text{H}_2\text{O}$ ). This, of course, will not generate electricity. This battery is discharged.

When a discharged battery is connected to a charger, the process is reversed. The  $\text{SO}_4$  is forced from the plates back into the electrolyte to make sulfuric acid ( $\text{H}_2\text{SO}_4$ ). The oxygen returns to the positive plate to make lead dioxide ( $\text{PbO}_2$ ) (Figure 18-4).

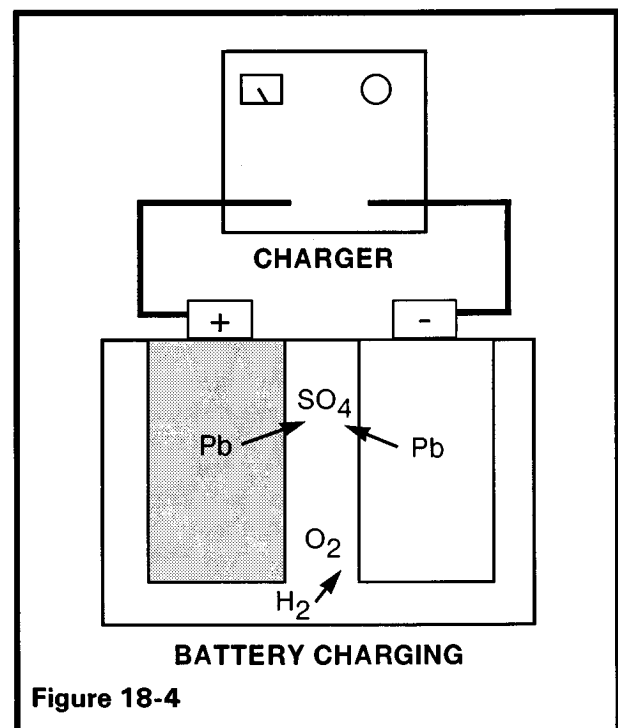
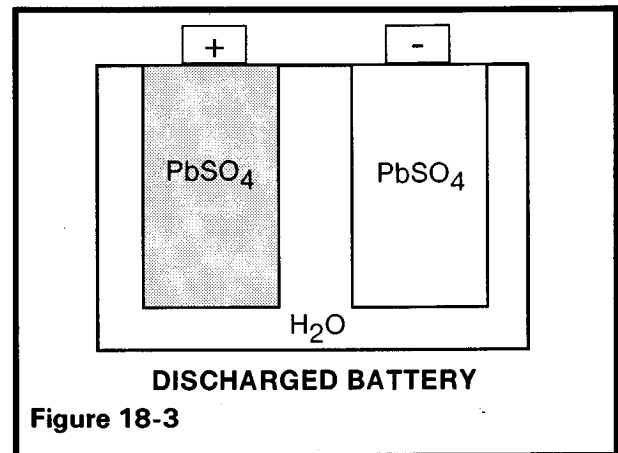
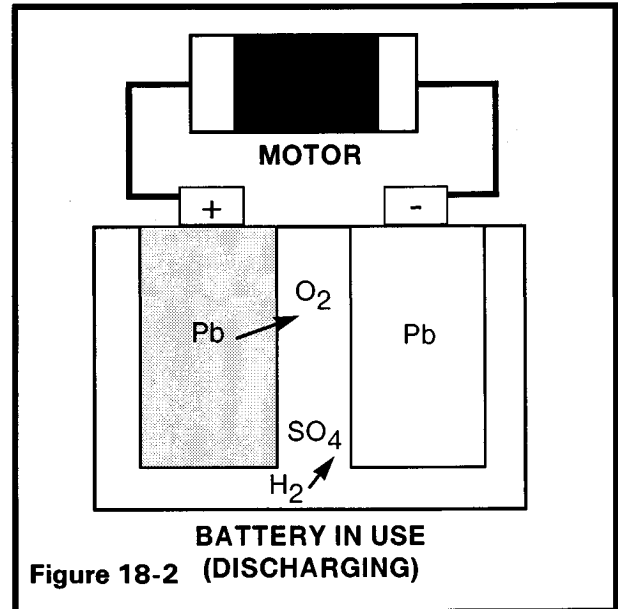
The result is a charged battery that is again capable of generating electricity (Figure 18-1).

In a deep cycle battery, the grids are heavy and the paste much denser to accommodate the deep cycle in electric vehicle application. Some manufacturers have gone to an even denser paste to avoid the shedding of the paste, especially from the positive grid, that occurs to a greater or lesser extent in all batteries as they age.

## COMMON MISCONCEPTIONS ABOUT BATTERIES

This chart cannot and does not describe all problems which may be encountered with batteries, but it does identify some of the common misconceptions and problems.

Problem	Misconceptions or Damage Caused
1) Deep Discharge	"This car can handle another 9 holes, it's only gone 36 holes today." Avoid deep discharge whenever possible. See Battery Charging.
2) Early Excessive Discharging	"Those are new batteries, they can handle 45 holes." New batteries do not reach their full capacity until they have been used and recharged about 20-50 times. See Battery Charging.
3) Mineral Content	"Tap water will do for our batteries." It may be OK, but have it checked first. See Battery Care.



Problem	Misconceptions or Damage Caused
4) Self Discharge	"That dirt and corrosion on the battery won't hurt anything." It may provide a path for current to flow and self discharge the battery. See Battery Care.
5) Over Watering	"Add water to the level indicator tonight, then we won't have to do it in the morning." Water should be added after charging. See Battery Care.
6) Under Watering	"Checking the water takes too much time, we'll check it next month." Under watering can ruin the battery. Water level should be checked weekly. See Battery Care.
7) Vibration Damage	"Tighten that battery hold-down as tight as you can." Too loose or too tight can cause problems. See Battery Care.

## REPLACING BATTERIES

### DANGER:

Always wear a full face shield when replacing batteries because of the danger of an exploding battery.

**Battery — Explosive Gases.** Keep sparks, flames, cigarettes away. Tools, wires and metal objects can cause sparks when "shorted" across a battery or batteries. Insulated tools should be used. Extreme care should be taken when disconnecting or reconnecting batteries. When wires are disconnected, be sure to keep them away from battery posts and other wires. Ventilate when charging or using in an enclosed space to prevent explosive gas build up.

**Poison — Contains Acid — Causes severe burns — Avoid contact with skin, eyes or clothing.**

**Antidotes:**

**External — Flush with water. Call physician immediately.**

**Internal — Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil. Call physician immediately.**

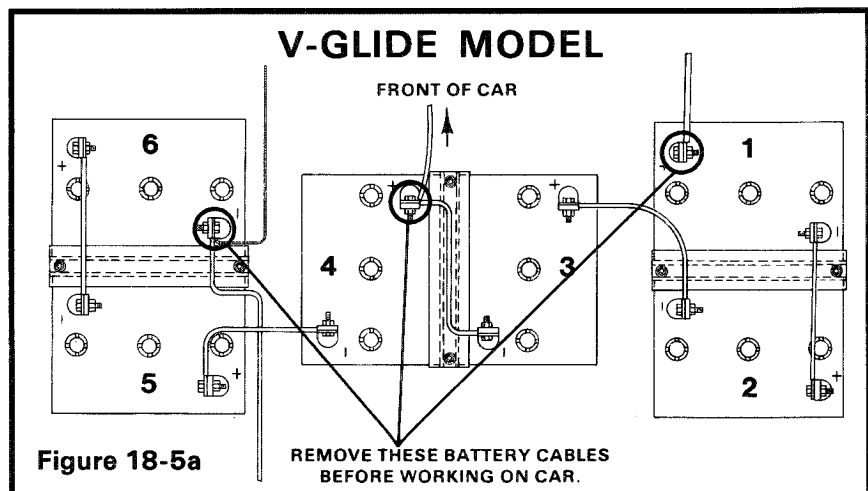
**Eyes — Flush with water for 15 minutes. Call physician immediately.**

### WARNING:

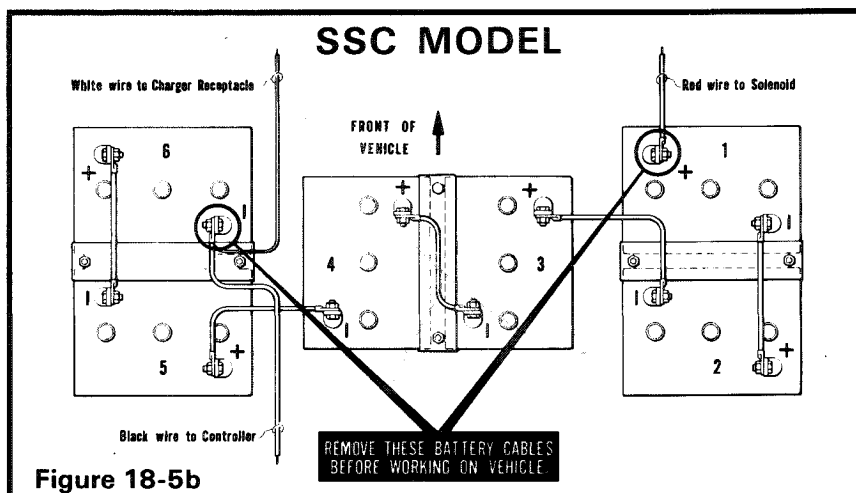
Remove key and place forward and reverse switch in neutral (straight up position) to avoid unintentional starting of the car.

The vents require keeping the battery in an upright position to prevent electrolyte leakage. Tipping the battery beyond a 45° angle in any direction can allow a small amount of electrolyte to leak out the vent hole. Do not exceed this 45° angle when lifting, carrying or installing the battery because battery acid could cause severe personal injury when accidentally coming in contact with skin or eyes, or could damage clothing.

1. Before removing batteries, note the orientation of the batteries and the connecting wires. First remove the negative wire (black) from battery #6 (Figure 18-5a or Figure 18-5b). Then remove remaining wires and batteries.
2. Visually inspect the new batteries for any damage that may have occurred in transit.
3. If the old battery wires are going to be reused, inspect them for broken or frayed wires, poor crimp connections or worn insulation. Remove any corrosion on the connectors. One cup of bicarbonate of soda (baking soda) in a gallon of water and a wire brush do an excellent job of neutralizing and removing the corrosion. Be careful not to allow this baking soda solution to enter the battery.



4. Check and clean the battery rack and hold downs. The nuts and bolts on the hold down may corrode, therefore, it is advised that they be cleaned periodically and replaced if necessary.
5. Install the batteries in the proper orientation (**Figure 18-5a** or **Figure 18-5b**). Install the battery hold downs. The hold downs should be tight enough so the batteries do not move while the car is in motion, but not so tight as to crack or buckle the battery case. Torque to 1.6/1.83 N-m (14-16 in.-lbs.) alternating between hold downs.



6. Install wires in proper sequence (**Figure 18-5a** or **Figure 18-5b**). Install black wire to negative post of battery number six last. Make sure all connections are tight. Torque to 1.0/1.6 N-m (9/14 in.-lbs.). Coat all terminals with Battery Protector Spray (CLUB CAR part # 1014305) to minimize future corrosion. (Be sure wire on lower left of F&R switch goes to battery #1 positive post. Wire on lower right of F&R switch goes to battery #4 positive post. This applies to vehicles equipped with resistor coil type speed controls only.)
7. Give the batteries a full charge prior to sending them out on the golf course. This ensures that all the batteries are fully charged and the cells are equalized prior to use.

## BATTERY CARE

### Preventive Maintenance

To keep batteries in good operating condition, follow these steps on a regular basis.

1. Any corrosion build-up on or around the batteries should be removed immediately. Terminal connections should be clean and tight and any frayed or worn wires should be replaced. After all cables have been connected, coat all terminals with Battery Protector Spray (CLUB CAR part # 1014305) to ward off future corrosion.
2. Batteries should be kept clean and dry to prevent self discharge. Any dirt, grime or acid spillage should be removed. Wash batteries with a bristle brush using water and bicarbonate of soda (baking soda — 1 cup per gallon). Rinse with water. Do not allow solution to enter battery through the vent cap holes. See Self Discharge.
3. Maintain proper water level. See Water Level.
4. Batteries should be properly charged every day they are used. Check the batteries periodically to see that they are in a full state of charge. See Battery Charging.
5. Keep hold downs tight. See Vibration Damage.

### Self Discharge

Dirty batteries can provide a path for a small current draw that can slowly discharge batteries, thus wasting valuable energy. To prevent self discharge, batteries should always be kept clean.

Hot weather also has an effect on a battery's self discharge rate. The higher the temperature, the quicker a set of batteries will discharge. Therefore, in hotter climates batteries should be checked more often. When storing batteries, keep in a cool place. See Battery Storage, page 18-11.

### Water Level

## CAUTION:

Do not allow battery acid from battery caps or hydrometer on the front or rear body. Battery acid will cause permanent blemishes. Wash off immediately.

Water only after charging unless the water is below the level of the plates. Filling a battery before charging will result in overfilling, because the electrolyte level will rise during charging and some of the electrolyte may bubble out of the cap. This reduces its capacity and corrodes the metal parts around it.

Water level should be checked weekly to be sure the water is at its proper level (Figure 18-6). Never allow the water level to fall below the tops of the plates because this will cause the exposed part of the plate to become permanently inactive. Check the water level more frequently in hot weather or when batteries become old.

**Mineral Content**

For the longest battery life, distilled water should be used in batteries. However, if tap water is going to be used, be sure the mineral content is below the following levels:

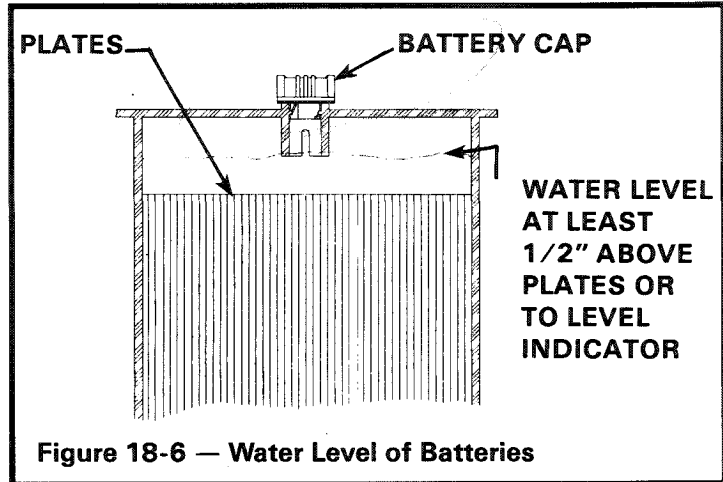


Figure 18-6 — Water Level of Batteries

IMPURITY	ALLOWABLE CONTENT IN PARTS PER MILLION
Suspended Matter	Trace
Total Solids	100.0
Calcium and Magnesium Oxides	40.0
Iron	5.0
Ammonia	8.0
Organic Matter	50.0
Nitrates	10.0
Nitrites	5.0
Chloride	5.0

Contact your local water department for this analysis.

**Vibration Damage**

The battery hold downs should always be tight enough to keep the battery from bouncing. Battery life may be severely shortened if the battery hold downs are too loose. Excessive vibration causes the plates to shed prematurely and shortens the life of the battery. It may also cause acid to leak out of the vent caps and corrosion to build up on surrounding metal parts. The acid which is lost reduces the capacity of the battery and cannot be replaced.

Also, battery hold downs should not be so tight as to crack or buckle the battery case. This may cause leaks which would dry up a cell or cause internal shorts.

**BATTERY CHARGING**

**General Information**

The charger supplied with the CLUB CAR DS Electric solves some of the most common problems in charging. Undercharging and overcharging are prevented provided the charger is allowed to shut off by itself. Also, all cells are automatically given an equalization charge at low current, which prolongs battery life.

Batteries should never be left in a discharged state as this too effects the internal components and can reduce the capacity of the battery. The batteries should be fully charged every day they are used even if only for ten minutes or nine holes. However, the batteries should not be charged if they have not been used. When running 36 holes per day, it is wise to put the cars on charge after the first 18 holes. Even if the charge is only for an hour or two, it will prevent the batteries from being discharged deeply. If a charger is still on in the morning and it becomes necessary to send the car out before charging is complete, be sure the car gets a catch-up charge between rounds. The following night this car must get a full charge.

### **Charger Doesn't Shut Off**

This may be due to one of the following factors:

1. New batteries
2. Hard use — 36 or more holes per day
3. Cold temperatures
4. Short charging times — in late at night, out early in the morning.

A catch-up charge may be necessary when these conditions are present. On a rainy day or an off day, when all or some of the cars do not go out, check the batteries in the cars for state of charge. Any batteries with a specific gravity lower than 1.250 need a catch-up charge.

### **Deep Discharge**

Never discharge a set of batteries in a car to where the car will no longer run. This will shorten the cycle life of the battery considerably and it is possible that the battery will not accept the recharge if **completely** discharged. The deeper the discharge, the harder it is on the batteries, which is the reason a charge is recommended between rounds. Placing the batteries on charge between rounds reduces the depth of discharge and prolongs battery life.

### **Early Excessive Discharging**

When golf car batteries are new, they do not reach their full capacity until they have been used and recharged 20-50 times. Therefore, if they are excessively discharged early in their life, their effective service life will be shortened. It is advisable to limit the use of any car with new batteries to 18 holes per day for at least the first 4 weeks and then gradually increase their range.

### **Incoming A.C. Service**

Insure that the incoming AC line service is sufficient. If circuit breakers are tripping, fuses blowing during the night or the charger will not give the required starting rate when perfectly good batteries are put on charge, an AC line problem exists. The electrical service to your car storage facility should be sufficient to deliver 115 volts (minimum 105 volts; maximum 128 volts) and 10 amps with all the chargers turned on.

If not, consult your local power company or electrical contractor.

### **Fleet Rotation**

Rotate your cars. Put a different set of cars out first each morning. It is very hard on batteries if the last cars in at night are the first ones out in the morning and also are required to go 36 holes. Spread the work load evenly giving all cars the same amount of play. It will keep your fleet in balance and will not overwork certain sets of batteries.

### **Numbering Cars and Chargers**

Return the cars to the same charger each night if possible. If the cars are put in storage facility at random and a car dies on the course and testing shows the batteries are good, you know you have a bad charger — you just don't know where. Numbering the cars and the charger and returning the car to that charger each night can be a great aid in trouble-shooting a problem.



## BATTERY TESTING

Four tests have been developed to test a set of batteries that has not lived up to its expected performance. Each test becomes progressively more thorough and time consuming. Therefore, it is suggested to begin with the first test and follow through with the other tests until the problem has been found as outlined in the battery trouble-shooting chart (Figure 18-7).

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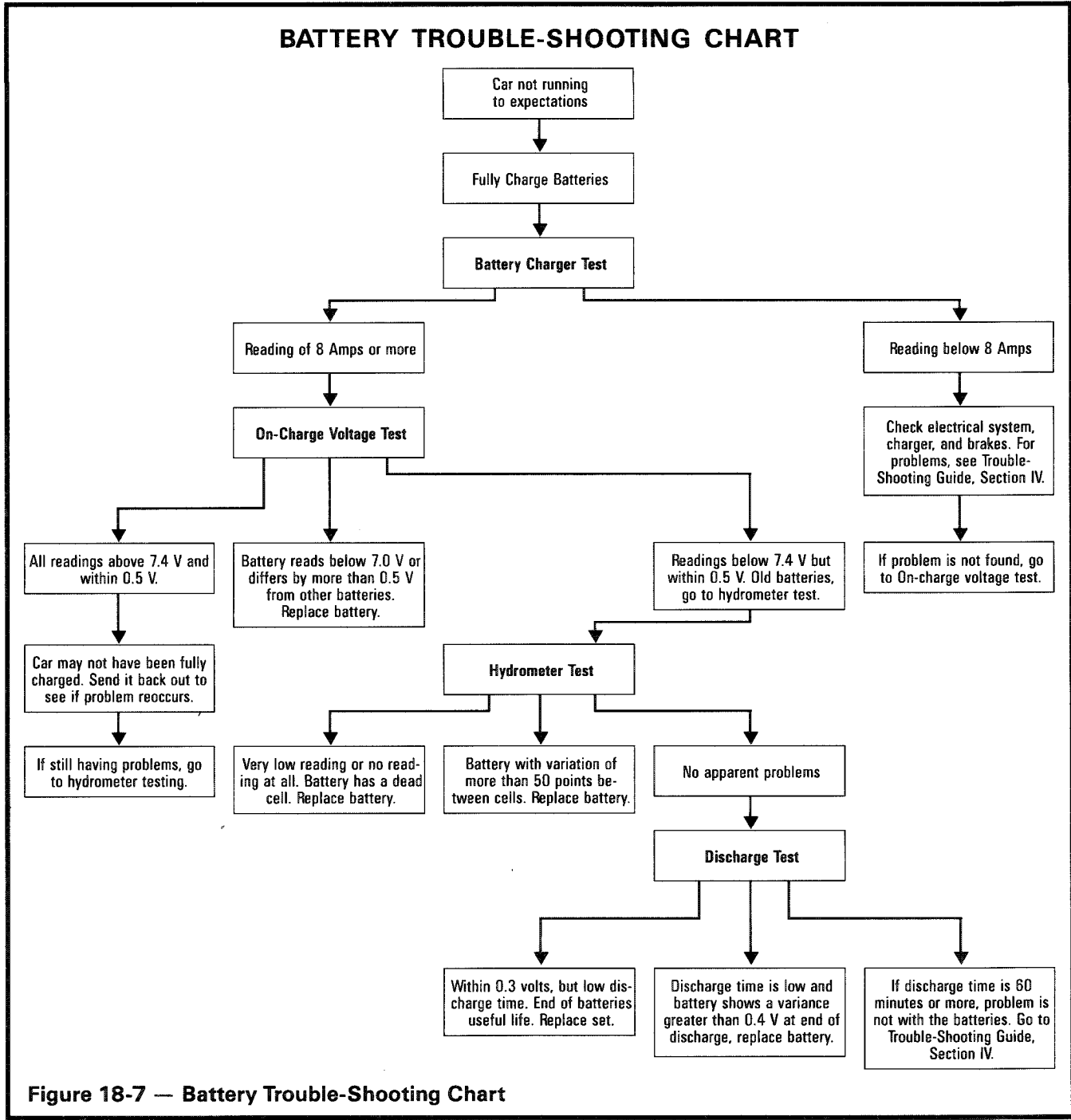


Figure 18-7 — Battery Trouble-Shooting Chart

### BATTERY CHARGER TEST

The easiest way to monitor the condition of your batteries is simply to observe the reading of your battery charger ammeter at the end of charge. After a full charge, disconnect and reconnect the charger 'DC' plug. The ammeter needle will jump to 15 amps or more and then taper into the 5 to 8 amp area within 15 to 20 minutes, indicating good fully charged batteries. Continued poor performance may be in the golf car electrical system, brakes or battery charger. If the problem is not found in the golf car or charging system, proceed to on-charge voltage test. Batteries that remain at 8 amps or higher should be tested further using the on-charge voltage test.

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## ON-CHARGE VOLTAGE TEST

When the batteries are fully charged, disconnect and reconnect the charger 'DC' plug to restart the charger. After 20 minutes, record the voltage of the battery set as well as the individual batteries, using the VOM, CLUB CAR part # 1011480. Set the meter on 50 VDC. Place the red (+) probe at the positive post of the battery No. 1 and the black (-) probe at the negative post of battery number 6 (Figure 18-5). Record reading. Then set VOM on 10 VDC and place the red (+) probe at the positive terminal and the black (-) probe at the negative terminal of each battery. Record reading. The on-charge voltage for the set should read between 42.0 volts and 47.4 volts depending on the make, size and age of battery being tested. If individual batteries read between 7.4 and 7.9 volts, car may not have been fully charged when problem occurred. Send the car back out to see if problem reoccurs. If problem persists, go to hydrometer test. If any battery reads below 7.0 volts or differs by more than 0.5 volts from the other batteries, have it replaced. If readings are below 7.4 volts but within 0.5 volts of each other, batteries are old. Batteries may have enough capacity left to last several more months. Go to hydrometer test. (See Trouble-Shooting Chart, Figure 18-7, and examples on following pages.)

## HYDROMETER TEST

A hydrometer measures the specific gravity. The higher the specific gravity, the higher the state of charge of the batteries. A fully charged battery should read between 1.250 and 1.280 at 80°F. (Never add acid to batteries to obtain a higher specific gravity.)

### Performing the Hydrometer Test

#### CAUTION:

Do not let battery acid from battery caps or hydrometer get on front or rear body. Battery acid will cause permanent blemishes. Wash off immediately.

#### DANGER:

Wear a full face shield when working around batteries, because of the danger of an exploding battery.

**Battery — Explosive Gases.** Keep sparks, flames, cigarettes away. Tools, wires and metal objects can cause sparks when "shorted" across a battery or batteries. Insulated tools should be used. Extreme care should be taken when disconnecting or reconnecting batteries. When wires are disconnected, be sure to keep them away from battery posts and other wires. Ventilate when charging or using in an enclosed space to prevent explosive gas build up.

**Poison — Contains acid — Causes severe burns — Avoid contact with skin, eyes, or clothing.**

#### Antidotes:

External — Flush with water. Call physician immediately.

Internal — Drink large quantities of milk or water. Follow with milk of magnesia or vegetable oil. Call physician immediately.

Eyes — Flush with water for 15 minutes. Call physician immediately.

#### WARNING:

Turn key switch off, remove key and place forward and reverse switch in neutral position.

1. Be sure that the batteries have sufficient water to cover the plates by approximately  $\frac{1}{2}$  inch and are fully charged prior to beginning the test. If water must be added, recharge the batteries before performing the hydrometer test.
2. Remove the vent cap.
3. Using a battery thermometer (CLUB CAR part # 1011767), record the electrolyte temperature of the center cell.
4. Squeeze the rubber bulb of the hydrometer and insert into the cell. Slowly release the bulb drawing electrolyte up into the glass tube of the hydrometer.