ElecTrak®

PRODUCT SERVICE MANUAL

General Electric Company
Outdoor Power Equipment Operation
Corporations Park, Bldg. 702
Schenectady, N. Y. 12345

GENERAL ELECTRIC

ElecTrak Tractor

CONTENTS

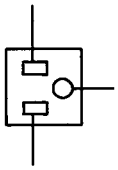
CONTENTS (Cont'd)

CONTENTS (Cont'd)

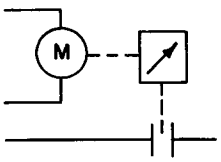
LIST OF ILLUSTRATIONS

2.1 SCHEMATIC DRAWING SYMBOLS

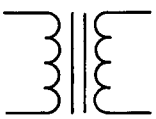
The following symbols will be encountered in using ELEC-TRAK schematics. All service personnel involved with the ELEC-TRAK should become familiar with each symbol and the function performed by the device it represents.



Grounded AC Line Plug.

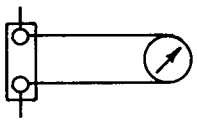


Timer - A motor driven device that shuts off a power source as well as itself after a preset time.

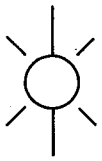


Transformer - Changes AC Voltage from one voltage to another. May step up or step down voltage level.

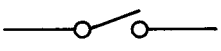
Battery-Power pack - Produces electrical energy by a chemical process.



Shunt and Meter - A method of reading high current values. The current is passed through the shunt. The meter reads the voltage drop.

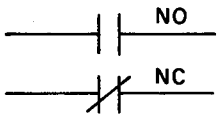


Light or lamp.

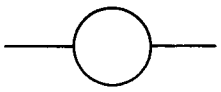


Manual Switch or Disconnect. (Shown in open position)

Cam-operated Switch. (Shown in closed position)



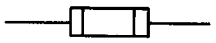
Relay or solenoid-operated contacts.
NO - normally open; NC - normally closed.



Actuating coil of relay or solenoid.

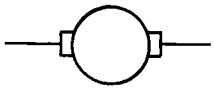
Thermal Overload Protector (Circuit Breaker) - Automatic reset protective device, senses current and/or temperature combinations. Provides a closed circuit until overloaded.

Thermal Overload Protector - Manual reset.



Fuse - A throw-away protective device in a circuit.

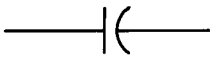
Plug-in Disconnect - Eases removal of electrical assemblies.



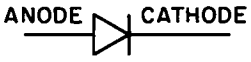
Motor Armature - The rotating center member of an electric motor.

Motor Field - The fixed outside member of a motor produces an electromagnetic field. (This field is produced by magnetic materials in permanent magnet motors.)

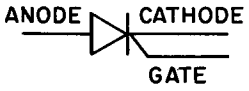
Resistor - Device to resist the flow of current measured in ohms.



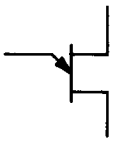
Capacitor - Two electrodes separated by an insulator or dielectric. This device can be charged and discharged at a controlled rate; also can store energy for short periods of time. Sizes consider in μf. (Microfarads)



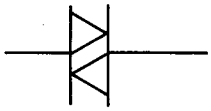
Diode - Allows current to flow only in one direction from anode to cathode.



SCR - Solid state semiconductor switch which closes when current is directed into the anode and gate. The SCR opens when anode current is cut off.



Unijunction Transistor - A variable resistance voltage divider. When used with a capacitor and resistor, controlled time delays can be had.



Varistor - An energy absorbing device used to protect switching contacts.

NOTE: Schematic symbols have not been completely standardized.

2.2 UNDERSTANDING SCHEMATIC DIAGRAMS

All electrical circuits must have closed paths for current flow in order to operate. The closed path is provided by wires and electric/electronic components in most applications. In tracing closed paths from schematics, the task is simplified by starting the path at the power supply (battery, line cord, etc.) and tracing through the associated components and wiring, back to the power supply.

Example 1: Consider a simple flashlight. Electrically, it consists of two batteries in series, a filament or lamp, a switch, and the wiring giving a closed path. Referring to the schematic symbols, the circuit could be represented pictorially and schematically as shown in Figure 2-1.

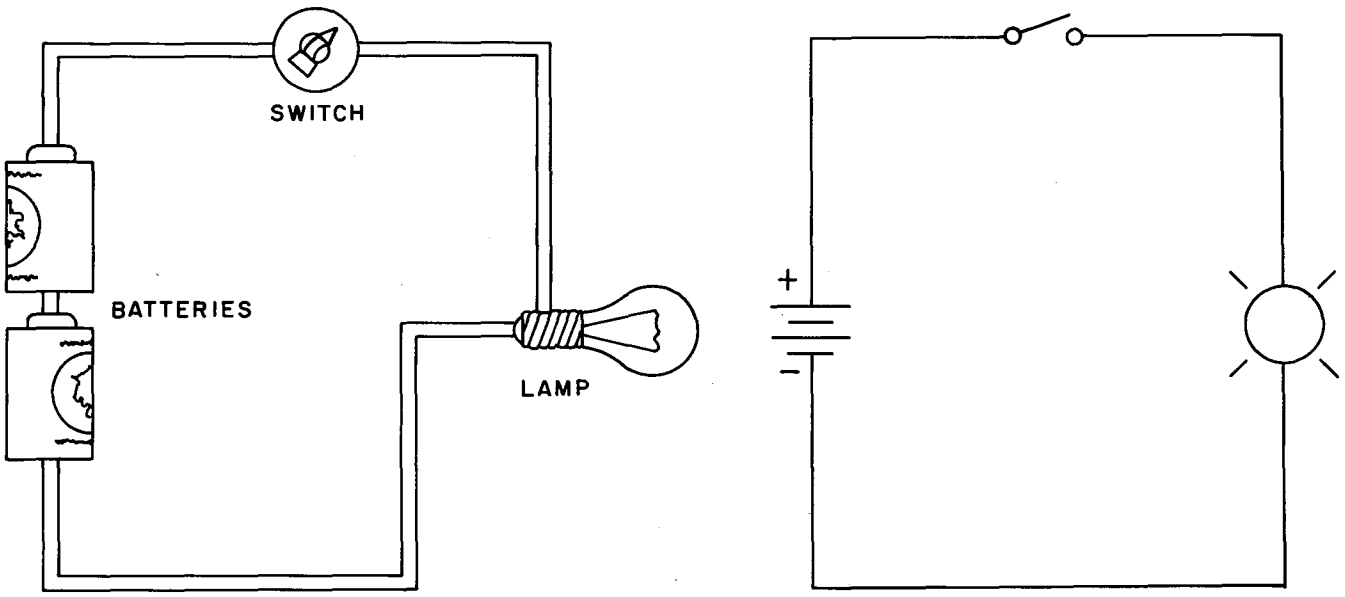


Figure 2-1

Notice that in tracing the circuit in the schematic, there is no closed path for current flow until the switch is manually closed.

Suppose an Elec-Trak light circuit requires service. A simplified schematic for the light with the lift circuit added for instruction is shown in Figure 2-2.

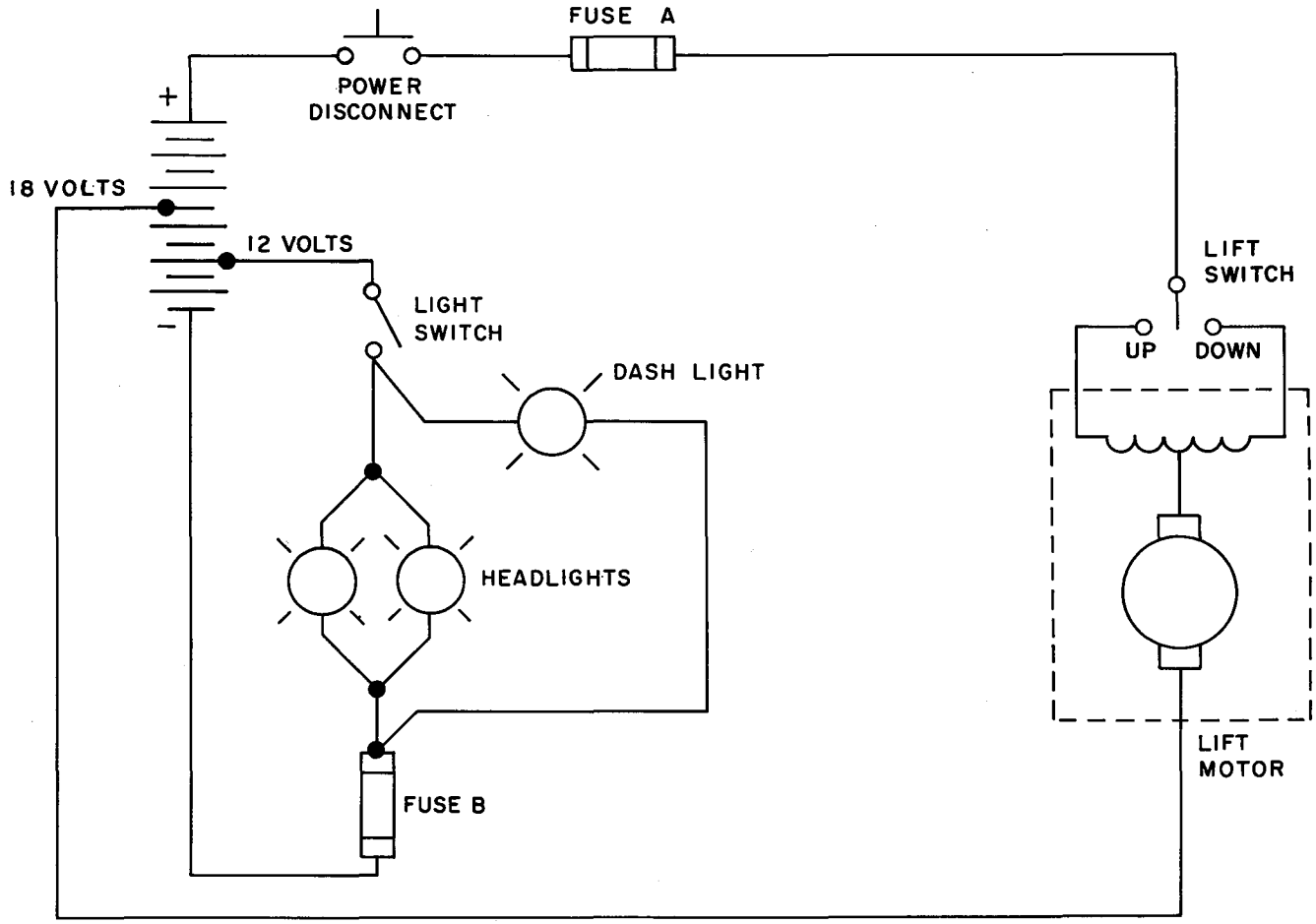


Figure 2-2

Since the trouble is in the headlight circuit, only that closed path need be considered. That path is shown in Figure 2-3, but should be visualized from the complete schematic, not redrawn.

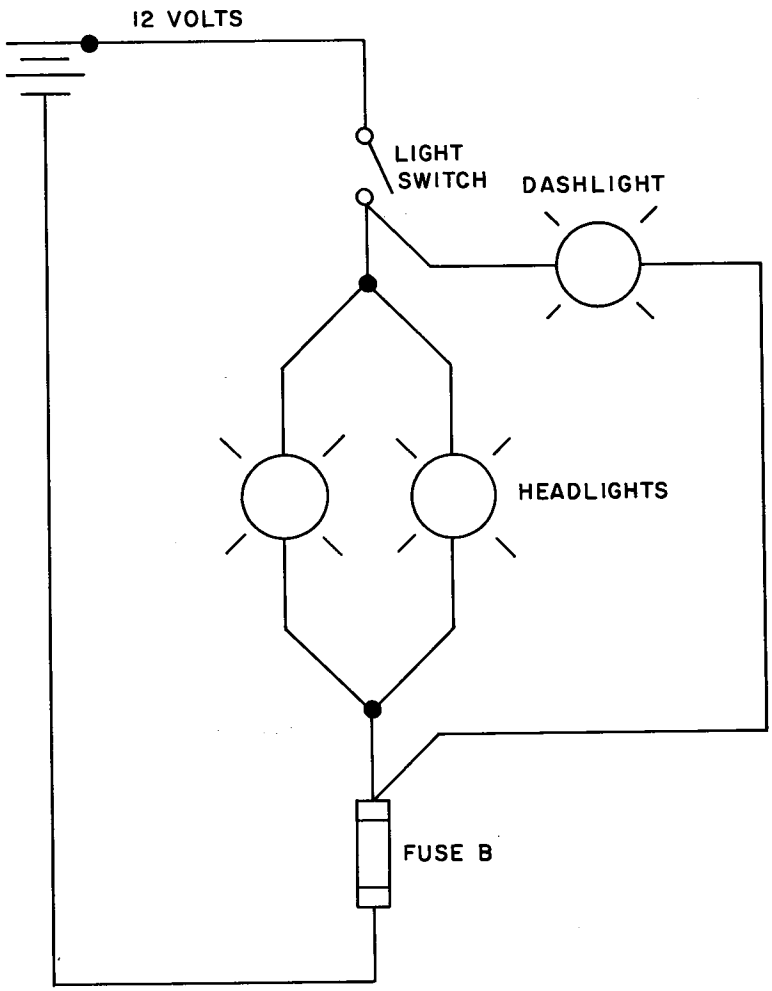


Figure 2-3

The tractor power pack maximum output is approximately 42 volts, but Figure 2-2 clearly indicates that the light system is tapped into a portion of the power pack, namely the bottom two batteries which deliver 12 volts. So, in servicing the system only those two batteries require attention in the troubleshooting procedure.

Let's assume neither headlight or the dash light illuminates. From the schematic of Figure 2-3, list all the faults that could cause this failure. The list should contain these major items:

1. Fuse blown.
2. All lamp filaments burned out.
3. Batteries discharged or very weak.
4. Light switch defective.
5. Break in wiring, or poor connection.

Since fuses are usually in a readily accessible place, they can be usually inspected quickly. It is good practice to check the fuses as the first step in any troubleshooting procedure.

If the lamps are easy to see or remove, a check of one filament could be a second step. Notice that if just one of the filaments is good, that lamp will operate regardless of the condition of the others since they are wired in parallel.

Very weak or discharged batteries would seriously impair drive motor operation since these tapped batteries are also used in the drive motor circuit. The specific gravity of the cells could be checked to verify the state of charge.

If the switch is defective, it may be checked in several ways. One simple method merely by-passes the switch with a length of wire. A "jumper" wire for this purpose can be made for use as a tool by attaching clips to either end of an insulated wire. Several different lengths may be made for different situations. The switch is then tested by clipping the jumper from one switch terminal to the other. If the lights do not operate with the switch turned on, but do with the jumper in place, the switch is defective.

Another procedure that could be used to isolate defective wiring or components, utilizes the volt-ohm-milliammeter (VOM). The VOM would be set to measure positive DC volts on a range greater than 12 volts in this case. The negative VOM lead is attached to the negative power pack connection or fuse B, which electrically is at the same voltage. The positive lead is then moved from the positive power pack tap to the next accessable connection encountered as the closed path is traced to the lamps. The 12 volts should be indicated at each check point with the switch on. If the voltage is "lost" between one point and the next, the wire, connection, or component between the points is defective.

It is also possible that the negative wire be open to the lamps and it may

be checked in similar fashion by initially moving the negative VOM lead to accessible points while the positive lead remains on the positive power pack tap. The 12 volt reading should again be indicated for good wiring.

The lift circuit in Figure 2-2 taps the top 18 volts from the power pack and uses a fuse in the positive wiring. Notice that the power disconnect can shut off lift power, and that the lift switch has a center off and two on positions. Troubleshooting of the wiring and components can be carried out in a manner similar to that used on the light circuit.

If on initial inspection burned wire insulation is noticed, its cause and results should be immediately corrected to prevent further shorting before proceeding with other troubleshooting steps.

The mechanics involved in troubleshooting are necessarily long. As the technician becomes familiar with logical troubleshooting procedures, experience develops, and familiarity with the circuits increases, he will find less need to refer to procedure guides, but will work solely from the wiring drawings and schematics.

The schematic shown in Figure 2-4 can be used to gain symbol familiarity, trace closed paths, establish a systematic troubleshooting procedure, or just figure out how it works.

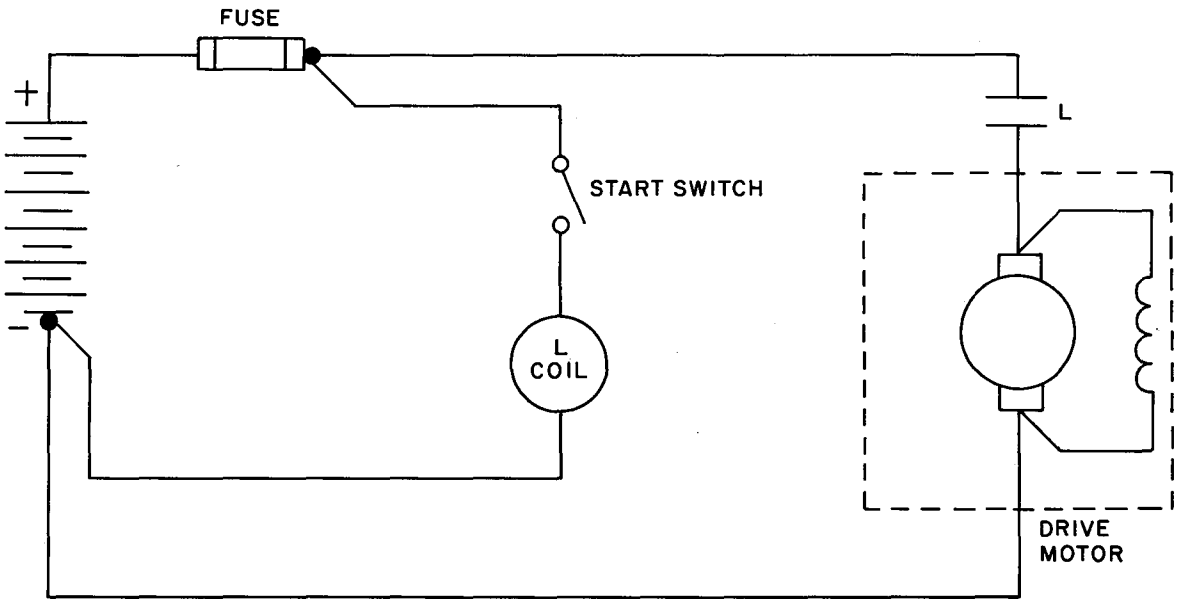


Figure 2-4

2.3 USE OF THE VOLT-OHM-MILLIAMMETER - (VOM)

Ranges:

DC Voltage:	0-10-50-250-500-1000V
AC Voltage:	0-10-50-250-500-1000V
DC Current:	0 - 500 microamps
	0 - 25 - 500 milliamps
Resistance:	Scale reading X 10 ohms
	Scale reading X 100 ohms
	Scale reading X 1000 (1K) ohms
Capacitance:	0.001 to 0.1 microfarads (μF)

Voltage and Current Measurements (AC/DC)

Insert red test lead plug into plus (+) jack, and the black test lead into the minus (-) jack. Set the selector switch to the required range. For voltage measurements, the test leads are connected across the device or circuit under test, whereas for current measurements, the VOM must be temporarily connected in series with the tested circuit. Notice that only DC current can be measured with the VOM. Always observe correct test lead polarity.

> CAUTION: If the voltage or current values to be read are unknown, select maximum range on the VOM and then lower the range sufficiently to obtain a reading.

Resistance

To measure resistance, turn selector switch to range desired. Short the test leads together and turn the "zero ohm adjust" for zero indication on the meter. Measure resistance by connecting test leads to resistor, device, or circuit under test. CAUTION: NEVER ATTEMPT TO MEASURE RESISTANCE IF VOLTAGE IS PRESENT.

False readings are obtained in many resistance measurements due to parallel wiring across the tested part or circuit. To eliminate this possibility, disconnect at least one end of the test part or wire from the rest of the circuitry.

NOTE: Replace the internal VOM batteries if the "zero ohm adjust" does not move the meter pointer to zero.

Continuity and Short Testing

The VOM can be used as a continuity and short testing instrument, which are both variations of resistance measurements.

With the VOM "zero adjusted" as outlined in the resistance instructions and the range selector on the X10, with all power removed from the circuit and one end of the wire free, the wire's resistance is measured by connecting the test probes. If the wire is continuous, an indication of zero ohms results. If the wire has a break in it, the indication is infinity, (∞), and a loose connection may indicate several thousand ohms.

Should intermittent problems occur, it may be necessary to slightly flex the wires during testing to detect a break.

The same procedure can be used to test several wires connected in series as well as switch and relay contact closures.

Similarly, if shorts are suspected between wiring, components, and body parts, the resistance test can be applied. If no short occurs, infinity (∞) will be indicated. If a positive short exists, zero ohms will be indicated.

2.4 TROUBLESHOOTING TECHNIQUES

Before starting to troubleshoot, visually check for loose wiring, and signs of faulty components; i.e., overheating, pitted relay contacts, binding or loose switches, etc.

WARNING: BEFORE ATTEMPTING TO SERVICE THE ELEC-TRAK, DISCONNECT THE CHARGER FROM THE LINE VOLTAGE SOURCE AND DISENGAGE THE POWER DISCONNECT.

Restore these power sources as needed for the specific test.

NOTE: All continuity tests must be made with the charger line cord disconnected and the power disconnect disengaged. Under no circumstances should continuity measurements be made on connected power pack interconnections. This will result in damage to the VOM.

The troubleshooting sections do not attempt to cover all possible failures, but will serve as guides to step-by-step procedures for solving common problems. Familiarity with these procedures develop logical approaches for failures not listed.

Most voltage measurements must be made under Normal Operating Conditions (NOC) which call for key "on", power disconnect engaged, seat switch closed, and brake pedal fully released.

WARNING: TO REDUCE THE LIKELIHOOD OF ACCIDENTS UNDER THESE CONDITIONS, PLACE THE RANGE SELECTOR IN ITS NEUTRAL POSITION, OR JACK BOTH REAR WHEELS OFF THE GROUND.

This will prevent unwanted movement of the Elec-Trak.

Carefully observe polarity when measuring DC voltage. (+ meter lead to + volts, - meter lead to - volts)

During the troubleshooting procedure, refer to the schematics, wiring diagrams, and appropriate assembly drawings as often as necessary to develop

skill in relating these illustrations to the tractor hardware. When a check, test, or measurement step fails, always suspect trouble in the circuit under test; do not proceed to the next step until the previous step produces satisfactory results.

When an open circuit in the control wiring is indicated, careful jumpering of the suspected components can confirm the indication if normal operation is restored with the jumper in place. The circuitry being jumpered can then be systematically reduced until a single wire or component causing the failure has been isolated. This procedure should only be attempted when the necessary wiring schematic is consulted and understood.

2.5 PARTS REPLACEMENT

Much time can be saved in the replacement of electrical components if wires can be transferred from the old component to the new one-at-a-time. This procedure also reduces the likelihood of an error in rewiring which could result in serious damage.

Besides the "one-at-a-time" wire transfer for printed circuit cards and relays, care should be taken in handling these components and in removing and installing their wires. To prevent damage to the component or the wire connector, removal should be done by grasping the connector and pulling straight away from its terminal, without any rocking motion. Installation should be done in much the same way; i. e., without rocking which can cause damage to connectors or components.

Wiring connections to the printed circuit cards must make solid contact with the printed circuit card pads. In some cases this calls for facing the connector a certain way, and in others, the connector must be adjusted or replaced to increase pad contact pressure. Much the same can be said about the connectors used on the relay terminals.

Servicing required on the power disconnect always requires that at least one of the battery clamps be removed from its post to "open" the series set of batteries. If this is not done, portions of the power disconnect carry voltage and may cause severe arcing to occur.

The "Dealer Stocked Parts Package" contains a kit of wire connectors. The connectors can be divided into two categories: those that can be crimped onto wires with the crimping tool and those that must be soldered. As a guide, select a connector that will accommodate both the terminal to be engaged and the gage of the wire used. Prepare the wire by stripping sufficient insulation to allow the wire to seat in the connector fully. If crimping is used, close the crimping tool handles completely to assure good contact. If the connector is equipped with an insulator, this should be crimped to hold the wire insulation securely.

The large connectors are easily soldered to the wire with a high wattage soldering iron, but the smaller connectors used in the plug and jack housing must be carefully soldered so as to allow the connector to enter the housing freely. After soldering, the upper connector tabs should be formed around the wire insulation for additional strength.

2.6 POWER PACK

GENERAL

Inspect for evidence of damage.

Adjust electrolyte level in each cell to just cover plates before charging and 3/8 in. above the plates after charging.

Measure spg (specific gravity) of each cell after a full charge cycle.

Clean corroded terminals, clamps, and exposed surfaces of power pack.

Make sure all connections are tight.

Do not mistake improper charging for a defective power pack.

Battery Tools

All of the special battery tools supplied to ELEC-TRAK dealers are designed to save time and extend battery serviceability. The tools should be used whenever necessary and compromises or substitutions should never be made.

Clamp pliers - These pliers are to be used on the nut on the bolt of the clamp whenever the nut is distorted so an open end wrench cannot be used in its removal. The nut should be replaced after removal with this tool.

Clamp puller - After the clamp bolt is loosened, the puller straddles and grips the clamp's sides and the puller screw bears against the battery post. The use of the puller restrict forces to the clamp and post only and prevents damage to the post supporting structure.

Terminal cleaner - This is a double ended wire brush which should be used before reconnecting any clamps to posts, including new batteries. The post and the inside of the clamp should be

brightened with this tool for maximum power pack efficiency.

Clamp spreader - Never hammer or force battery clamps onto post, as this may damage post supporting structure. Instead, the clamp should be spread with the spreader so it just slides over the post easily. The bolt and nut when retightened will restore sufficient contact.

Cleaning and Protecting

Gases and overflowed electrolyte usually resulting from the charging process may cause a residue or oxidation to form on the power pack surfaces. Besides causing self-discharge of the cells, the residue may attack power pack terminals and clamps and can cause deterioration and performance problems if left unchecked.

The residue is best neutralized by sponging a sufficient solution of five tablespoons of baking soda to one quart of water to the power pack surfaces after the power pack hold-downs and covers have been removed. After a few minutes wipe all surfaces dry and clean.

Preventative measures can be taken to reduce the need of this service. Many times the residue accumulation can be attributed to one or more of the following practices:

1. Overfilling of cells.
2. Excessive charging.
3. Careless testing of electrolyte.
4. Repeated tractor operation on very rough terrain.

The customer should be made aware of proper care to eliminate recurrence of these problems, but even then the gases produced during normal charging may cause clamps and terminals to oxidize. When clamps and terminals are new or thoroughly cleaned they may be coated with red Glyptal* to retard corrosion. Coating procedure is found on page 2-20.

*Trademark of General Electric Co.

Power Pack Testing

Several methods are used to establish power pack condition and/or serviceability. Specific gravity measurement (spg) provides a quick means of determining whether each cell is accepting full charge or not. Another method, the discharge test, measures the ability of the power pack to deliver a specified number of amperes over a given time. Before applying either test, the power pack should be allowed to reach room temperature and should be put through a full charging cycle.

Specific Gravity (spg)

Power pack electrolyte is heavier than pure water. Assigning a value of 1.000 for pure water, the relative weight of an equal volume of any other substance is called the specific gravity of the substance. The electrolyte specific gravity of a new power pack normally varies between 1.110 and 1.26 representing a discharged condition and a charged condition respectively at 80 F. If the spg is higher than 1.26 slightly more ampere hour capacity will result (increasing range), but power pack life will be shortened. While using the power pack after a full charging cycle, the spg gradually decreases to 1.110 until the cells are fully discharged. Continued discharge causing the spg to go lower than the 1.110 point will also shorten the power pack life, therefore overcharging and deep discharging should be avoided.

The hydrometer is a direct-reading instrument used to measure the spg. To apply the test it is only necessary to draw up a sample of electrolyte from a cell and record the indicated spg. The spg readings of the three cells of any power pack unit should not vary from each other by more than 0.05. If variations do not exceed this figure and the spg in each cell is above 1.24 the unit is presumed to be in reasonably good condition. Considerable variation in specific gravity readings (0.05 points or more) usually indicate sources of trouble such as short circuits through cell plate separators; leakage of electrolyte through partitions between cells; worn out plates in one or more cells; or badly contaminated electrolyte. Spg varies with

temperature, so for correct readings the electrolyte temperature should be at 80 F.

Whenever a variation in spg of over 0.050 points is observed, discharge testing should be applied to determine serviceability. This is covered elsewhere in this section.

Hydrometer Care and Correction

Hydrometers become inaccurate if not cleaned regularly. It is good practice to flush them out with clean water after use. They should be taken apart and cleaned thoroughly every two months. Broken or leaking hydrometer floats prevent correct specific gravity readings. A good hydrometer will read accurately at electrolyte temperatures of 80 F. Four points specific gravity must be added for every 10 degrees above 80 F, and four points must be subtracted for each 10 degrees under 80 F to get very accurate readings, but this calibration is not necessary when checking cell spg uniformity. Hydrometers will not give an accurate reading when used immediately after water has been added to the cells. Cycling the power pack twice after the addition of water allows the proper mixing necessary for correct readings.

Watering

Cell water level should be maintained from 1/4 inch to 3/8 inch above the cell plates when cell is fully charged. Distilled water is ideal, but tap water with a low to average mineral content may be used. Overfilling of cells results in electrolyte loss during the charging process causing corrosion to attack connectors. Avoid overfilling!

Altering Electrolyte

Electrolyte should not be added under any circumstances unless it is known that electrolyte has been lost from the cell. Whenever it is necessary to add acid to the cells, the acid should be in diluted form. The cells should be placed on charge and the concentration of the electrolyte within the cells adjusted to the proper value before the conclusion of the charge.

Battery Connection Protection

All battery connections can be coated with red Glyptal to retard corrosion. Surfaces of the battery posts and clamps should be free of corrosion, grease, and dirt before the protective spray is applied, and the battery brush should be used to make contact surfaces bright and shiny.

With the clamps tightened in place, spray all exposed surfaces of each connection from a distance of 10 to 12 inches with short "dusting" strokes. Mask off adjacent areas to protect them from the air-borne spray.

ELEC-TRAK E12S
26AE12AA

3.1 E12S THEORY OF OPERATION

There are only slight differences between the E12S and E15. Areas of difference are:

Area Involved	E12S (26AE12AA)	E15 (26AE15BA)
Speed Control	3 Forward speeds, therefore no Card #3 on FW Relay	7 Forward speeds
Drive System	Single belt, large motor pulley	Dual belt, small motor pulley
Body and Trim	Tires: 4.80 x 8 and 8:50 x 12. Identification decals.	Tires: 6:50 x 8 and 9:50 x 12. Identification decals.

Besides the omission of indicated parts, other parts have different identification numbers. Troubleshooting techniques must change slightly to accommodate these similarities and differences. Refer to pages 3-2 before proceeding with service or parts ordering.

26AE12AA

Area of Interest	Reference	Remarks
Theory of Operation	Section 4.1	Ignore reference to field weakening, i.e., speed control, Card #3, FW relay, etc.
Troubleshooting Sketch Interpretation	Section 4.2	
Use of the Troubleshooting Guide	Section 4.3	Observe E12S differences.
Troubleshooting Guide	Section 4.4	Observe E12S differences.
Brake Service	Section 4.5	
Troubleshooting Sketch	Figure 3-1	
Card #1 (Control) Schematic	Figure 3-2	
Tractor Wiring	Figure 3-3	
Control Panel Wiring	Figure 3-4	
Speed Control Wiring	Figure 3-5	
Timer Assembly Wiring	Figure 4-6	
Battery Charger Sub-Assembly	Figure 4-8	
Dash Assembly	Figure 4-9	
Control Panel Assembly	Figure 3-6	
Speed Control Assembly	Figure 4-11	
Charger Cover Assembly	Figure 4-12	
Front Axle Assembly	Figure 4-13	
Steering Assembly	Figure 4-14	
Rear Axle Assembly	Figure 4-15	
Elec-Trak 2318 Transaxle	Figure 4-16	
Drive Motor and Mounting	Figure 4-17	
Brake Assembly	Figure 4-18	
Lift Assembly	Figure 4-19	
Frame and Body Mounted Parts	Figure 4-20	
Miscellaneous Parts	Last Parts Page - Section 4	

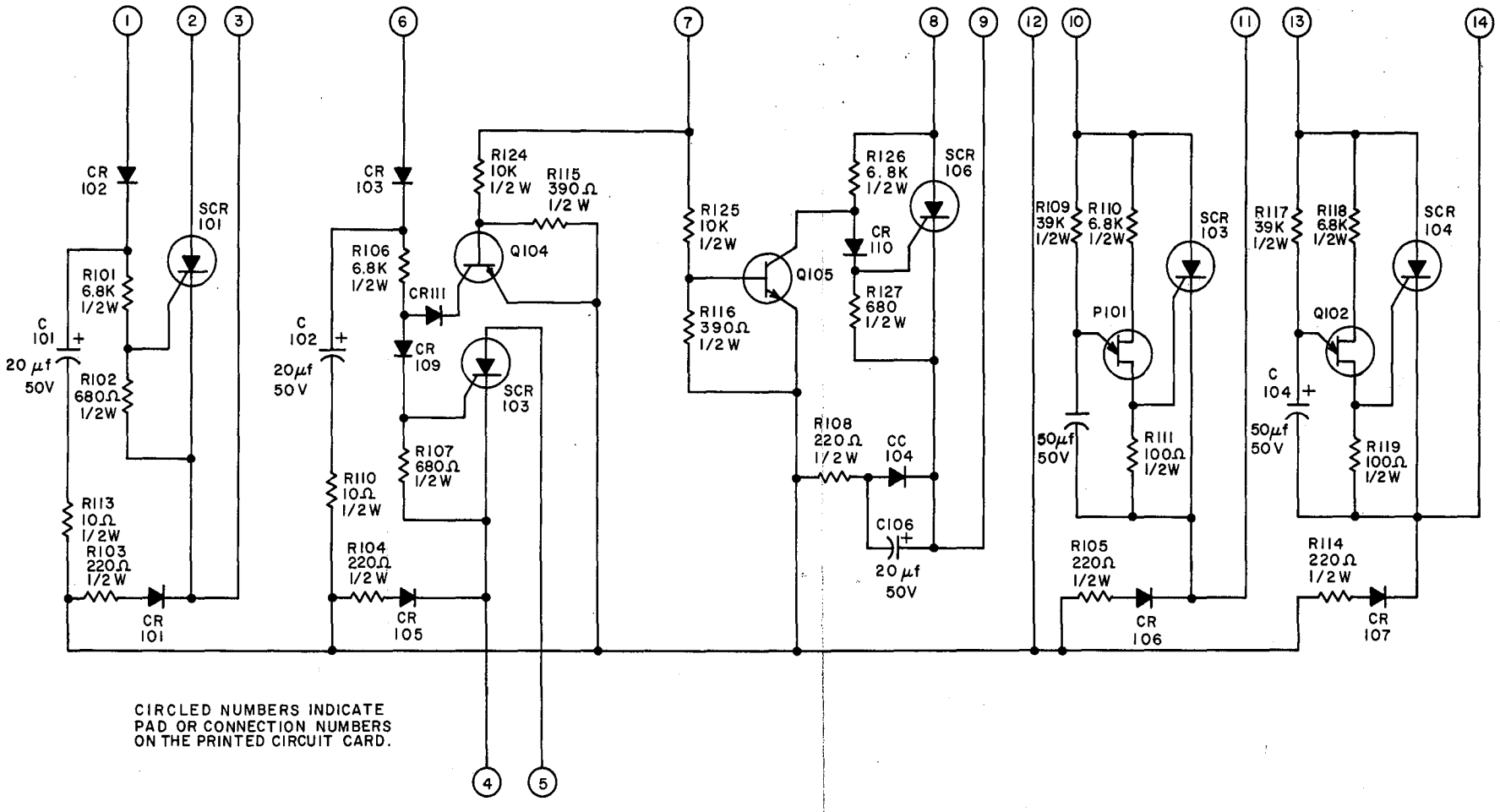


Fig. 3-2 E12S Card #1 (Control) Schematic

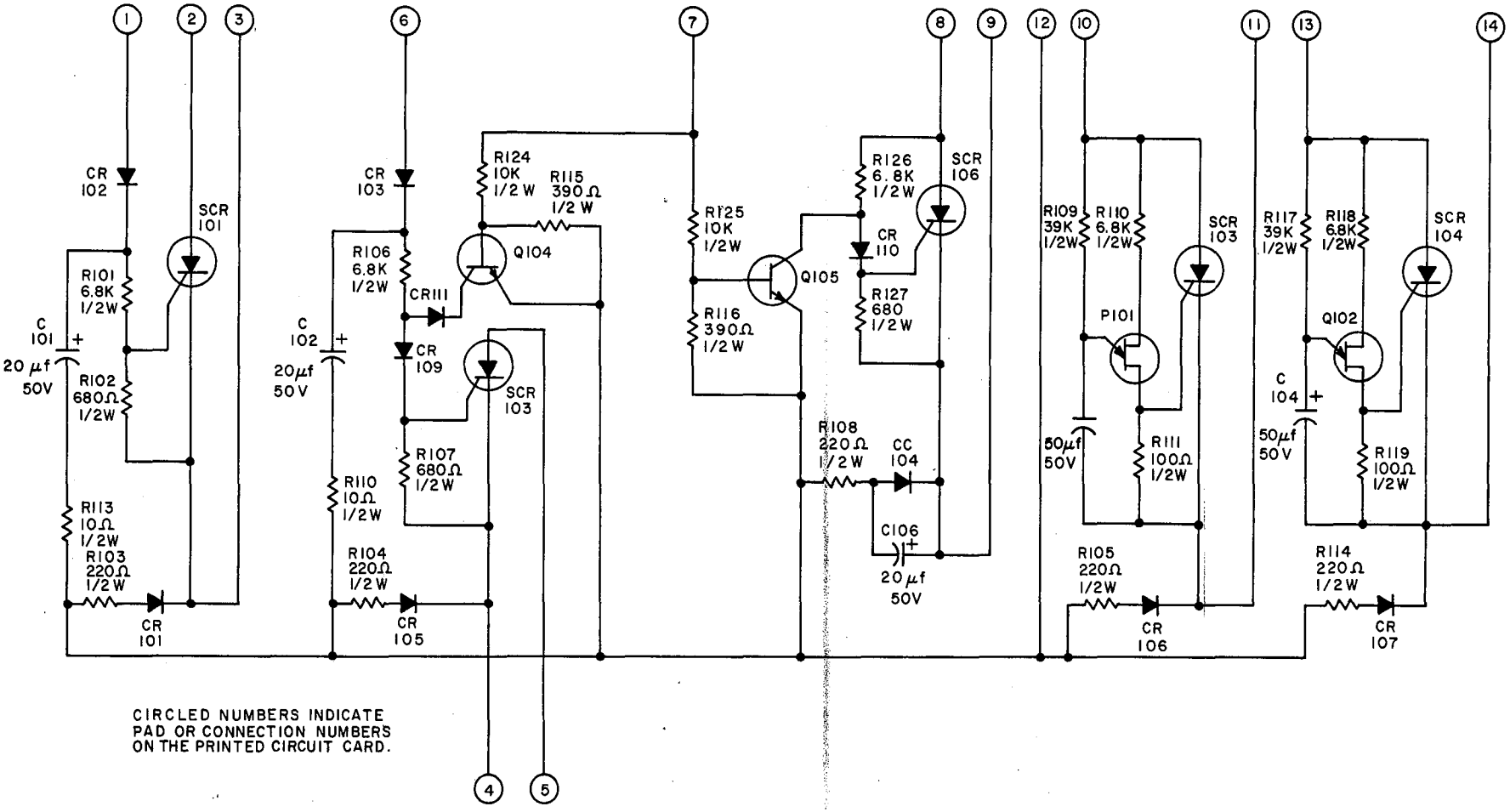
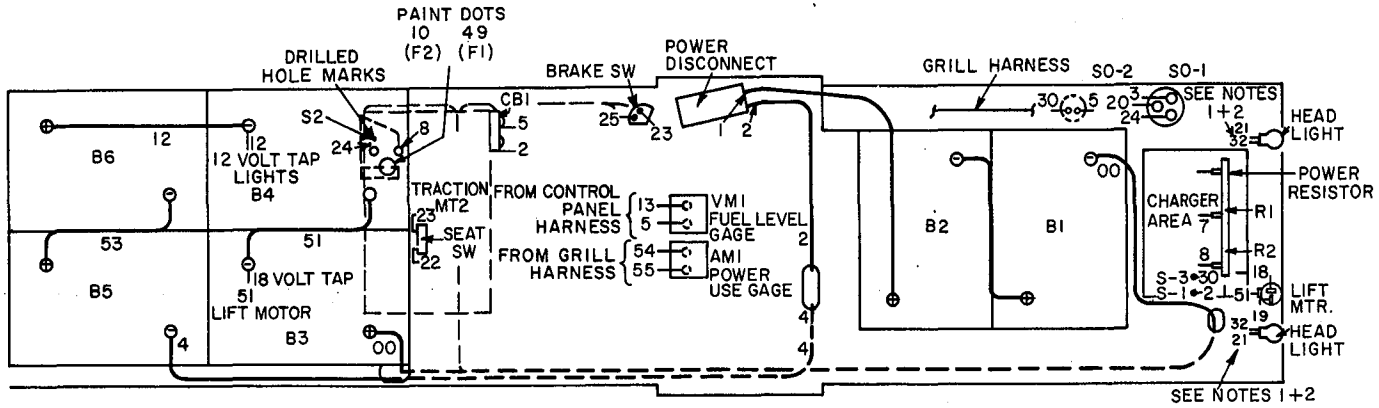


Fig. 3-2 E12S Card #1 (Control) Schematic



THIS FIGURE IS NOT INTENDED TO SHOW COMPLETE WIRING. IT IS TO BE USED FOR COMPONENT AND SIGNIFICANT WIRE LOCATION ONLY.

NOTES:

1-HEAD LIGHT LEADS 21 & 32 MUST NOT MAKE CONTACT WITH POWER RESISTOR.

2-CONNECT HEAD LIGHT LEADS TOGETHER WITH WIRES 21 & 32 FROM UNDERCARRIAGE HARNESS.

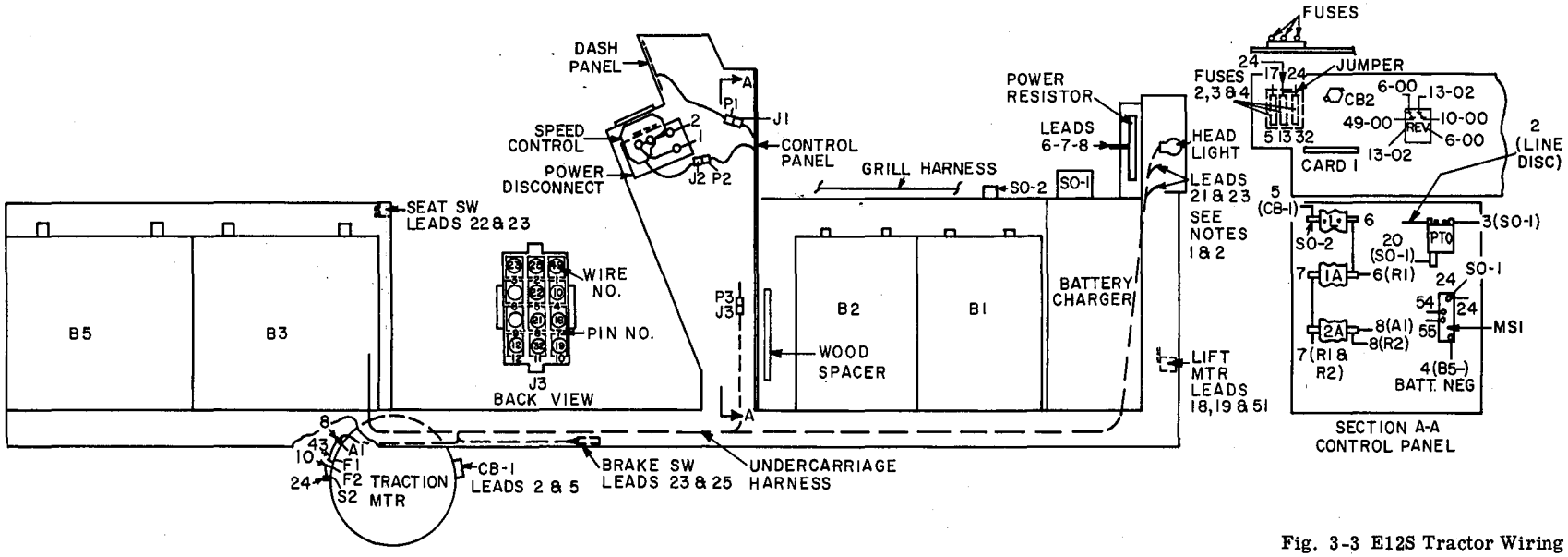
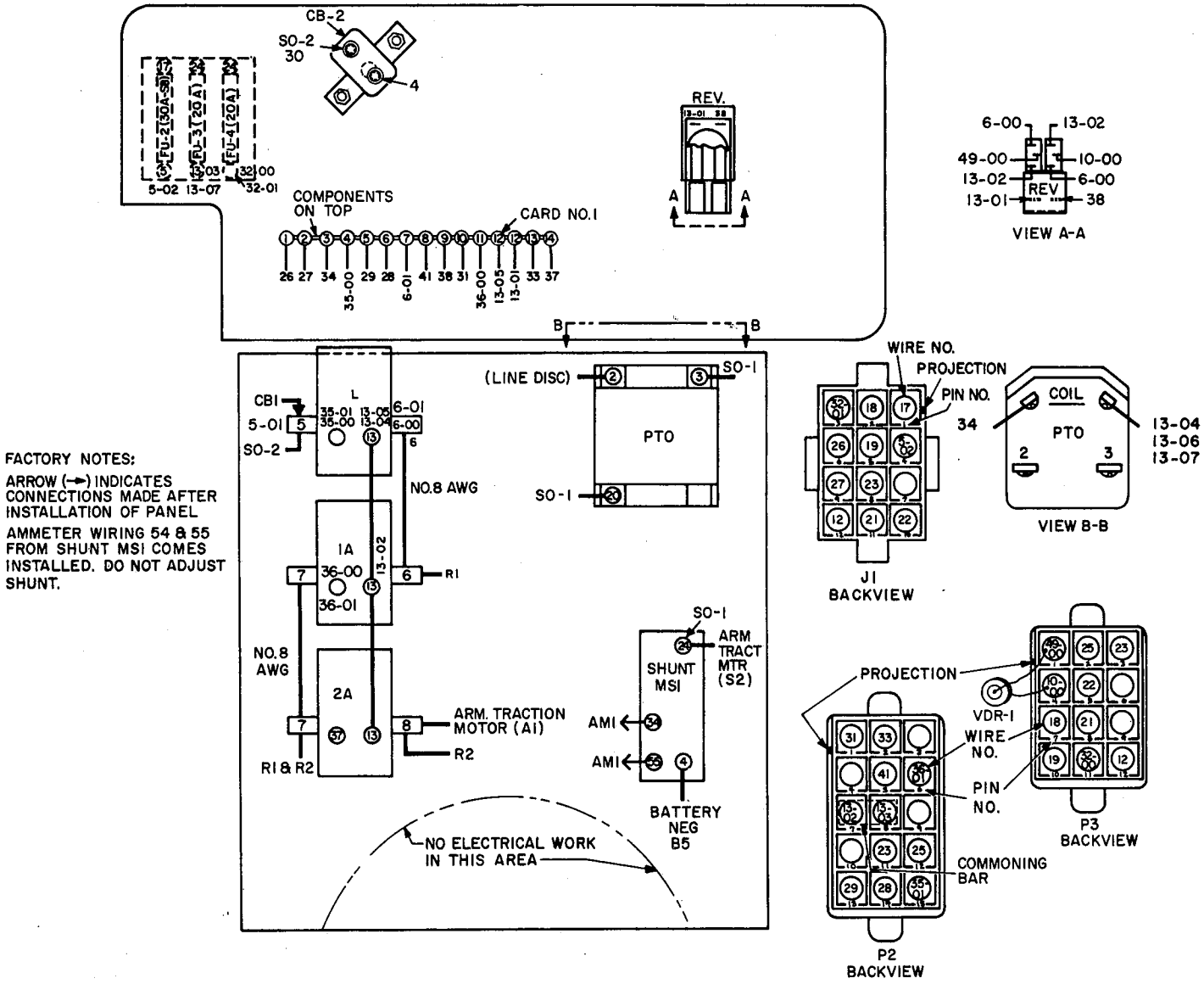


Fig. 3-3 E12S Tractor Wiring



FACTORY NOTES:

ARROW (→) INDICATES CONNECTIONS MADE AFTER INSTALLATION OF PANEL

AMMETER WIRING 54 & 55 FROM SHUNT MSI COMES INSTALLED. DO NOT ADJUST SHUNT.

Fig. 3-4 E12S Control Panel Wiring

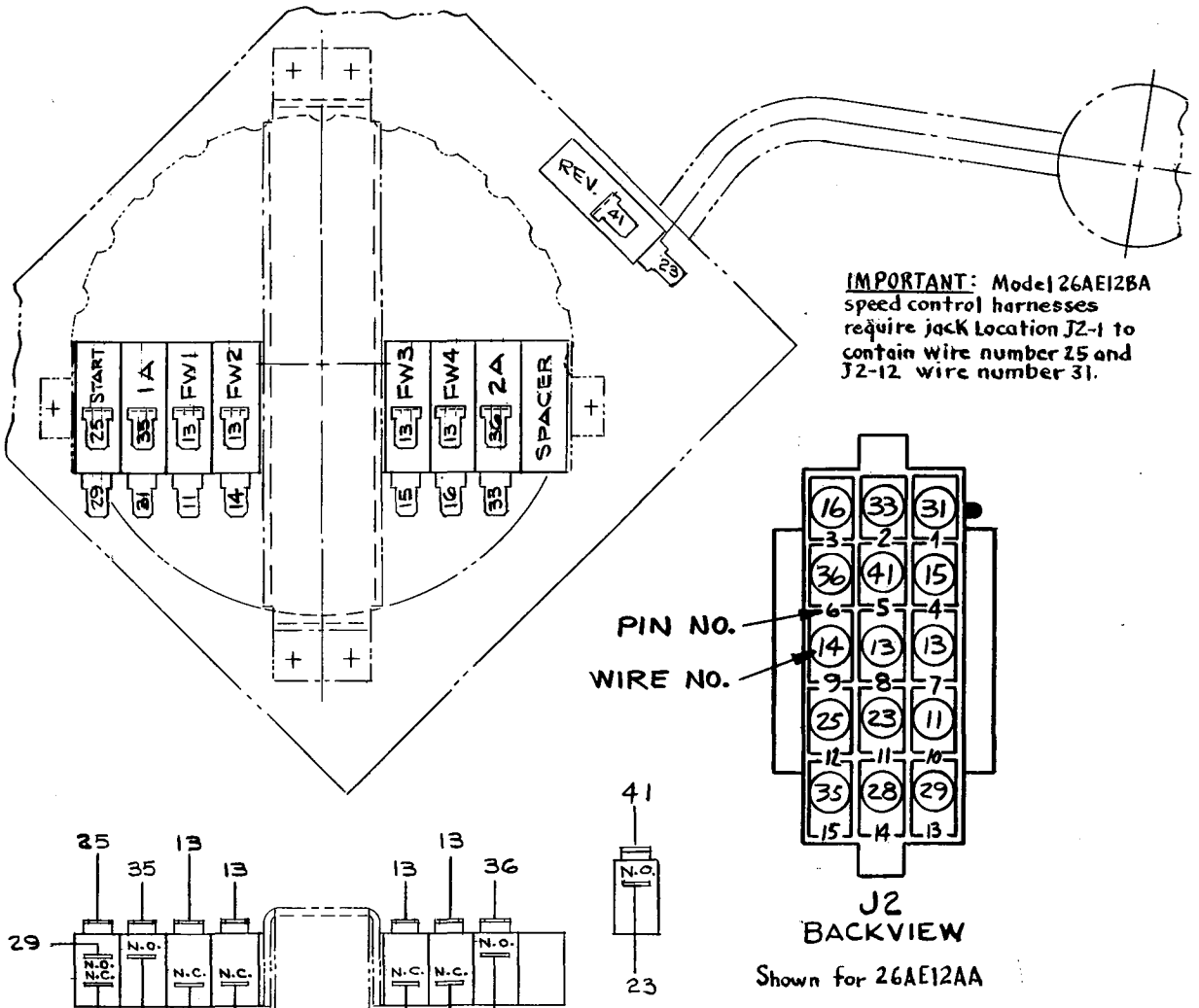


Fig. 3-5 E12S Speed Control Wiring

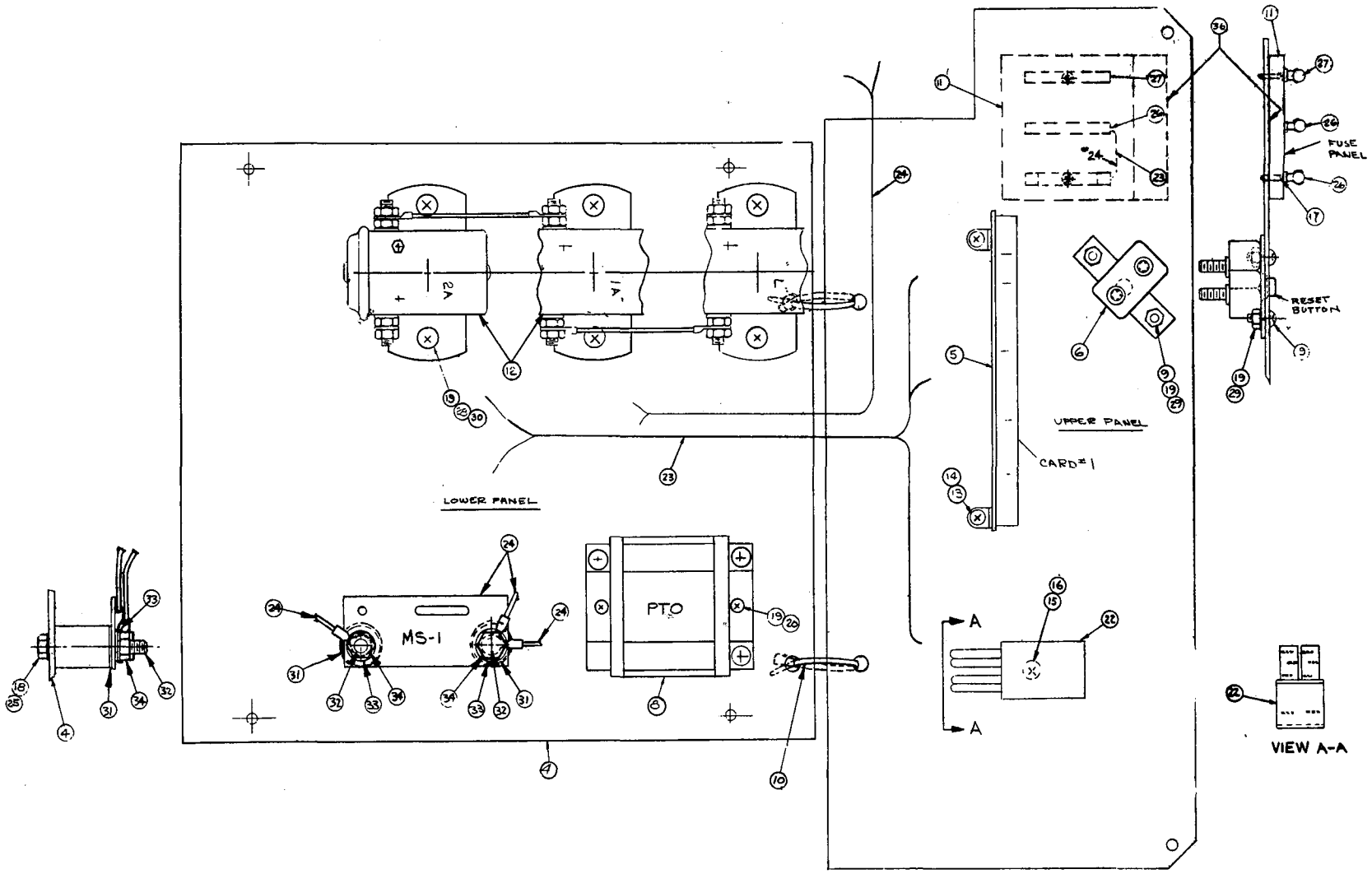


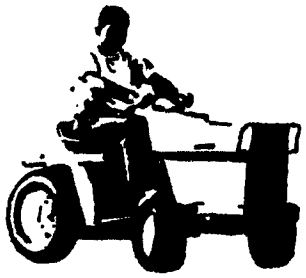
Fig. 3-6 E12S Control Panel Assembly

CONTROL PANEL ASSEMBLY

Use this list to order replacement parts from Fig. 3-6.

Ref. No.	Description	Part Number	26A					
			E12A	E12B				
5	Card #1	163B9987G1	X	X				
6	Circuit Breaker	243A4719P1	X	X				
8	Contactor (PTO)	243A4524P1	X	X				
9	Machine Screw - Phillips #10-32 x 3/8"	(1)	X	X				
10	Cable Tie	243A4540P2	X	X				
11	Fuse Board	243A4591P1	X	X				
12	Contactor (L, 1A, 2A)	211A3567P1	X	X				
13	Self-tapping Phillips Screw 6-32 x 3/8"	(1)	X	X				
14	Lockwasher, #6	(1)	X	X				
15	Machine Screw - Phillips 8-32 x 3/8"	(1)	X	X				
16	Lockwasher #8	(1)	X	X				
17	Self-tapping Phillips Screw 6-32 x 1/2"	(1)	X	X				
18	Hex Head Screw 1/4"-20 x 3/8"	(1)	X	X				
19	Lockwasher #10	(1)	X	X				
20	Self-tapping Screw - Phillips 10-32 x 1/2"	(1)	X	X				
22	Relay (Rev.)	243A4562P1	X	X				
23	Control Panel Harness	423D241G1	X	X				
24	Grill Harness	541C958G2	X	X				
25	Lockwasher 1/4"	(1)	X	X				
26	Fuse (FU-3, FU-4) 3AG20A	243A4657P1	X	X				
27	Fuse (FU-2) 3AG30ASB	243A4597P1	X	X				
28	Self-tapping Phillips 10-32 x 3/8"	(1)	X	X				
29	Nut, Hex 10-32	(1)	X	X				
30	Washer #10	(1)	X	X				
31	Washer 1/4"	(1)	X	X				
33	Lockwasher 1/4"	(1)	X	X				
34	Nut, Hex 1/4" - 20	(1)	X	X				

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.



SECTION 3A

GE ElecTrak®

E12 PRODUCT SERVICE

E12 WIRING ILLUSTRATIONS AND PARTS IDENTIFICATION

	Figure	Same as Model
Troubleshooting Sketch	3A-1	-
Tractor Wiring	3A-2	-
Control Panel Wiring	3A-3	-
Speed Control Wiring (26AE12C)	3A-4	-
Speed Control Wiring (26AE12D)	3A-5	-
Dash Panel Wiring	3A-6	-
Timer Assembly Wiring	4-6	26AE15
Battery Charger Subassembly	4-8.1	26AE15C
Dash Assembly	3A-7	-
Control Cabinet Assembly	3A-8	-
Control Panel Assembly	3A-9	-
Speed Control Assembly (26AE12C)	3A-10	-
Speed Control Assembly (26AE12D)	3A-11	-
Charger Cover Assembly	4-12	26AE15C
Front Axle Assembly	4-13	26AE15C
Steering Assembly	4-14	26AE15C
Rear Axle Assembly	4-15	26AE12A
Elec-Trak 2318 Transaxle	4-16	26AE15
Motor and Mounting Assembly	3A-12	-
Brake Assembly	4-18	26AE20B
Lift Assembly	4-19	26AE15C
Frame and Body Mounted Parts	3A-13	-
Miscellaneous Parts	3A-14	-

3A.1 THEORY OF OPERATION

A block diagram showing the major functional areas of the E12 will make the detailed information easier to understand. The interconnecting lines between the blocks show dependency of one area on another and also show the direction of control. Notice that house voltage is fed into the charger, changed to an appropriate d-c voltage, and is then fed to the power pack to recharge the cells. The connecting line returning to the charger indicates that battery condition is sampled by the charger to properly meter the charging rate. This sampling results in a high charging rate when the power pack is deeply discharged and a low charging rate when the fully charged state is attained. This rate change is fully automatic.

The accessory receptacle is wired directly to the power pack and is shown that way in Figure 3A-A. Actually, the power disconnect, fuse FU1, a circuit breaker, and a shunt (MS-1) are in this circuit, but are not considered essential elements in the block diagram.

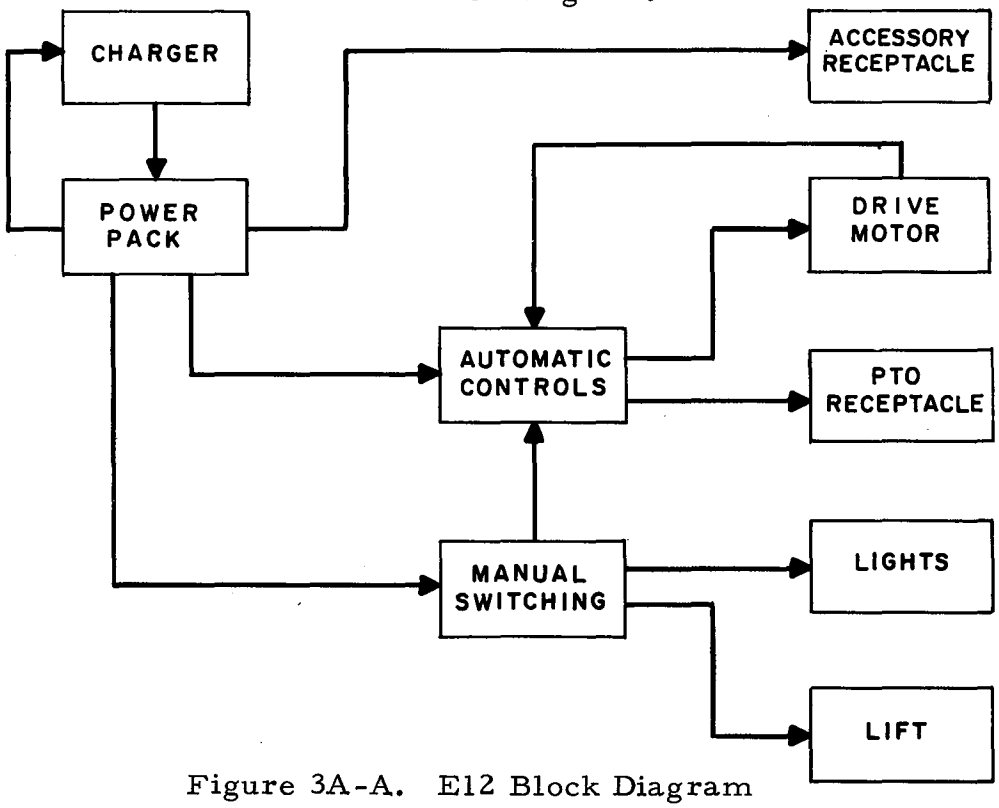


Figure 3A-A. E12 Block Diagram

Lift and light circuits are also powered by the power pack, but manual switching must be performed to operate these devices. The line drawn from the manual switching block to the automatic control block represents the control of all other manual switches. This includes the key, PTO, seat, brake, power pulse, and the four speed-control switches. All of these switches control functions of the E12 and their detailed operation is covered in the following pages.

Successful troubleshooting of the E12 Elec-Trak tractor requires an understanding of the performance during normal operation. Areas that the serviceman should become completely familiar with are the speed control and power pulse circuits. These areas will be examined individually, but with attention directed to the over-all tractor response.

Speed Control

The speed control is basically a mechanical device which actuates switches in an orderly sequence. These switches are actuated as high portions on the speed control cam contact the switch buttons as the cam is rotated.

In all, the speed control contains four switches which are of two types. They are as follows:

Start, Reverse Switches - Single-pole double-throw (SPDT) - Two current carrying positions one of which is normally closed.

1A, 2A Switches - Single-pole single-throw (SPST) - Normally open (NO), i. e. unactuated, the switch is open.

Locate each of these switches on the troubleshooting sketch and note that they are shown in their unactuated position.

As the speed control is slowly moved forward from the right-hand neutral position, the switches that are actuated are (in order):

1. Start switch
2. 1A switch
3. 2A switch

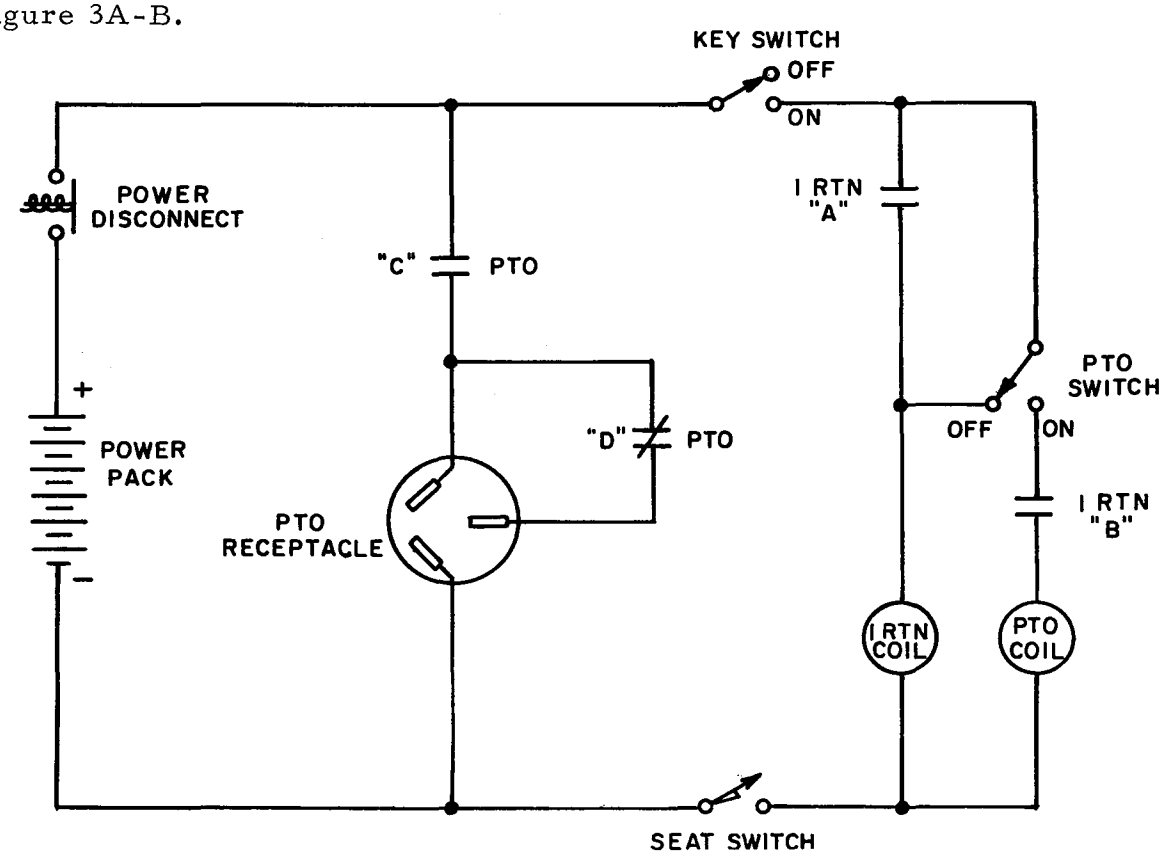
Once any switch is actuated it is held actuated in all the following speed control positions until the lever is moved toward neutral past its initial actuating position. For example, if the tractor were being operated in the third speed forward, the Start, 1A and 2A switches would all be actuated.

Operation of the speed control in reverse is much the same as forward operation. The only difference is that as the speed control lever is moved from the left-hand neutral towards the rear of the tractor, the first switch to actuate is the reverse switch. The switches that are actuated are (in order):

1. Reverse switch
2. Start switch
3. 1A switch

PTO

For instruction purposes, let's consider the PTO circuit simplified in Figure 3A-B.



Note: This drawing not for troubleshooting. See pages 3A-9 through 3A-18 and Figures 3A-1 through 3A-13 for troubleshooting.

Figure 3A-B. E12 PTO Circuit

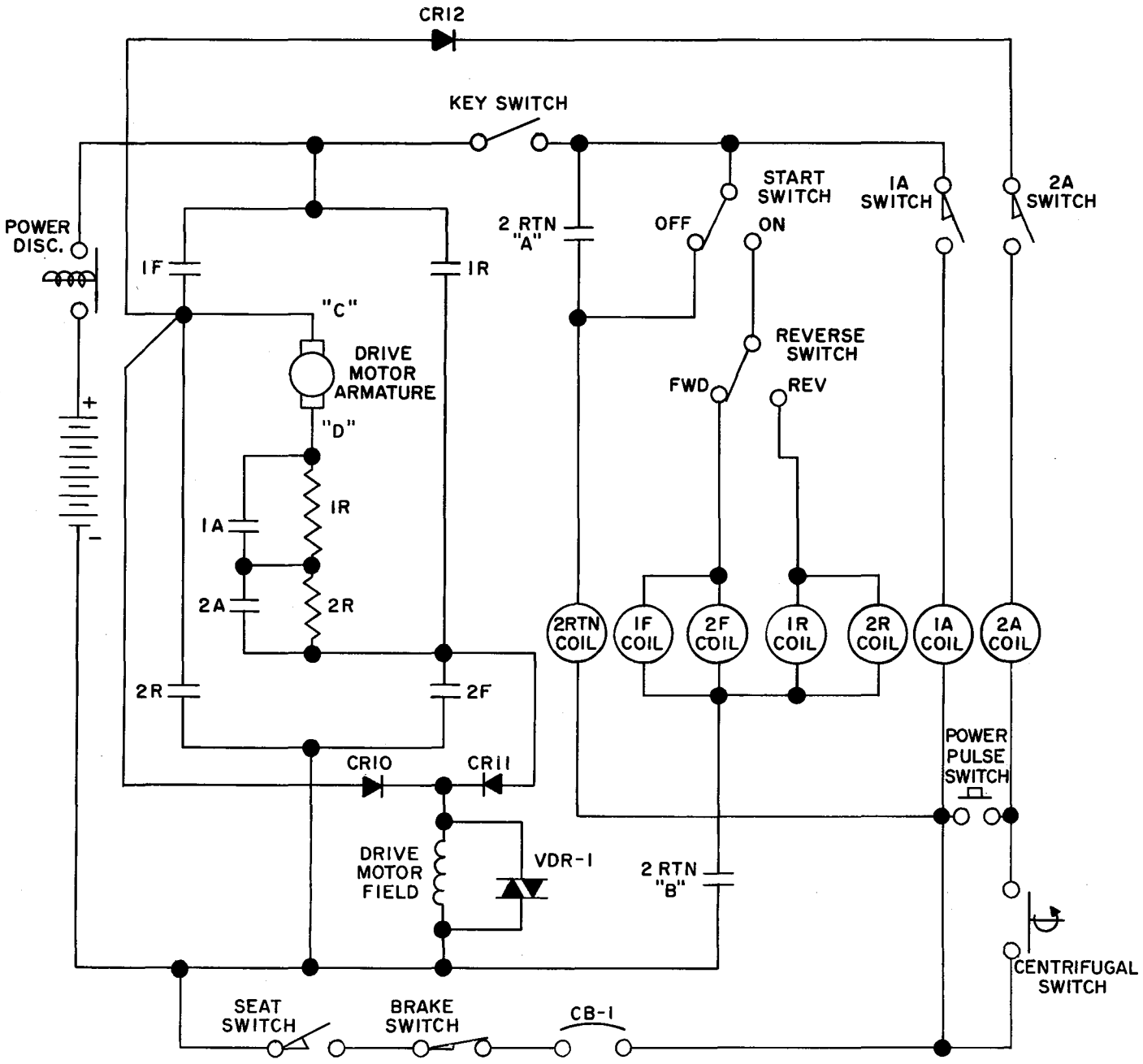
Assume the power disconnect is engaged (closed), an operator is on the seat, and the PTO switch is in the "Off" position. When the key switch is turned "On", a circuit is completed carrying current through the key switch, the PTO switch, the 1RTN coil, the seat switch, and back to the power pack. Notice that this current through 1RTN coil energizes (or actuates) it, which closes its normally-open contacts "A" and "B". With the pair of contacts labeled "A" closed, the PTO switch can be moved to "On" and the 1RTN coil will continue to be supplied with current. This action is referred to as "sealing in".

With the 1RTN coil sealed-in, the PTO switch can now be placed in the "On" position and another closed current path is produced through 1RTN contacts "B" and the PTO coil. Current through this coil closes contacts "C" and opens contacts "D". These contacts supply the PTO operated attachment with power and dynamic braking respectively.

Should the operator get off the seat with the mower running, the seat switch opens and interrupts the 1RTN coil and PTO coil current. Both coils are de-energized and the mower is dynamically braked. To re-start the mower, the PTO switch must be turned to "Off" to seal-in the 1RTN coil and then to "On" to energize the PTO coil.

Speed Control Circuit

In examining the "Start" circuit, simplified in Figure 3A-C, it is seen the sealing-in circuit is repeated, but there are two contactors to be actuated in the "On" position in forward and two others in reverse, namely, 1F and 2F, and 1R and 2R. The state of the reverse switch selects which pair of contactors are energized.



Note: This drawing not for troubleshooting. See pages 3A-9 through 3A-18 and Figures 3A-1 through 3A-13 for troubleshooting.

Figure 3A-C. E12 Drive Motor Circuit and Control

When the speed control is moved to the start position in forward, contacts 1F and 2F close and their mechanical coupling with 1R and 2R respectively, guarantee that 1R and 2R are open. Now armature current flows from "C" to "D" and the drive motor armature rotates.

When the speed control is moved into reverse, subsequent closure of the start switch energizes contactors 1R and 2R, closing these contacts and forcing open 1F and 2F. Armature current now flows from point "D" to "C" and the armature rotates in the reverse direction.

When the seat switch, brake switch, or circuit breaker CB-1 opens, 2RTN contacts open. This in turn causes the starting contactors (1F and 2F, or 1R and 2R) to open and interrupt drive motor power as they seek a center neutral position.

1A, 2A Contactors

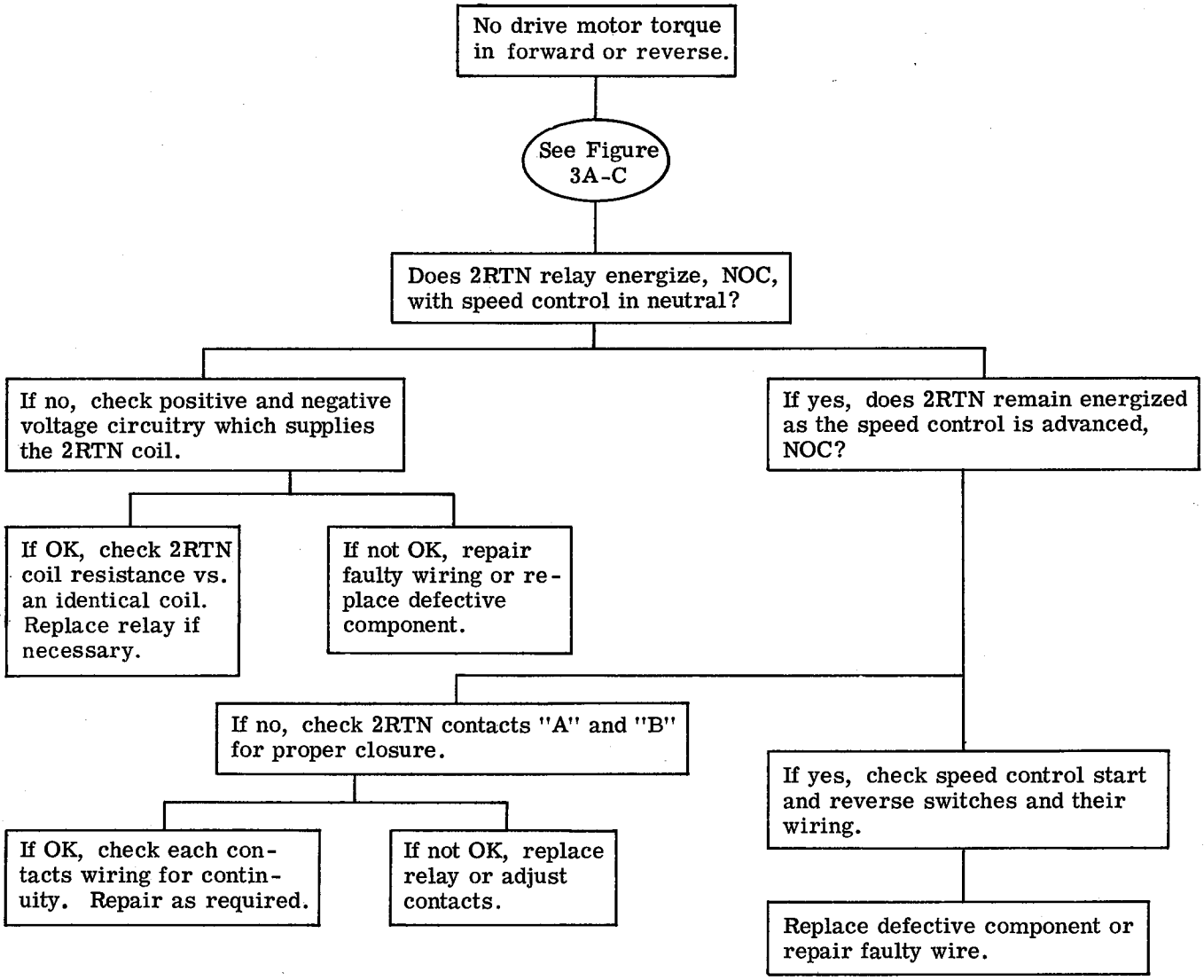
Developing the circuitry further, operation of contactor 1A is the same as the E20 model, i. e. when the 1A speed control switch is actuated, voltage is applied to the 1A contactor coil. When the 1A contacts close, resistor R1 is bypassed and additional armature voltage is available, giving a motor speed increase.

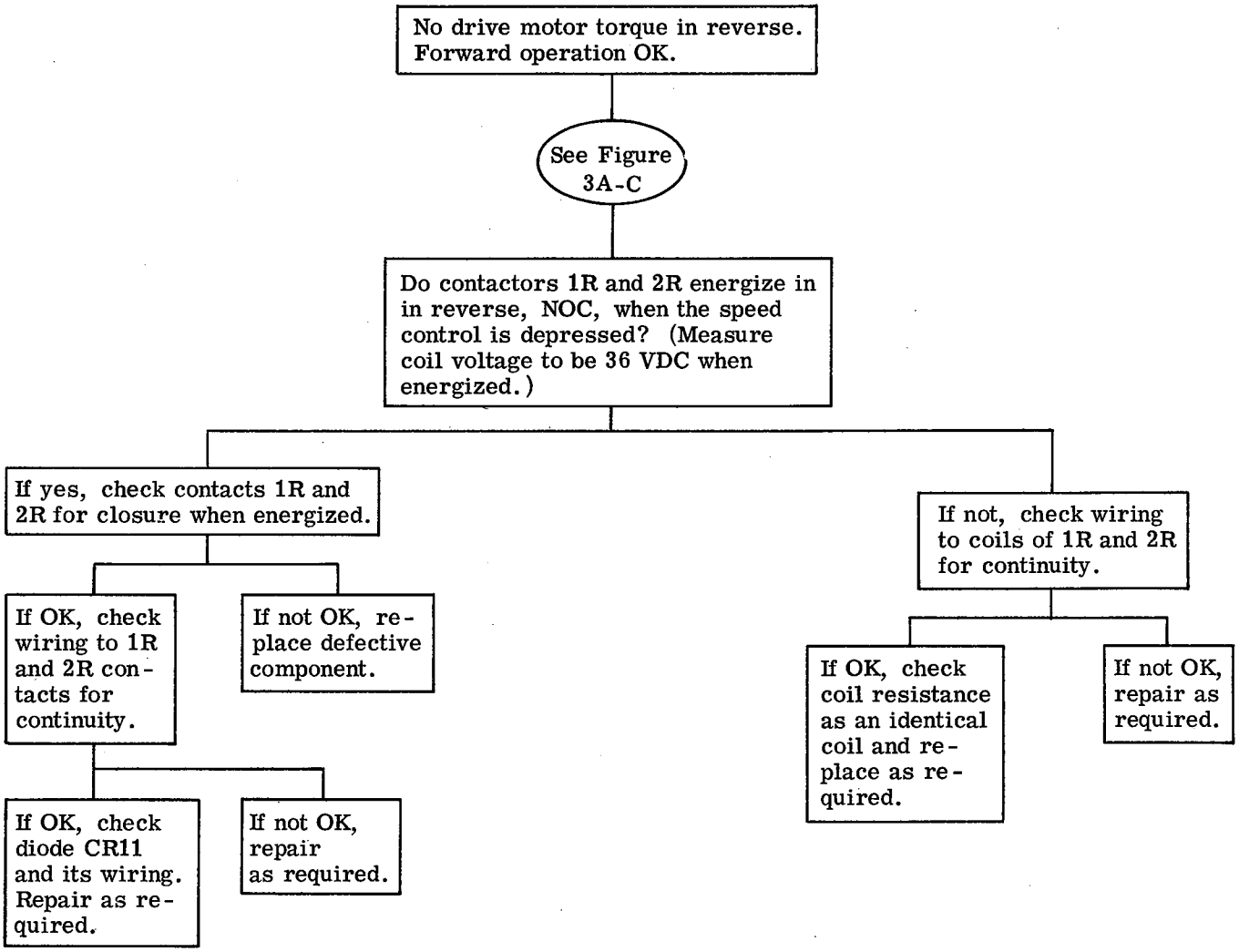
Resistor R2 is effectively removed in this fashion when the 2A switch energizes the 2A contactor, except that the drive motor armature must be turning fast enough to close its centrifugal switch before the negative return path to the 2A coil is established. Momentary depression of the power pulse switch button when the speed control is fully forward and the armature is not turning bypasses the centrifugal switch so that contactor 2A energizes and forward motion is obtained. This action may be required to regain motion after stopping during an uphill climb.

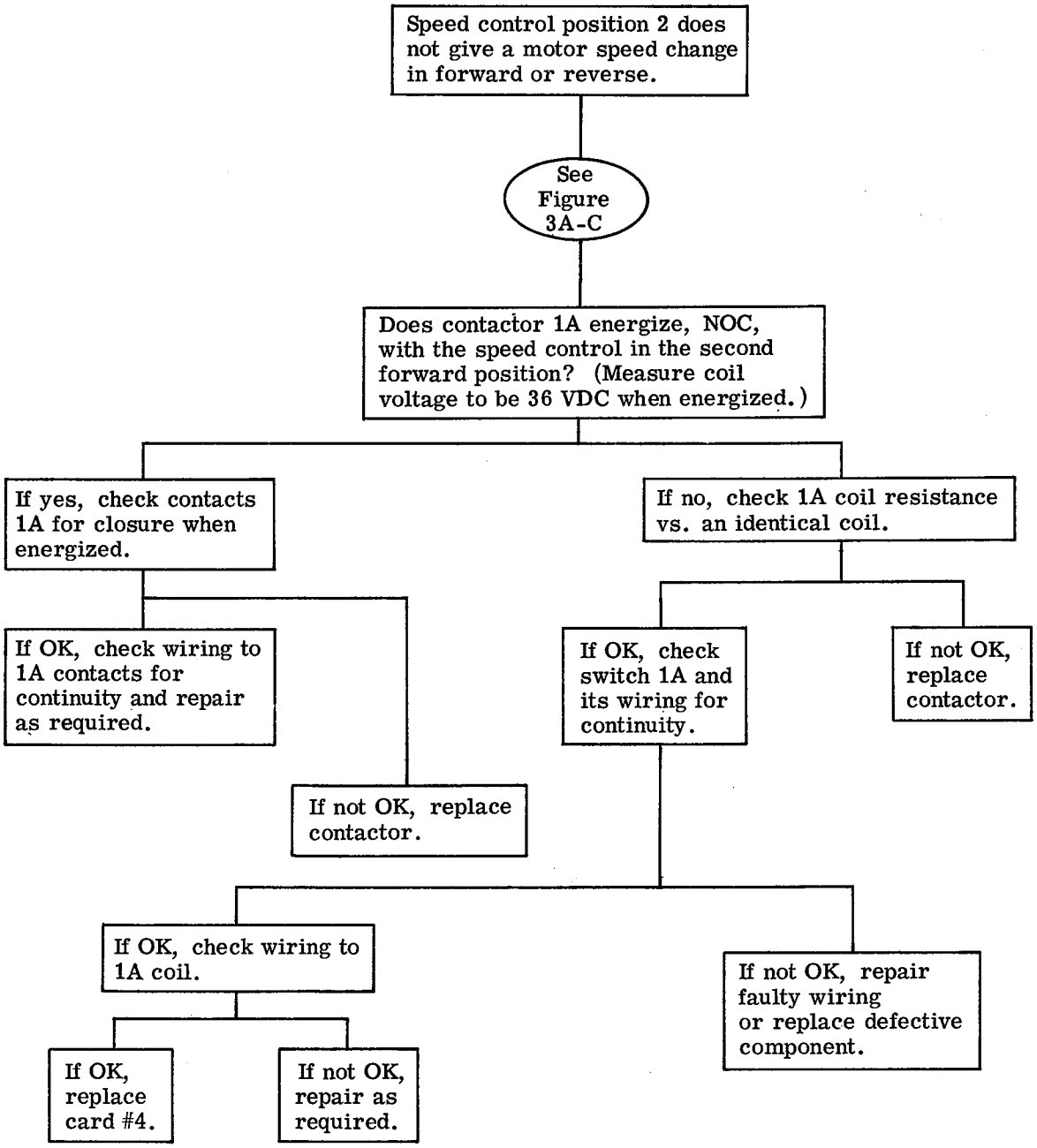
Notice that positive 36-volts d-c is available to 2A only when contacts 1F are closed, which means 2A can energize only in forward. In reverse the equivalent of 1F is 1R and when 1R is closed a negative potential is carried to the 2A coil and therefore the coil cannot be energized.

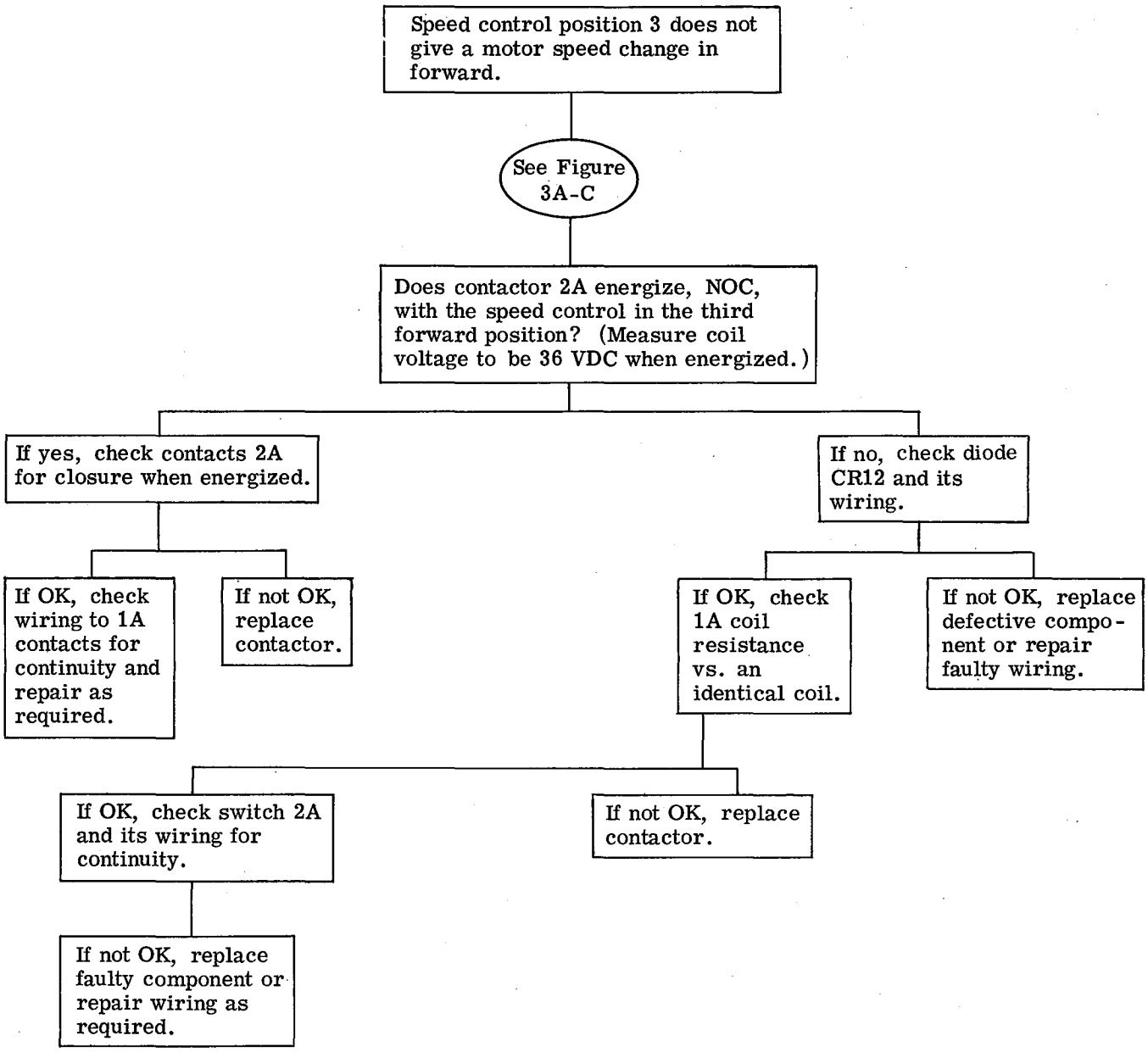
Charger, Lift, Lights, Accessory Receptacle

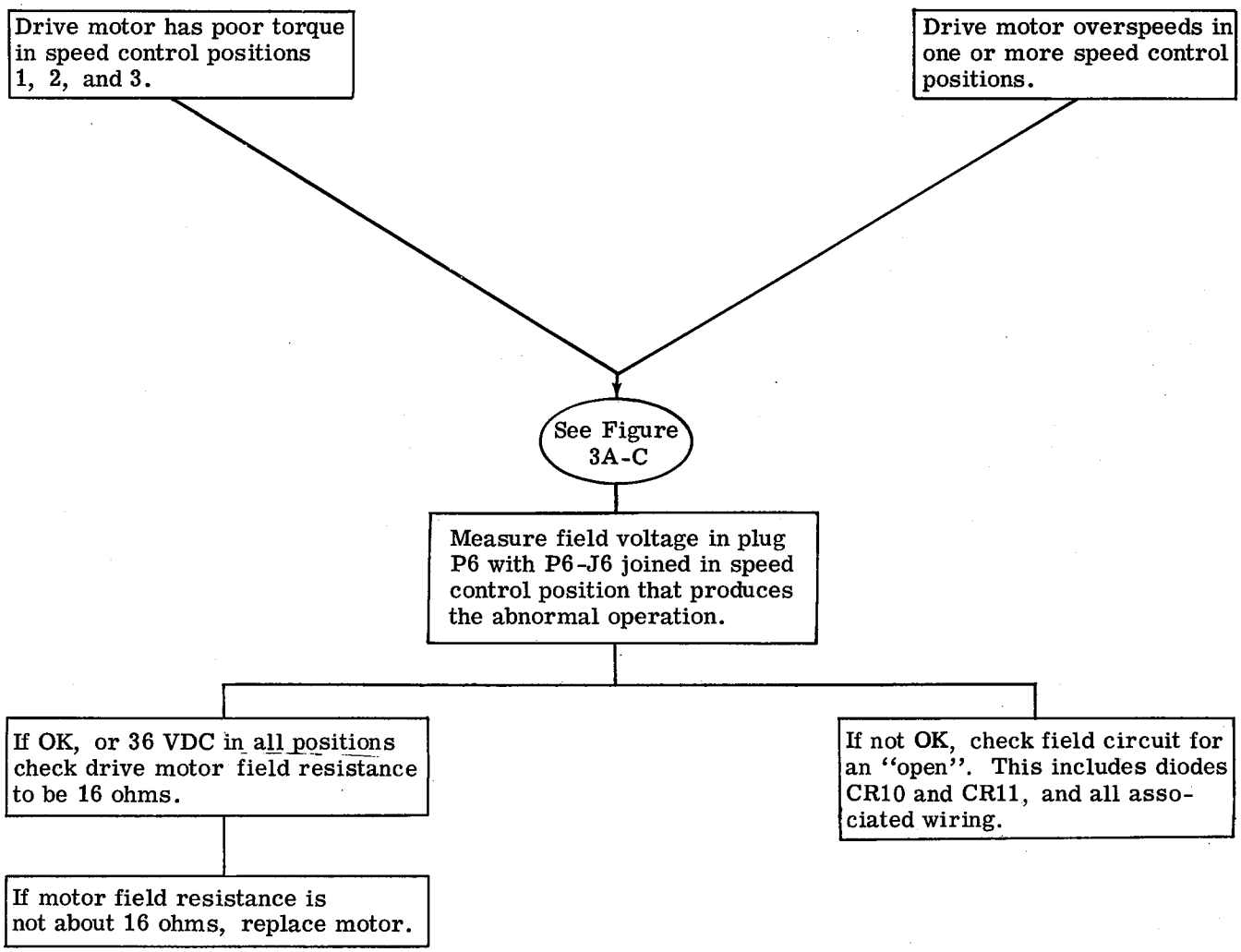
The charger, lift, light, and accessory receptacle circuits are identical to those of the E15 except for wire numbering and some of the physical wire connection points. Refer to the E15 section for operation information.

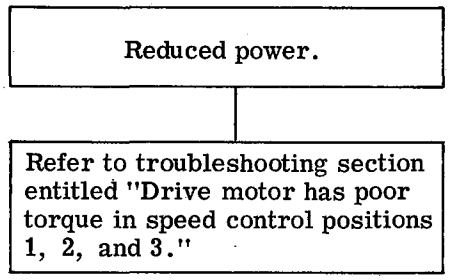

No drive motor torque in forward or reverse.
See Figure 3A-C
Does 2RTN relay energize, NOC, with speed control in neutral?
If no, check positive and negative voltage circuitry which supplies the 2RTN coil.
If yes, does 2RTN remain energized as the speed control is advanced, NOC?
If OK, check 2RTN coil resistance vs. an identical coil. Replace relay if necessary.
If not OK, repair faulty wiring or replace defective component.
If no, check 2RTN contacts "A" and "B" for proper closure.
If yes, check speed control start and reverse switches and their wiring.
If OK, check each contacts wiring for continuity. Repair as required.
If not OK, replace relay or adjust contacts.
Replace defective component or repair faulty wire.

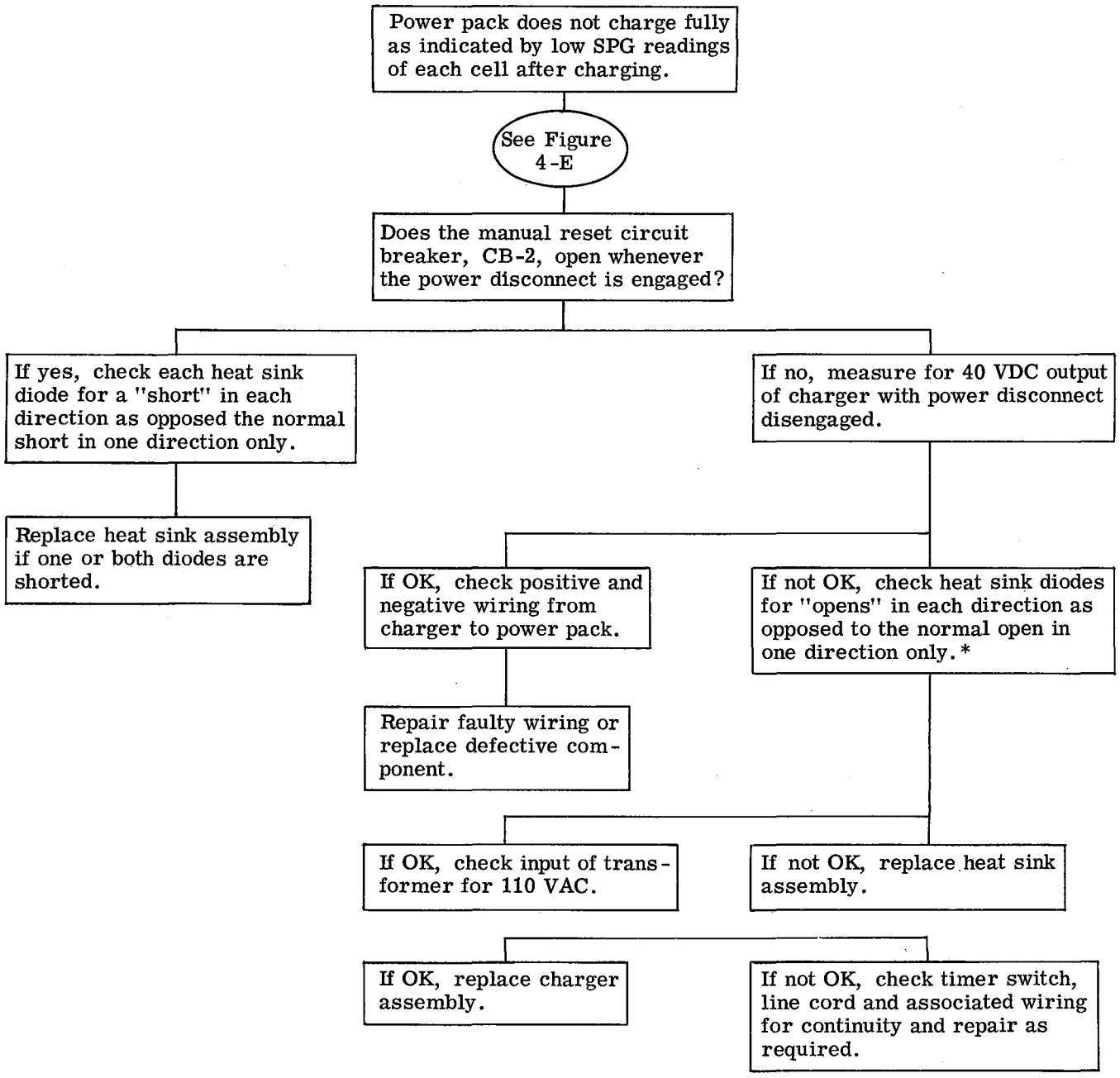

No drive motor torque in reverse. Forward operation OK.
See Figure 3A-C
Do contactors 1R and 2R energize in in reverse, NOC, when the speed control is depressed? (Measure coil voltage to be 36 VDC when energized.)
If yes, check contacts 1R and 2R for closure when energized.
If not, check wiring to coils of 1R and 2R for continuity.
If OK, check wiring to 1R and 2R contacts for continuity.
If not OK, replace defective component.
If OK, check coil resistance as an identical coil and replace as required.
If not OK, repair as required.
If OK, check diode CR11 and its wiring. Repair as required.
If not OK, repair as required.


Speed control position 2 does not give a motor speed change in forward or reverse.
See Figure 3A-C
Does contactor 1A energize, NOC, with the speed control in the second forward position? (Measure coil voltage to be 36 VDC when energized.)
If yes, check contacts 1A for closure when energized.
If no, check 1A coil resistance vs. an identical coil.
If OK, check wiring to 1A contacts for continuity and repair as required.
If not OK, replace contactor.
If OK, check switch 1A and its wiring for continuity.
If not OK, replace contactor.
If OK, check wiring to 1A coil.
If not OK, repair faulty wiring or replace defective component.
If OK, replace card #4.
If not OK, repair as required.

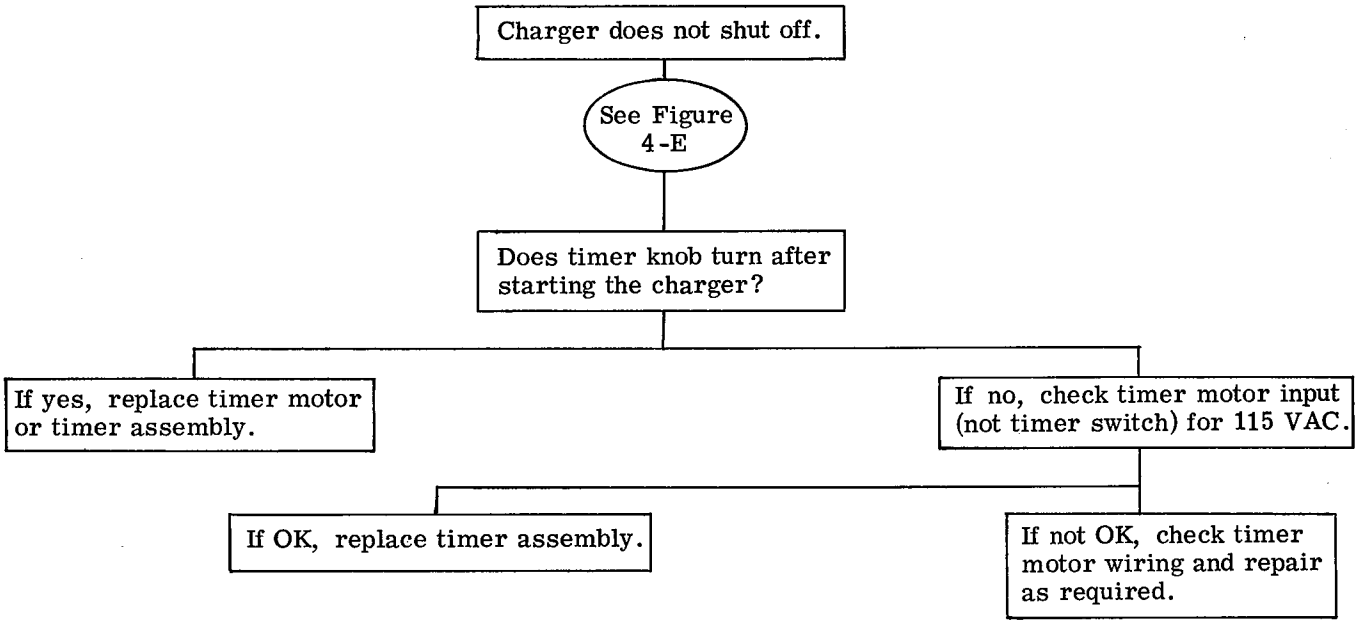

Speed control position 3 does not give a motor speed change in forward.
See Figure 3A-C
Does contactor 2A energize, NOC, with the speed control in the third forward position? (Measure coil voltage to be 36 VDC when energized.)
If yes, check contacts 2A for closure when energized.
If no, check diode CR12 and its wiring.
If OK, check wiring to 1A contacts for continuity and repair as required.
If not OK, replace contactor.
If OK, check 1A coil resistance vs. an identical coil.
If not OK, replace defective component or repair faulty wiring.
If OK, check switch 2A and its wiring for continuity.
If not OK, replace contactor.
If not OK, replace faulty component or repair wiring as required.

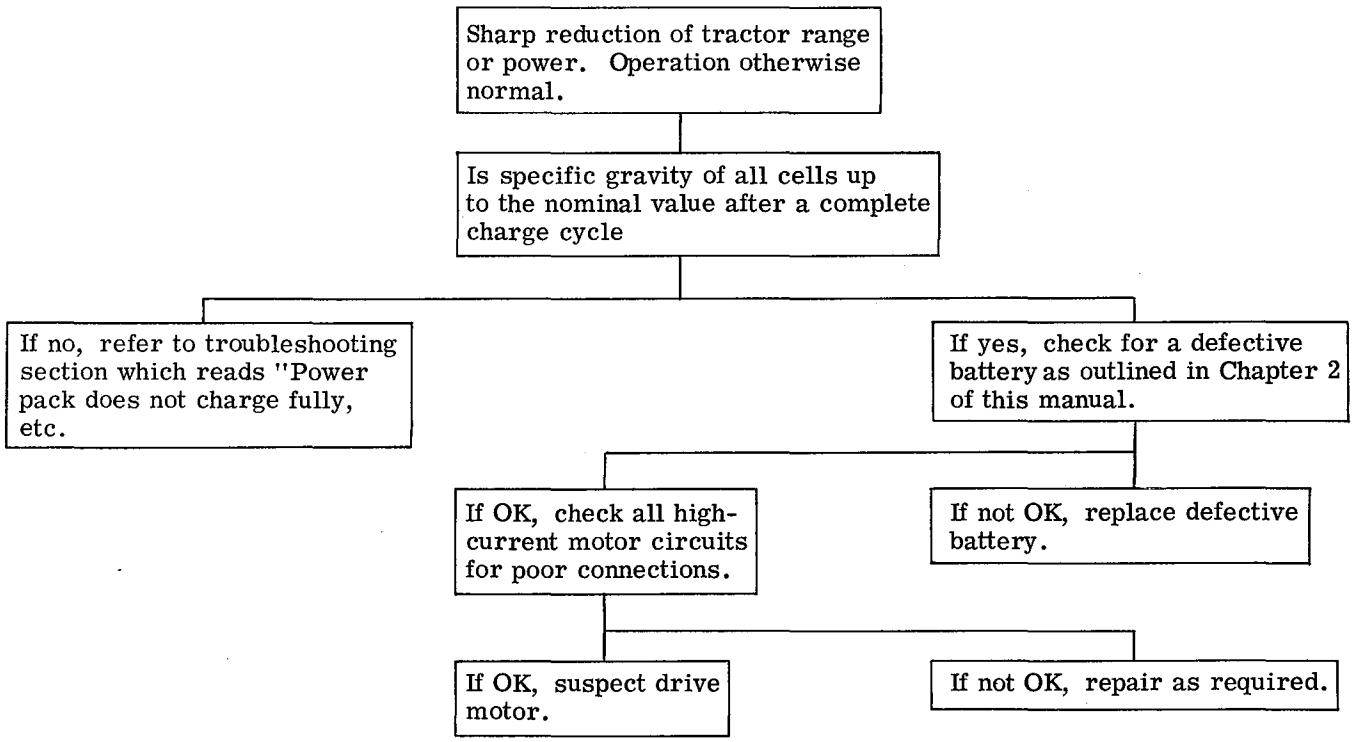

Drive motor has poor torque in speed control positions 1, 2, and 3.
Drive motor overspeeds in one or more speed control positions.
See Figure 3A-C
Measure field voltage in plug P6 with P6-J6 joined in speed control position that produces the abnormal operation.
If OK, or 36 VDC in all positions check drive motor field resistance to be 16 ohms.
If not OK, check field circuit for an "open". This includes diodes CR10 and CR11, and all associated wiring.
If motor field resistance is not about 16 ohms, replace motor.

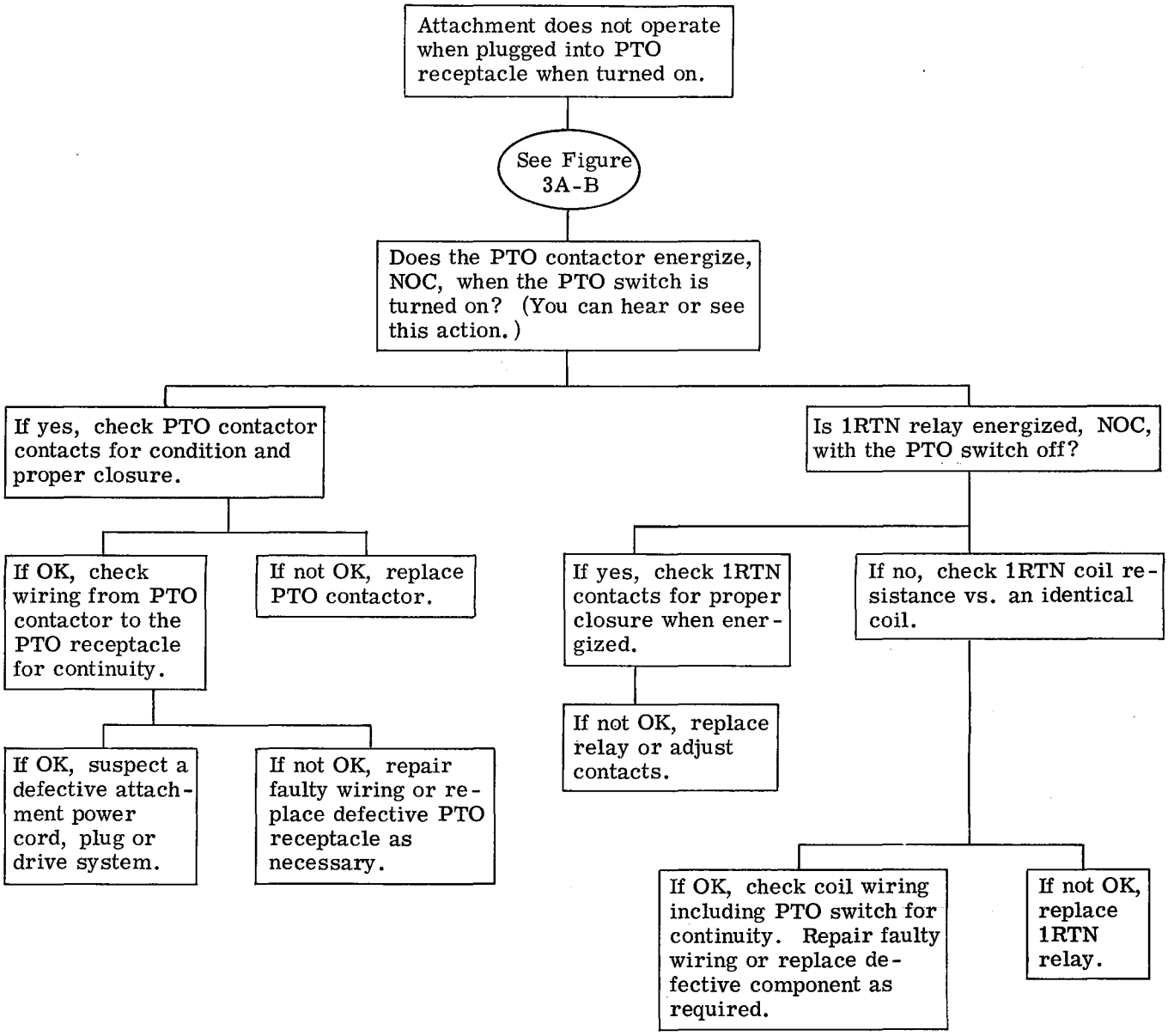

Reduced power.
Refer to troubleshooting section entitled "Drive motor has poor torque in speed control positions 1, 2, and 3."

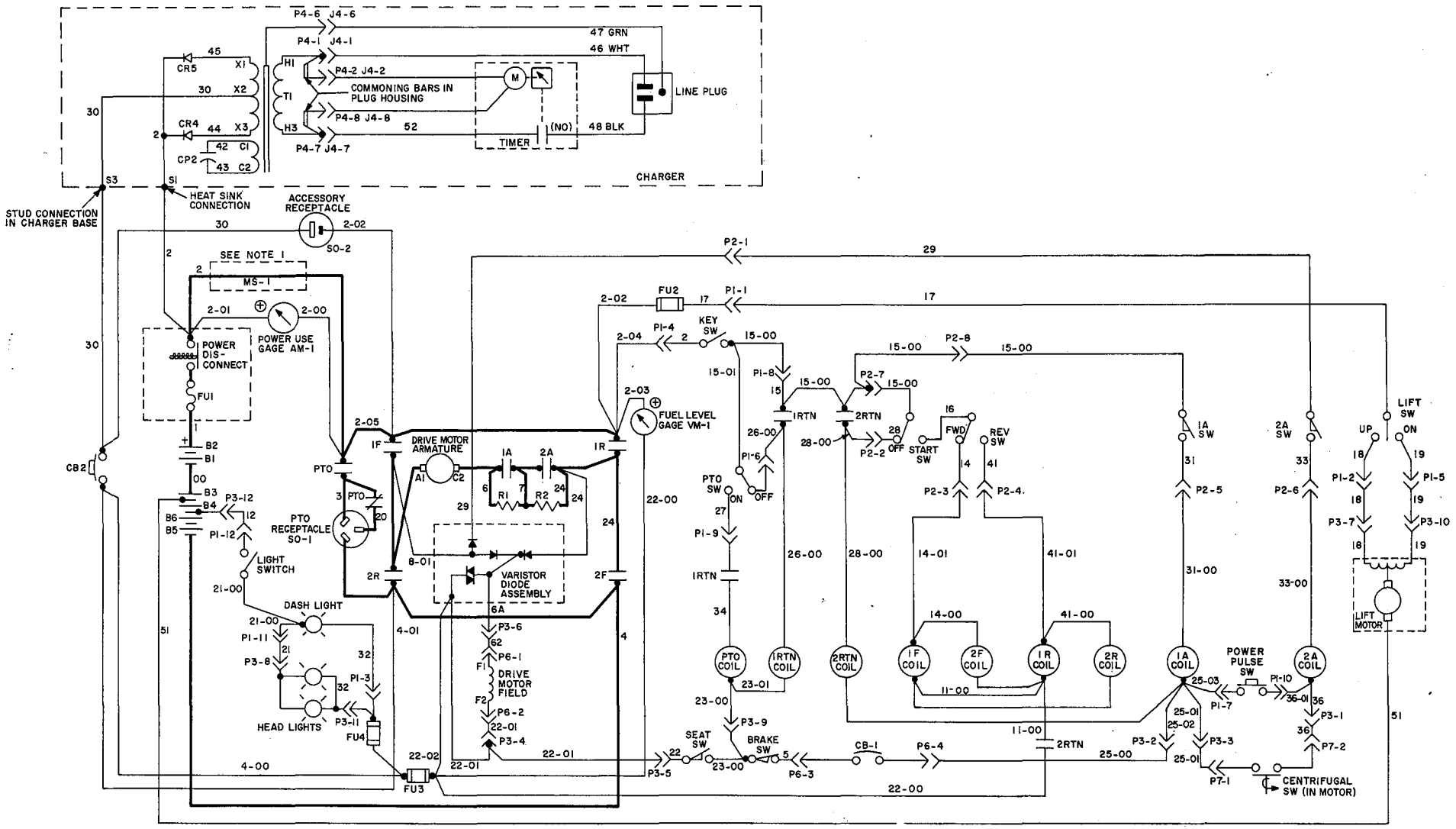


*Since both diodes are in parallel, one of the diode wires must be removed before either diode can be checked for an "open". Removing a wire is not necessary to check for a short.


Charger does not shut off.
See Figure 4-E
Does timer knob turn after starting the charger?
If yes, replace timer motor or timer assembly.
If no, check timer motor input (not timer switch) for 115 VAC.
If OK, replace timer assembly.
If not OK, check timer motor wiring and repair as required.


Sharp reduction of tractor range or power. Operation otherwise normal.
Is specific gravity of all cells up to the nominal value after a complete charge cycle
If no, refer to troubleshooting section which reads "Power pack does not charge fully, etc.
If yes, check for a defective battery as outlined in Chapter 2 of this manual.
If OK, check all high-current motor circuits for poor connections.
If not OK, replace defective battery.
If OK, suspect drive motor.
If not OK, repair as required.


Attachment does not operate when plugged into PTO receptacle when turned on.
See Figure 3A-B
Does the PTO contactor energize, NOC, when the PTO switch is turned on? (You can hear or see this action.)
If yes, check PTO contactor contacts for condition and proper closure.
If OK, check wiring from PTO contactor to the PTO receptacle for continuity.
If not OK, replace PTO contactor.
If OK, suspect a defective attachment power cord, plug or drive system.
If not OK, repair faulty wiring or replace defective PTO receptacle as necessary.
Is 1RTN relay energized, NOC, with the PTO switch off?
If yes, check 1RTN contacts for proper closure when energized.
If not OK, replace relay or adjust contacts.
If no, check 1RTN coil resistance vs. an identical coil.
If OK, check coil wiring including PTO switch for continuity. Repair faulty wiring or replace defective component as required.
If not OK, replace 1RTN relay.



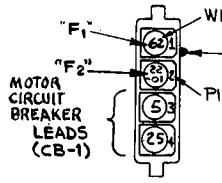
NOTES: SHUNT MS-1 IS A 20" LENGTH OF 6 AWG CABLE

Figure 3A-1 E12 Troubleshooting Sketch

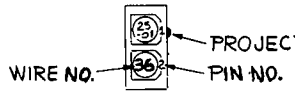
NOTE:

1. CABLE CONNECTION FROM LINE DISCONNECT TO PTO CONTACTOR MUST BE 18.25 INCHES OF # 6 AWG.
2. → INDICATES CONNECTIONS TO BE MADE UPON INSTALLATION OF PANEL INTO TRACTOR.
3. WIRE FROM CONTROL PANEL CABLE HARNESS.

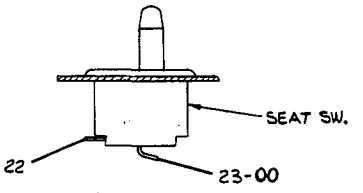
This figure is not intended to show complete wiring. It is to be used for component and significant wire location only.



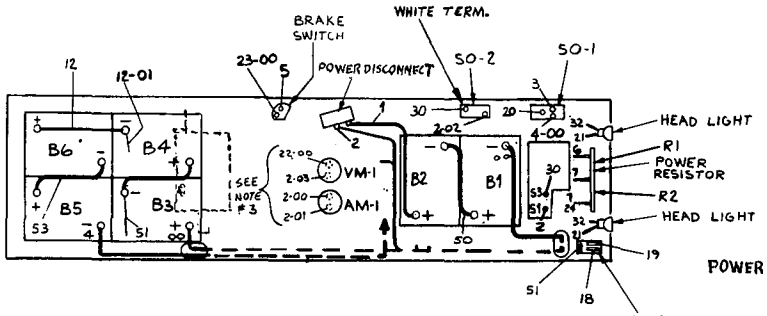
J6 BACKVIEW

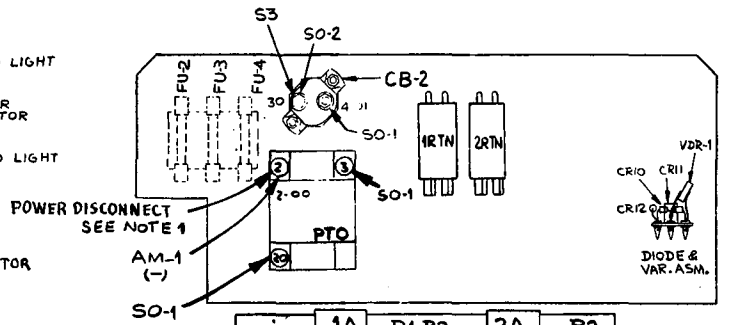


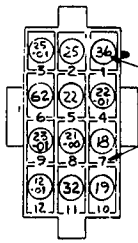
J7 BACKVIEW



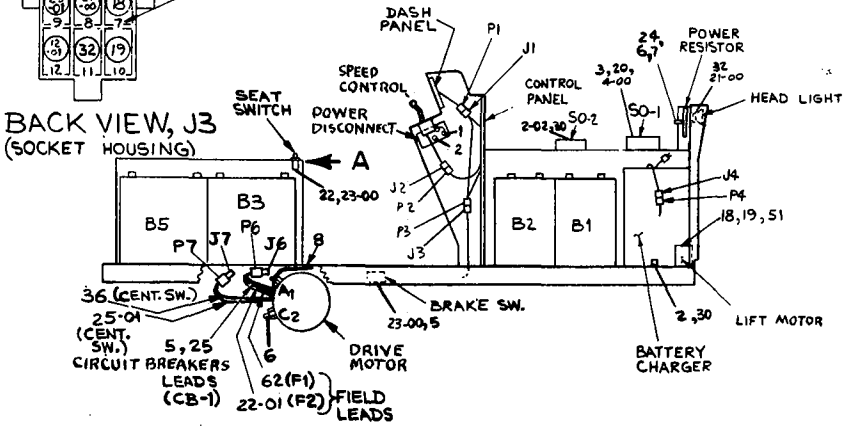
ENLARGED VIEW "A"

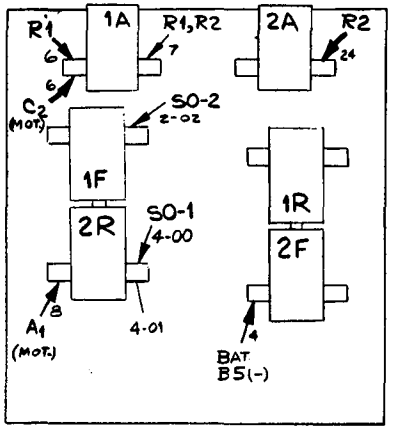






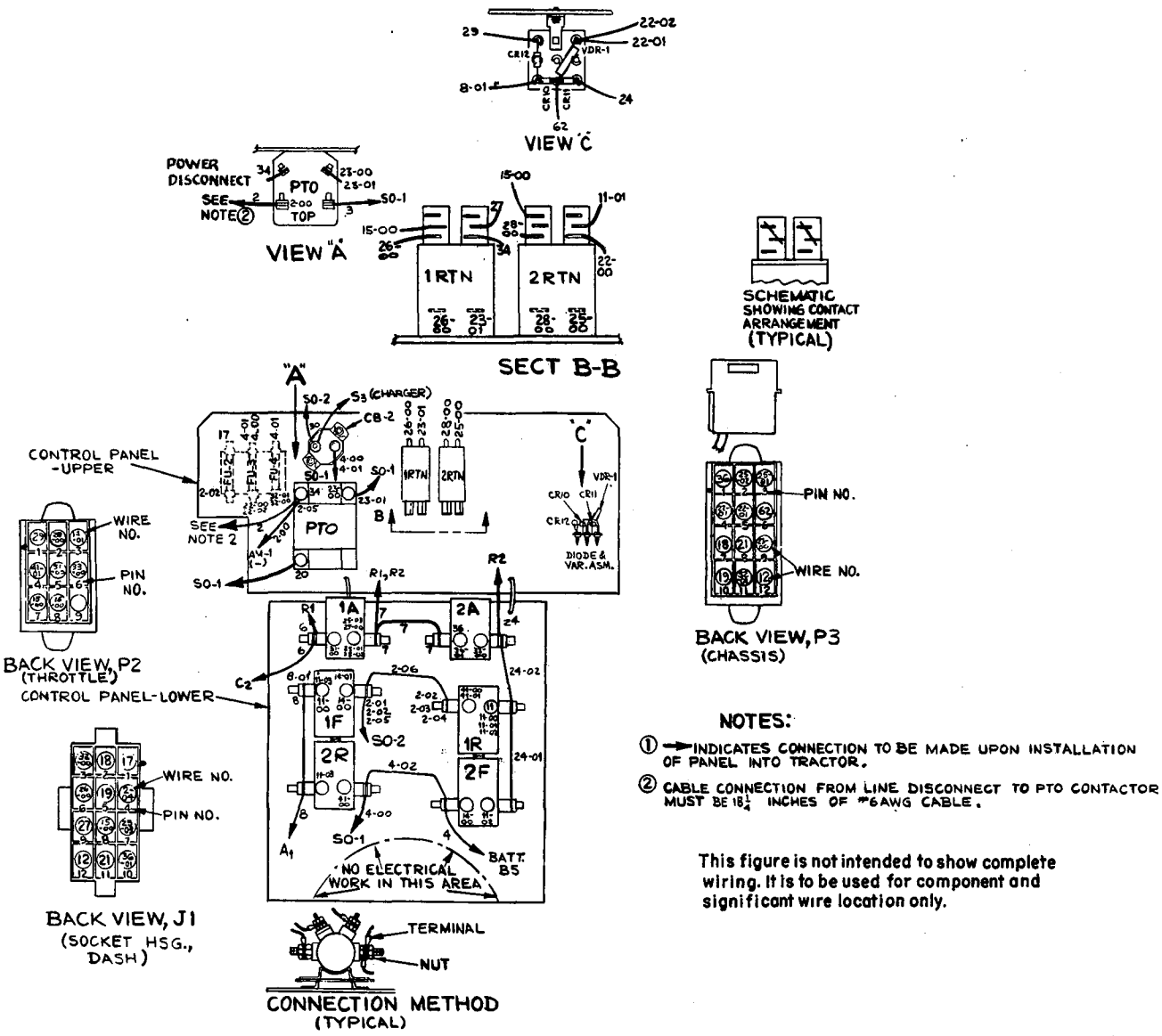
BACK VIEW, J3 (SOCKET HOUSING)





CONTROL PANEL DIAGRAM

Figure 3A-2 E12 Tractor Wiring



NOTES:

① → INDICATES CONNECTION TO BE MADE UPON INSTALLATION OF PANEL INTO TRACTOR.

② CABLE CONNECTION FROM LINE DISCONNECT TO PTO CONTACTOR MUST BE 18¼ INCHES OF #6 AWG CABLE.

This figure is not intended to show complete wiring. It is to be used for component and significant wire location only.

Figure 3A-3 E12 Control Panel Wiring

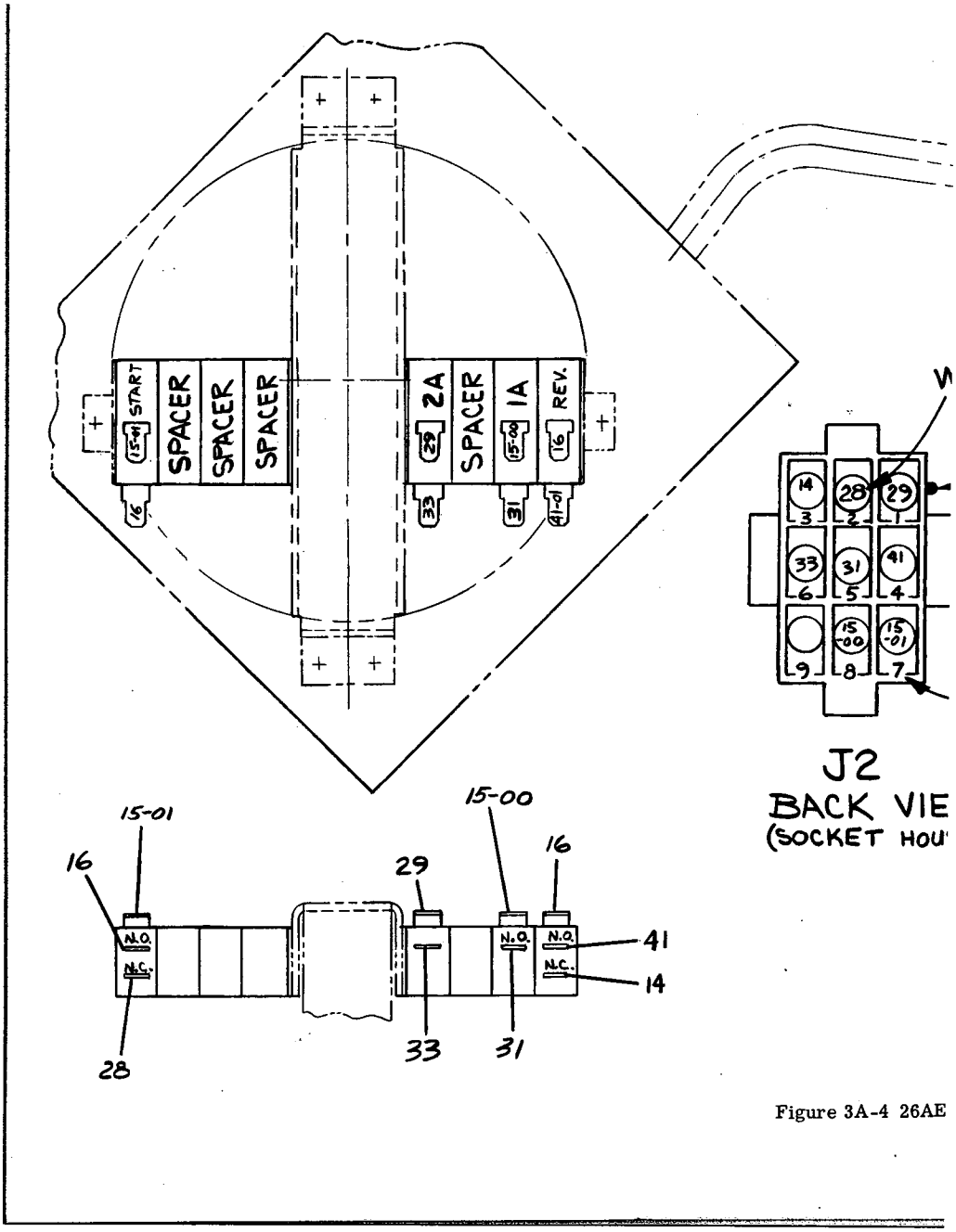


Figure 3A-4 26AE

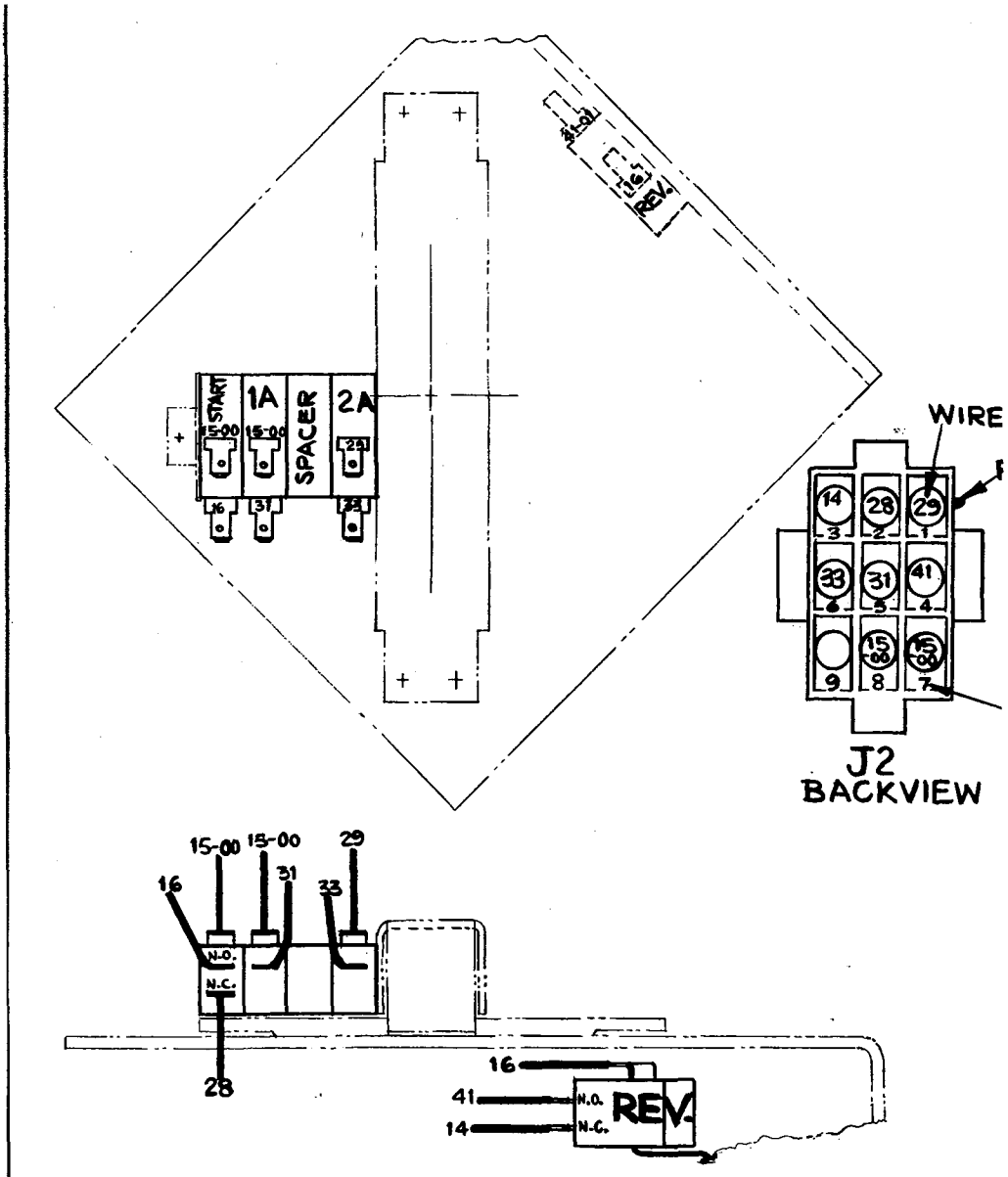


Figure 3A-5 26AE12D

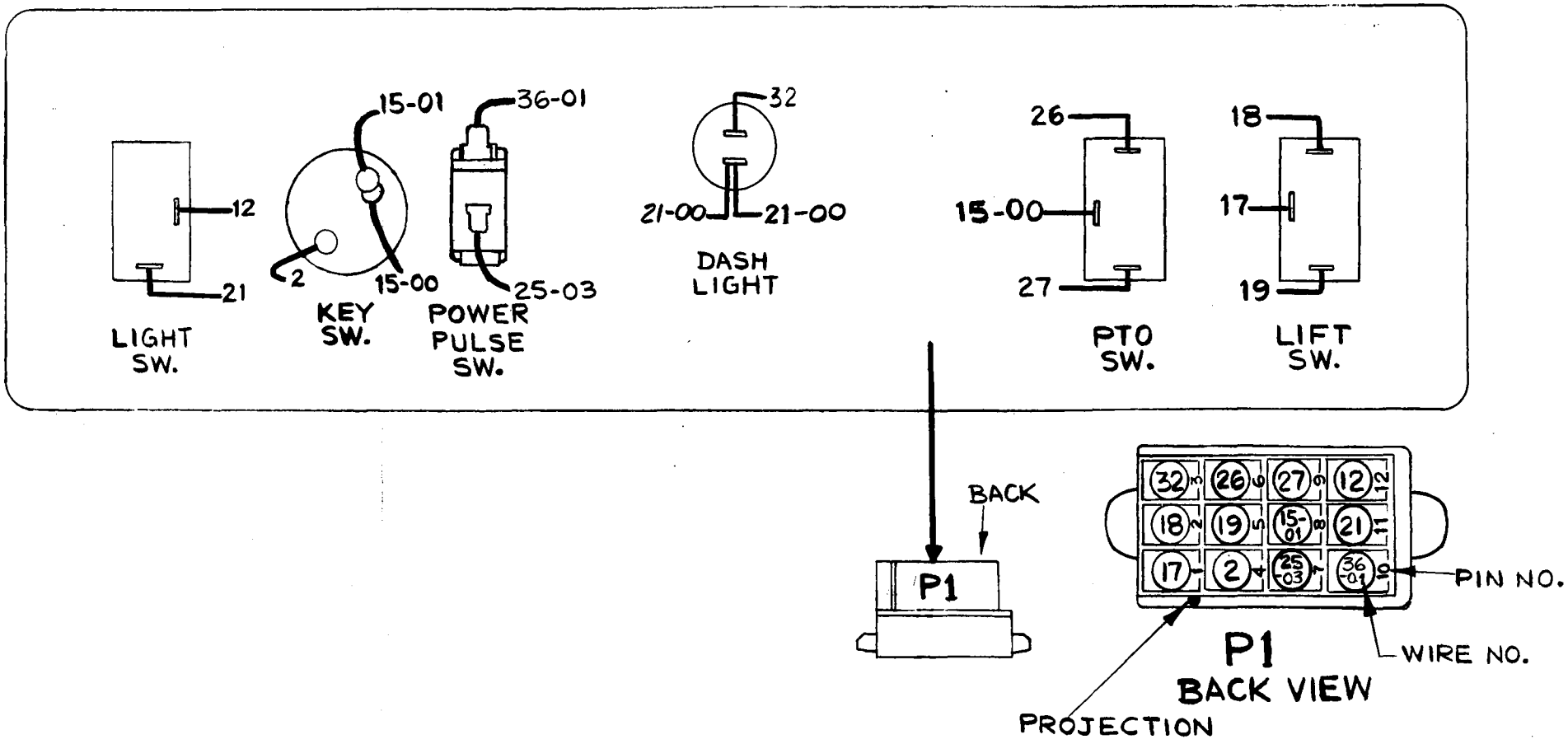


Figure 3A-6 E12 Dash Panel Wiring

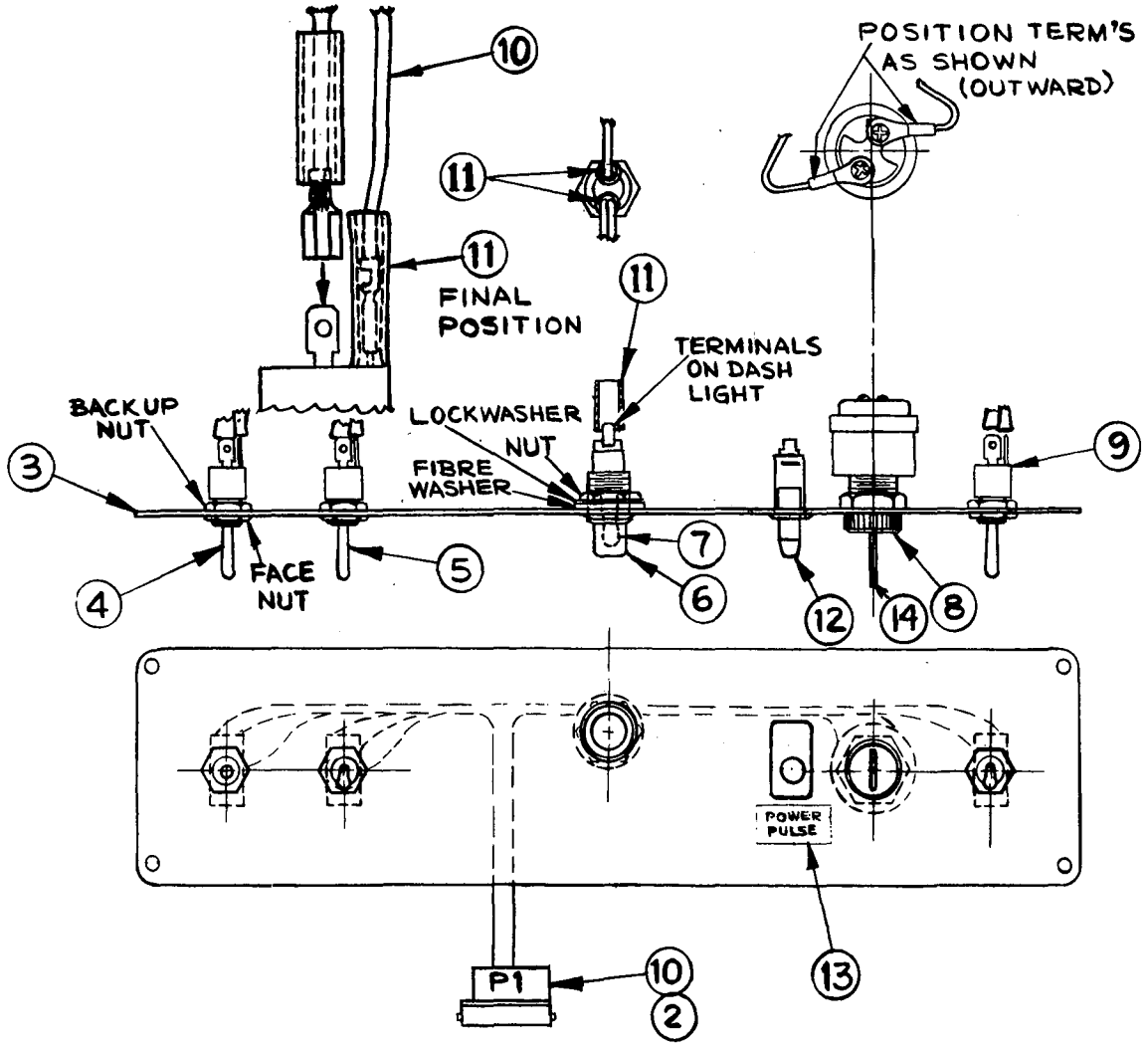


Figure 3A-7 E12 Dash Assembly

DASH ASSEMBLY
Use this list to order replacement parts from Fig. 3A-7.

Ref. No.	Description	Part Number	26A						
			E12C	E12D					
1	Dash Assembly (All parts as shown)	178B8133G1	X	X					
3	Dash Panel	178B8132P1	X	X					
4	Lift Switch	243A4531P2	X	X					
5	PTO Switch	243A4531P1	X	X					
6	Light	243A4574P1	X	X					
7	Lamp Assembly	211A3591P1	X	X					
8	Key Switch (With Key)	243A4573P1	X	X					
9	Light Switch	243A4531P3	X	X					
10	Dash Harness	541C967G1	X	X					
11	Tubing	211A3551P1	X	X					
12	Power Pulse Switch	243A4790P1	X	X					
13	Power Pulse Decal	244A7088P1	X	X					
14	Key (On-Off)	211A3597P1	X	X					

CONTROL CABINET ASSEMBLY

Use this list to order replacement parts from Fig. 3A-8.

Ref. No.	Description	Part Number	26A						
			E12C	E12D					
2	Control Cabinet	423D260P1	X	X					
3	Dash Assembly	See Fig. 3A-7	X	X					
4	Control Panel Assembly	See Fig. 3A-9	X	X					
5	Thread Rolling Screw	N722AP15008	X	X					
6	Speed Control Assembly	See Fig. 3A-10 and 3A-11	X	X					
7	Cover	542C868P2	X	X					
8	Thread Rolling Screw	N722AP15006C6	X	X					
9	Power Disconnect	163B9923G1	X	X					
10	Fuel Level Gage (VM-1)	243A4629G1	X	X					
11	Power Use Gage (AM-1)	243A4630G2	X	X					
12	Bearing	211A3101P1	X	X					
13	Cap Screw, Hex Head 5/16-18 x 1/2	See Note 1	X	X					
14	Lockwasher 5/16	See Note 1	X	X					
15	Decal	541C681P1	X	X					
22	Thread Rolling Screw	N722AP15008C6	X	X					

(1) Not stocked. Order locally. For bolt and screw replacement use Grade 5 or better.

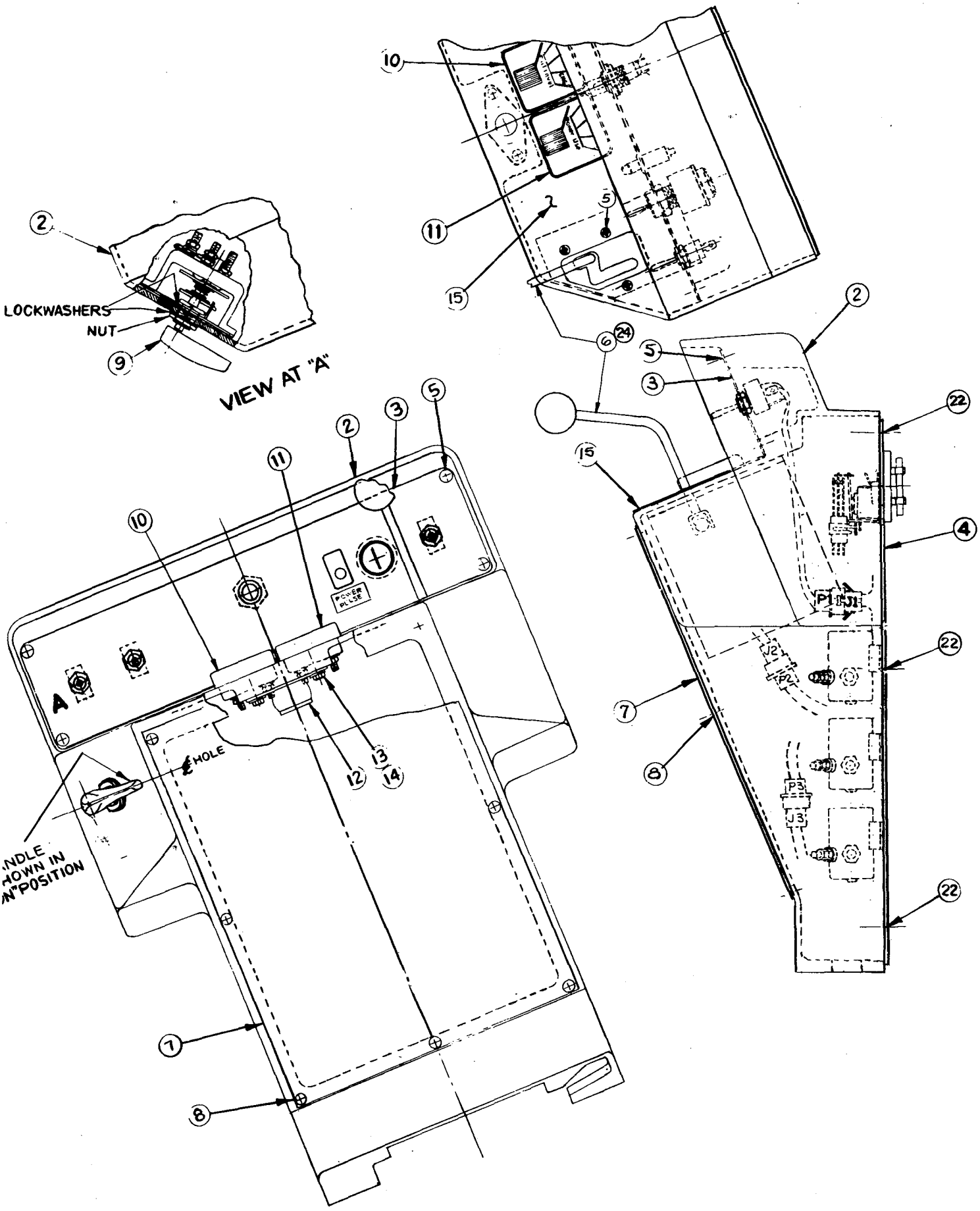


Figure 3A-8 E12 Control Cabinet Assembly

CONTROL PANEL ASSEMBLY

Use this list to order replacement parts from Fig. 3A-9.

Ref. No.	Description	Part Number	26A						
			E12C	E12D					
4	Panel (Upper)	178B8005P1	X	X					
5	Panel (Lower)	178B8006P1	X	X					
6	Circuit Breaker (Manual Reset)	243A4719P1	X	X					
7	Screw, Hex Head Machine, 10-32 x 3/4	See Note 1	X	X					
8	Lockwasher, Spring, #10	See Note 1	X	X					
9	Nut, Hex, 10-32	See Note 1	X	X					
10	Relay	243A4562P1	X	X					
11	Screw, Hex Head Machine, 8-32 x 3/8	See Note 1	X	X					
12	Lockwasher, Spring, #8	See Note 1	X	X					
13	PTO Contactor	243A4524P1	X	X					
14	Screw, Thread Rolling	N722AP16008C	X	X					
15	Fuse Block	243A4807P1	X	X					
16	Screw, Hex Head Machine, 6-32 x 3/8	See Note 1	X	X					
17	Fuse (FU-2)	243A4597P1	X	X					
18	Fuse (FU-3, FU-4)	243A4657P1	X	X					
19	Contactor (Power)	211A3567P1	X	X					
20	Screw, Thread Rolling	N722AP16006C	X	X					
21	Washer, Spring, 1/4"	See Note 1	X	X					
22	Control Panel Harness	423D229G1	X	X					
23	Grill Harness	541C944G1	X	X					
24	Cable Tie	243A4540P2	X	X					
25	Diode and Varistor Assembly	243A4970G1	X	X					
26	Screw, Hex Head Machine	N722AP13006C	X	X					
27	Lockwasher, Spring, #6	See Note 1	X	X					
28	Tubing, Insulation	211A3552P1	X	X					
29	Fuse Decal	211A3528P1	X	X					
30	Contactor, Double	178B8009P1	X	X					
31	Nut, Hex, 6-32	See Note 1	X	X					

(1) Not stocked. Order locally. For bolt and screw replacement use Grade 5 or better.

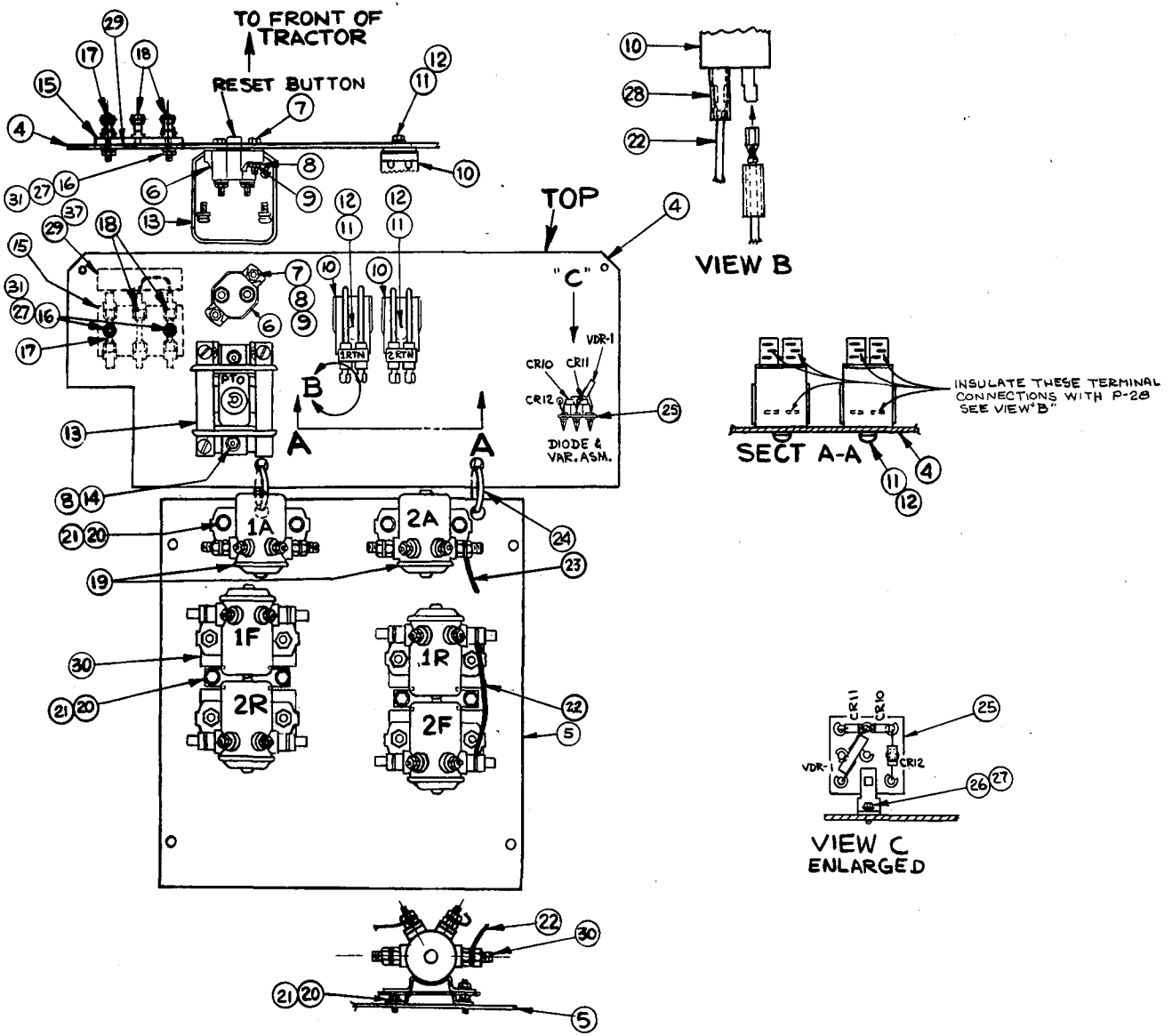


Figure 3A-9 E12 Control Panel Assembly

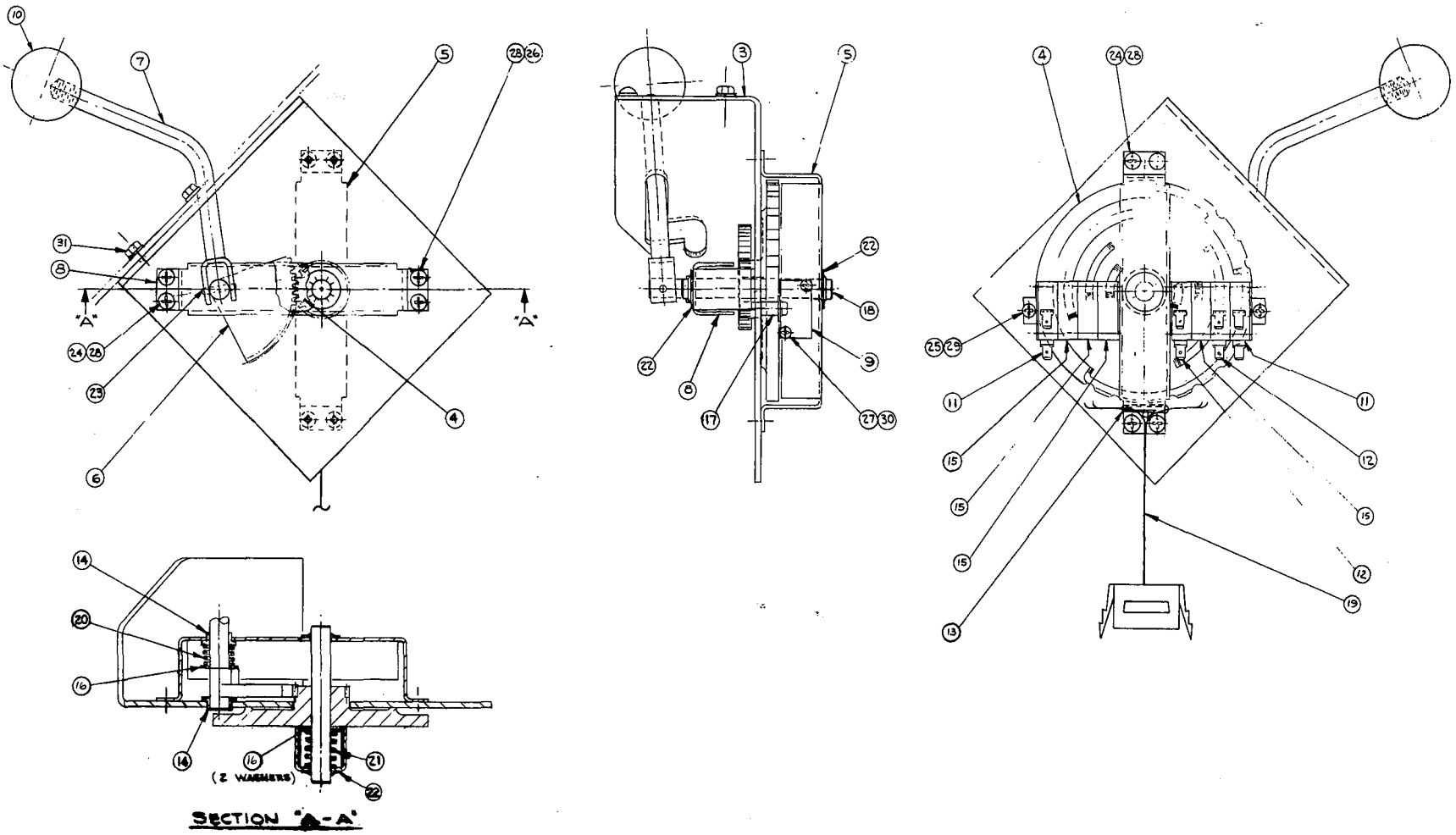


Figure 3A-10 26AE12C Speed Control Assembly

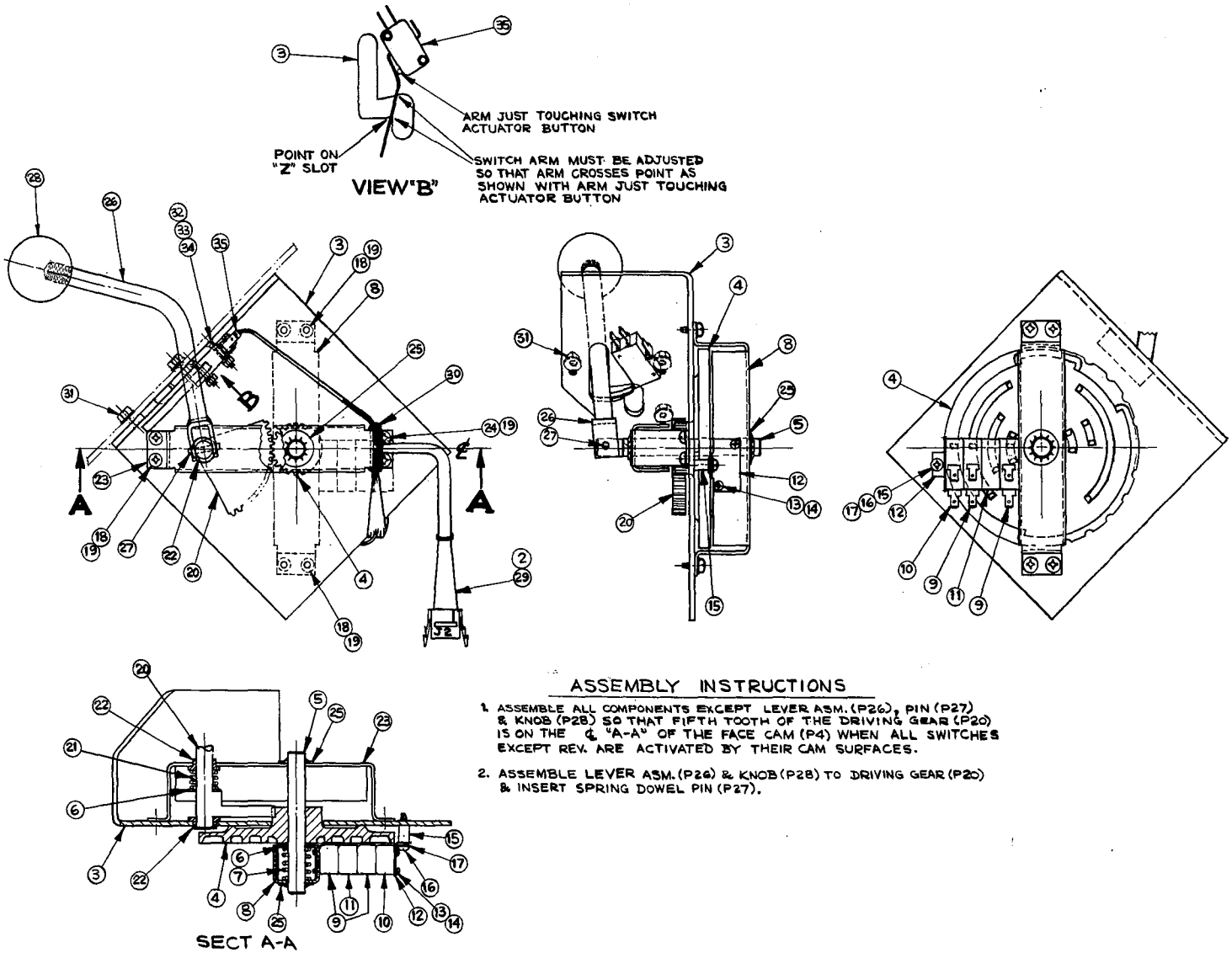
26AE12C SPEED CONTROL ASSEMBLY

Use this list to order replacement parts from Fig. 3A-10.

Ref. No.	Description	Part Number	26A						
			E12C	E12D					
1	Speed Control (As shown)	See Note 2	X						
3	Switch Plate	541C923P1	X						
4	Face Cam	541C667P1	X						
5	Switch Mount	163B9715P1	X						
6	Driving Gear	211A3295P1	X						
7	Lever Assembly	211A3239G1	X						
8	Switch Mount	163B9715P3	X						
9	Bracket	211A3287P1	X						
10	Knob	211A3249P1	X						
11	Switch	211A3198P1	X						
12	Switch	211A3198P2	X						
13	Cable Tie	243A4540P2	X						
14	Bushing	211A3199P1	X						
15	Spacer	211A3524P1	X						
16	Washer, Plain	N402P13B6	X						
17	Spacer	243A4550P3	X						
18	Shaft	243A4555P1	X						
19	Wire Harness	541C985G1	X						
20	Spring	211A3577P3	X						
21	Spring	211A3577P4	X						
22	Push Nut	243A4554P1	X						
23	Spring Dowel Pin, 1/8 x 3/4	N509P1312C6	X						
24	Screw, Self-Tapping 8-32 x 3/8	See Note 1	X						
25	Screw, Self-Tapping 6-32 x 3/4	See Note 1	X						
26	Screw, Pan Head, 8-32 x 1/4	See Note 1	X						
27	Screw, Pan Head, 4-40 x 1-3/4	See Note 1	X						
28	Lockwasher, Internal #8	See Note 1	X						
29	Lockwasher, Internal #6	See Note 1	X						
30	Lockwasher, Internal #4	See Note 1	X						
31	Screw, Thread Rolling	N722AP15008	X						

See Fig. 3A-11.

(1) Not stocked, Order locally. For bolt and screw replacement use Grade 5 or better.
(2) Replace assembly with 26AE12D Speed Control, Part No. 423D297G1. Record this change in area of identification plate.



ASSEMBLY INSTRUCTIONS

1. ASSEMBLE ALL COMPONENTS EXCEPT LEVER ASM. (P26), PIN (P27) & KNOB (P28) SO THAT FIFTH TOOTH OF THE DRIVING GEAR (P20) IS ON THE ℄ "A-A" OF THE FACE CAM (P4) WHEN ALL SWITCHES EXCEPT REV. ARE ACTIVATED BY THEIR CAM SURFACES.
2. ASSEMBLE LEVER ASM. (P26) & KNOB (P28) TO DRIVING GEAR (P20) & INSERT SPRING DOWEL PIN (P27).

Figure 3A-11 26AE12D Speed Control Assembly

26AE12D SPEED CONTROL ASSEMBLY

Use this list to order replacement parts from Fig. 3A-11.

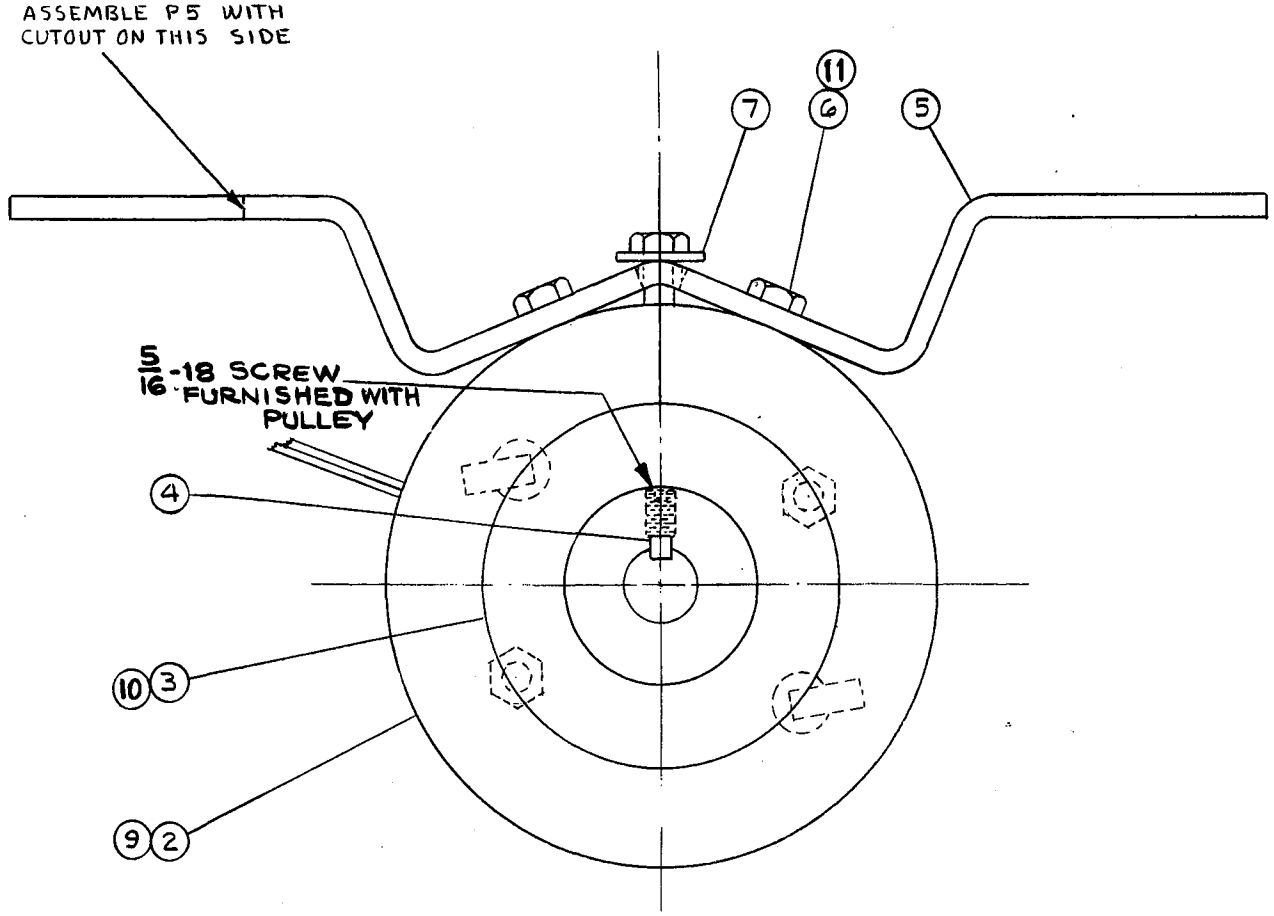
Ref. No.	Description	Part Number	26A						
			E12C	E12D					
1	Speed Control (As Shown)	423D297G1	See Fig. 3A-10.	X					
3	Switch Plate	541C923P1		X					
4	Face Cam	541C667P1		X					
5	Shaft	243A4551P1		X					
6	Washer	N402P13B6		X					
7	Spring	211A3577P4		X					
8	Switch Mount	163B9715P1		X					
9	Switch	211A3198P2		X					
10	Switch	211A3198P1		X					
11	Spacer	211A3524P1		X					
12	Bracket	211A3287P1		X					
13	Screw, Pan Head Machine, 4-40 x 1-3/4	See Note 1		X					
14	Lockwasher, Internal #4	See Note 1		X					
15	Spacer	243A4550P3		X					
16	Screw, Thread Cutting	N117P13012C		X					
17	Lockwasher, Internal #6	See Note 1		X					
18	Screw, Thread Cutting	N117P15006C		X					
19	Lockwasher, Internal #8	See Note 1		X					
20	Driving Gear	211A3295P1		X					
21	Spring	211A3577P3		X					
22	Bushing	211A3199P1		X					
23	Switch Mount	163B9715P3		X					
24	Screw, Pan Head Machine, 8-32 x 1/4	See Note 1		X					
25	Push Nut	243A4554P1		X					
26	Lever Assembly	211A3239G1		X					
27	Spring Dowel Pin	N509P1312C6		X					
28	Knob	211A3249P1		X					
29	Wire Harness	155C8065G1		X					
30	Cable Tie	243A4540P2		X					
31	Screw, Thread Rolling, black	N722AP1508		X					
32	Screw, Flat Head, 4-40 x 3/4	See Note 1		X					
33	Lockwasher, Spring, #4	See Note 1		X					
34	Nut, Hex 4-40	See Note 1		X					
35	Switch	211A3558P2		X					

(1) Not stocked. Order locally. For bolt and screw replacement use Grade 5 or better.

MOTOR AND MOUNTING ASSEMBLY

Use this list to order replacement parts from Fig. 3A-12.

Ref. No.	Description	Part Number	26A						
			E12C	E12D					
1	Motor and Mounting Assembly	163B9993G2	X	X					
5	Motor Plate	541C915P1	X	X					
9	Motor	178B8034P1	X	X					
10	Pulley	243A4675P5	X	X					
11	Bolt, Hex Head, 5/16-18 x .625	N22P23010B6	X	X					



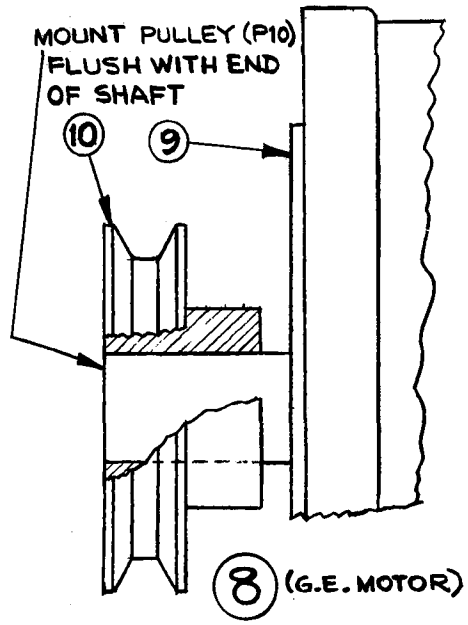


Figure 3A-12 E12 Motor and Mounting Assembly

FRAME AND BODY MOUNTED PARTS

Use this list to order replacement parts from Fig. 3A-13.

Ref. No.	Description	Part Number	26A					
			E12C	E12D				
1	Seat (Complete)	243A4740G1	X	X				
2	Knob	211A3249P3	X	X				
3	Wheel and Tire	541C658G1	X	X				
4	Wheel and Tire	541C951G1	X	X				
5	Clevis Pin	211A3505P2	X	X				
6	Hair Pin Cotter	243A4543P3	X	X				
7	Headlight Lens	211A3413P1	X	X				
8	Reflector and Socket	163B9879P1	X	X				
9	Lamp	211A3592P1	X	X				
10	Steering Wheel	163B9843P1	X	X				
11	Cap Assembly	243A4853G1	X	X				
12	Bearing, Front Wheel	243A4640P1	X	X				
13	Hood Assembly (E12 with Decals)	541C940G1	X	X				
14	Rear Battery Box Cover	541C938G1	X	X				
15	Back Cushion	243A4852P1	X	X				
16	Seat Pan	243A4770P1	X	X				
17	Seat Cushion	178B8030P1	X	X				

Note: Other frame, body sheet metal parts, and body castings are available only from the factory on special order.

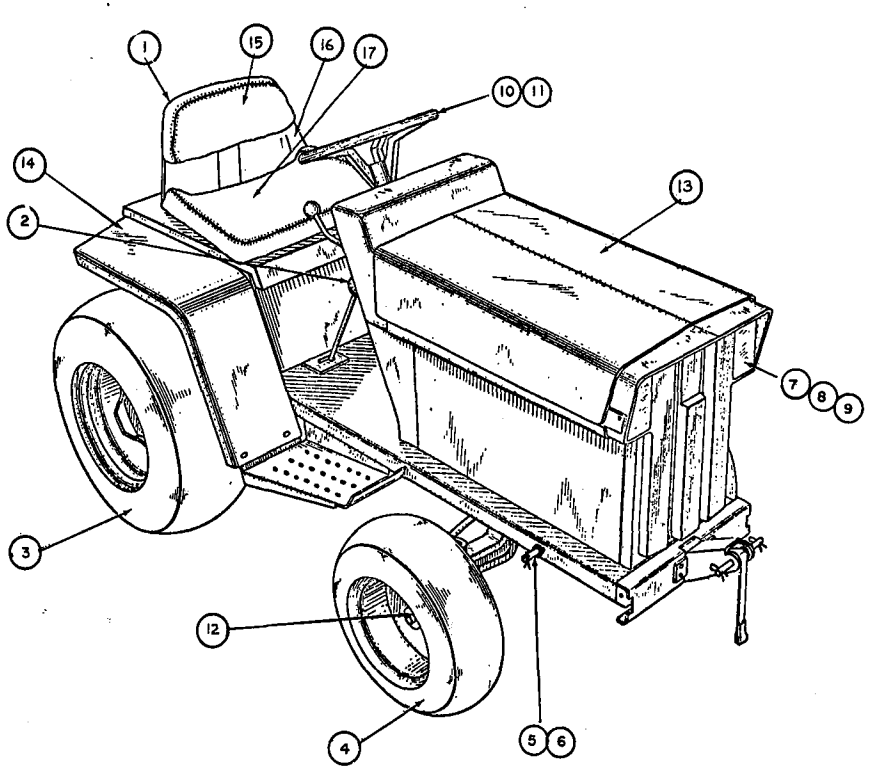


Figure 3A-13 E12 Frame and Body Mounted Parts

E12 MISCELLANEOUS PARTS

Description	Part Number	26A						
		E12C	E12D					
Undercarriage Harness	423D228G1	X	X					
Battery Clamp Assembly (Front)	163B9887G1	X	X					
Battery Clamp (Rear)	163B9875G1	X	X					
Battery Tray (Front)	541C699P1	X	X					
Battery Tray (Rear)	541C698P1	X	X					
Battery Cover (Front)	243A4523G1	X	X					
Battery Cover (Rear)	243A4522G1	X	X					
Instruction Decal (Under Hood)	541C922P1	X	X					
Artwork (Dash)	541C681P1	X	X					
Fuse Decal	211A3528P1	X	X					
Parking Brake Decal	211A3247P1	X	X					
Hood Decal (Right)	422D848P5	X	X					
Hood Decal (Left)	422D848P6	X	X					
Caution Decal (Battery Covers)	211A3511P1	X	X					
Tail Reflector	211A3250P1							
Battery Cable (Interconnecting)	211A3531G1	X	X					
Socket SO-1 (PTO)	243A4572P1	X	X					
Socket SO-2 (Accessory)	243A4542P1	X	X					
Fuel Level Gage	243A4629G1	X	X					
Power Use Gage	243A4630G1	X	X					
Power Disconnect Assembly	163B9923G1	X	X					
Fusible Link FU1	211A3448G1	X	X					
Knob (Power Disconnect)	243A4502P1	X	X					
Plug (12-position)	423D216P4	X	X					
Jack (12-position)	243A4568P4	X	X					
Plug (15-position)	423D216P3	X	X					
Jack (15-position)	243A4568P5	X	X					
Jack (9-position)	243A4568P3	X	X					
Friction Pad Set (Brake Caliper)	211A3593P1	X	X					
Seat Switch	243A4790P1	X	X					
Spring (Seat)	211A3577P8	X	X					
Rivet (Seat Spring)	211A3191P1	X	X					
Convenience Hitch Assembly (Extension)	211A3546G1	X	X					
Battery Liner, Front (Poly Bag)	155C8005P1	X	X					
Battery Liner, Rear (Poly Bag)	155C8006P1	X	X					
Post Clamp (Battery)	243A4521P1	X	X					

4.1 E15 THEORY OF OPERATION

A basic explanation of the E15 circuitry is usually helpful in making the detailed theory easier to understand. The block diagram in Figure 4-A is a simplified representation of the entire E15 circuitry. Notice how the function blocks are interconnected.

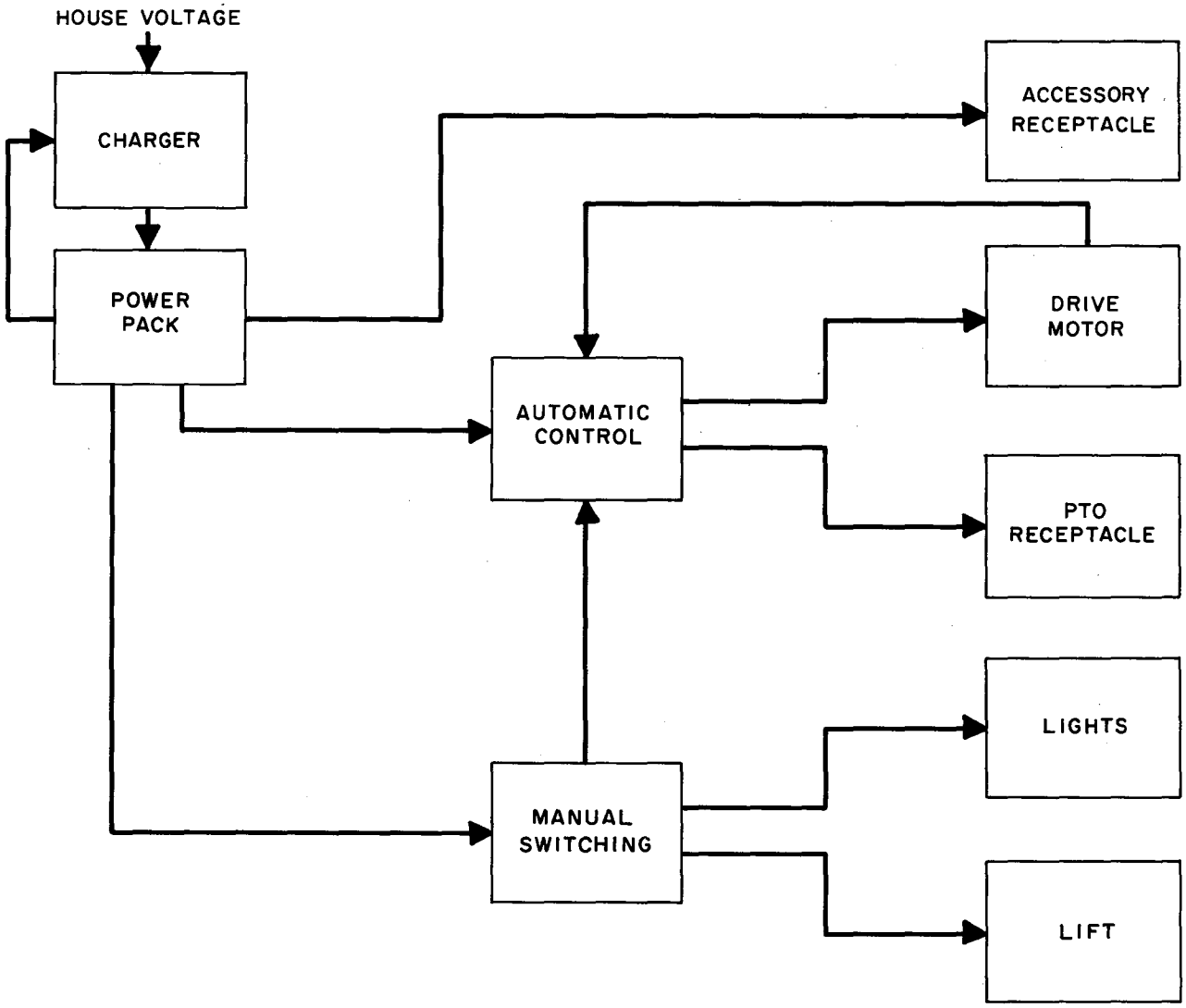


Fig. 4-A E15 Elec-Trak Block Diagram

After the house voltage is fed into the charger, it is changed to an appropriate d-c voltage and is then fed to the power pack to recharge the cells. The connecting line returning to the charger indicates that a sample of battery condition is used by the charger to properly meter charger output current.

The accessory receptacle is wired directly to the power pack and is shown that way in the diagram. Actually, the power disconnect, fuse FU1, and two circuit breakers are in this circuit, but for this purpose these are considered wires direct to the power pack.

Light and lift circuits are also powered by the power pack, but manual switching must be performed to operate these devices. The line drawn from the manual switching block to the automatic control block represents the control of all other manual switches. These include the key switch, PTO switch, seat switch, brake switch, and the eight speed control switches. All of these switches control functions of the printed circuit cards, which deliver commands to the drive motor or PTO receptacle. The return line from the drive motor to the automatic control block indicates a sensing circuit which overrides portions of the manual switching.

Successful trouble shooting of the E15 Elec-Trak requires an understanding of the electronics and mechanics involved in normal operation. Three major areas that usually require instruction in operation are: 1) speed control, 2) printed circuit control card, 3) the charger. These three areas will be discussed individually, but with attention directed to the over all tractor response. The troubleshooting sketch should be closely followed during the explanation.

Speed Control

The speed control is basically a mechanical device which actuates switches in an orderly sequence. The switches are actuated as high portions on the speed control cam contact the switch buttons as the cam is

rotated, with the exception of the reverse switch which is actuated directly by the speed control lever.

In all, the speed control contains eight switches which are made up of three different types. They are as follows:

Start Switch - Single pole-double throw (SPDT) - Two current carrying positions.

Reverse, 1A, 2A Switches - Single pole-single throw (SPST) - Normally open (NO), i.e., unactuated, the switch is open.

Field Weakening Switches, FW SW1, 2, 3, 4 - Single pole-single throw (SPST) - Normally closed (NC), i.e., unactuated, the switch is closed.

Locate each of these switches on the troubleshooting sketch and note that they are shown in their unactuated position.

As the speed control is slowly moved forward from the right hand neutral position, notice that very little resistance is felt immediately. This area is an extension of the neutral position which improves field switching action. No switches are actuated in this area. As the speed control is slowly moved forward, the switches that are actuated in order are:

1. Start switch
2. 1A switch
3. 2A switch
4. FW SW1 switch
5. FW SW2 switch
6. FW SW3 switch
7. FW SW4 switch

Once any switch is actuated it is held actuated in all the following speed control positions until the lever is moved toward neutral past its initial actuating position. For example, if the tractor were being operated in the

third speed forward, abbreviated SC3, the Start, 1A, and 2A switches would all be actuated.

Operation of the speed control in reverse is much the same as forward operation. The greatest difference is that as the speed control lever is moved from the right hand neutral position to the left hand neutral, the reverse switch is immediately actuated by contact of the lever directly with the reverse switch. This switch is held actuated in all reverse speed control positions.

As the lever is moved rearward, through an extended neutral as in forward, the switches actuated in order are:

1. Start switch
2. 1A switch
3. 2A switch

For speed control position differentiation, the three reverse positions are abbreviated SC-1, SC-2, and SC-3 respectively. SC-0 indicates the left hand neutral position and SCO indicates the right hand neutral position.

Printed Circuit Cards

The printed circuit control card is not meant to be a dealer repairable component, but an understanding of its operation is helpful in tracing trouble to the card as well as other parts of the tractor.

Before proceeding, notice that terminal pad 12 of the card is the power pack negative return for the entire card.

The "Start" portion of the card is a good area to examine first. Wire 25 connects the common terminal of the start switch with a source of 36 volts, so in the unactuated position 36 volts is available to control card pad 6, abbreviated CC6, which charges the capacitor in that circuit. When the speed control actuates the start switch, the 36 volt source is applied to an SCR through CC5. Remember that an SCR is an electronic switch that "turns on"

(closes), when current is directed into the anode and gate. Anode current is supplied by the 36 volts and gate current by the charged capacitor. It is important to realize that the capacitor becomes discharged quickly through the gate of the SCR, but the SCR remains closed until anode current is interrupted. This interruption can be made by opening the seat switch, applying the brake hard or various other ways, but when the voltage is restored to the anode of the SCR, it does not close again, because the capacitor is discharged and cannot supply gate current. This feature is referred to as the "Return To Neutral"[1] condition; that is, the speed control must be returned to neutral to allow the capacitor to recharge.

When the SCR is closed, there is about 36 volts available to the coil of the L contactor through CC4 and wire 35. The other side of the coil is connected to the negative side of the power pack, so the contactor coil becomes "energized" and its contacts close making power available to the drive motor field and armature (through R1 and R2) and the motor drives the tractor forward.

Another wire 35 connected to the L contactor coil is connected to switch 1A. If L is energized, the same 36 volts is available at CC10 if switch 1A is actuated. Since the capacitor connected here is in series with a resistor, a controlled charging rate results; that is, the time it takes to charge is dependent on the value of the resistor and capacitor used. When the capacitor charges sufficiently, the unijunction transistor, UJT, "turns on" or closes momentarily and supplies gate current to the SCR, energizing the coil of 1A contactor through CC11. When contactor 1A energizes, resistor R1 is by-passed making more current available to the drive motor armature, resulting in a higher speed.

The same operation is repeated after coil 1A energizes and switch 2A actuates. Energizing 2A by-passes R2 and another increase in speed

[1] Patent Pending

results. This is the most efficient position to operate the tractor in since both the armature and field are in parallel with the power pack without resistance in series.

Energizing coil 2A results in operation of a similar circuit without the necessity of actuating another speed control switch since the circuit is tied directly into CC14 on the printed circuit card. When this circuit's SCR closes, the FW coil is energized and prepares the field circuit for use of the last four-speed control switches by opening the FW contacts.

Actuation of FW SW1 (FW SW1 opens) allows R4 to be connected in series with the drive motor field. This resistor causes a reduced field current which increases armature current and speed. After each of the next three switches is actuated, another resistor is connected to the field series circuit and each time the motor speed increases.

NOTE: If an "open" occurs anywhere in the field circuit, the effect is that of adding a resistor of infinite ohms. This causes the motor to over-speed which requires excessive armature current and severe motor heating.

The FW contacts by-pass all of the FW switches in the speed control and therefore the resistors R4, R5, R6 and R7. If the speed control is moved from neutral to SC7 rapidly no resistance is connected in series with the field until L, 1A, 2A, and FW coils are energized. This time delay limits armature starting currents to a safe level and prevents "jack rabbit" starts. It is important to realize that the last four speeds are had directly from the speed control without any time delays.

The reverse coil, Rev, is energized immediately if when the reverse switch is actuated and if the drive motor is not turning forward rapidly. The reverse relay has four sets of contacts all operated from one coil. Two contacts are normally closed and two are normally open. The two normally closed contacts cause current to flow through the field in one direction, and when the reverse relay is energized, the current flows in the opposite

direction, resulting in the motor rotating in the reverse direction. SC-1, SC-2, and SC-3 positions give identical operations as the corresponding forward positions.

The circuitry associated with CC7 senses back EMF (generated voltage) of the drive motor armature. If the armature is rotating very rapidly, this circuit prevents any drive motor switching until the back EMF is reduced sufficiently.

Since switching is possible when the drive motor is rotating at a slower speed, spikes of energy may be generated as the switching occurs. These spikes may be capable of closing SCR's by supplying gate current. The varistor, VR-1, effectively suppresses these spikes.

The PTO portion of the card is identical to the "Start" portion previously discussed. The circuitry differs in that the PTO switch is manually positioned and there are two sets of contacts operated on the PTO contactor. When the PTO coil is energized, one set of contacts opens and the other set closes. This applies 36 volts to be available at the PTO receptacle through wires 3 and 24. When power is interrupted to the coil, the contacts return to their normal position. The two sets of contacts permit dynamic braking of motors such as those on the rotary mower. One set applies power and when de-energized the normally closed contacts short the input terminals of the motor causing it to brake rapidly.

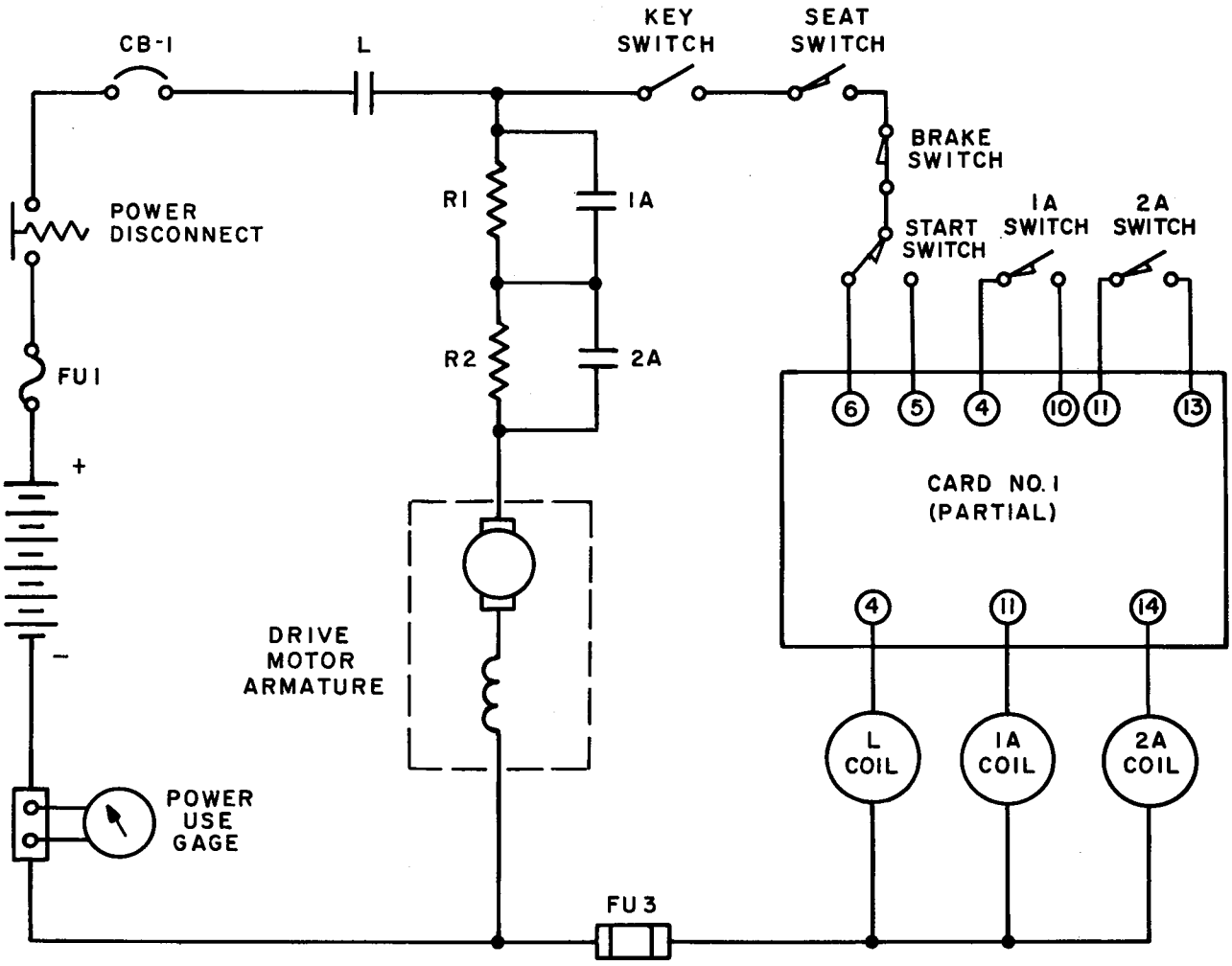
Charger

The heart of the charger is a specially designed transformer. Besides the primary winding on the line or input side of the transformer, the secondary is connected to the power pack to supply charging current, and a third winding connected to capacitor CP2 allows fast charging rates for deeply discharged power packs.

A more detailed explanation may be appropriate. Line voltage is applied to the primary winding through a normally open switch. When the

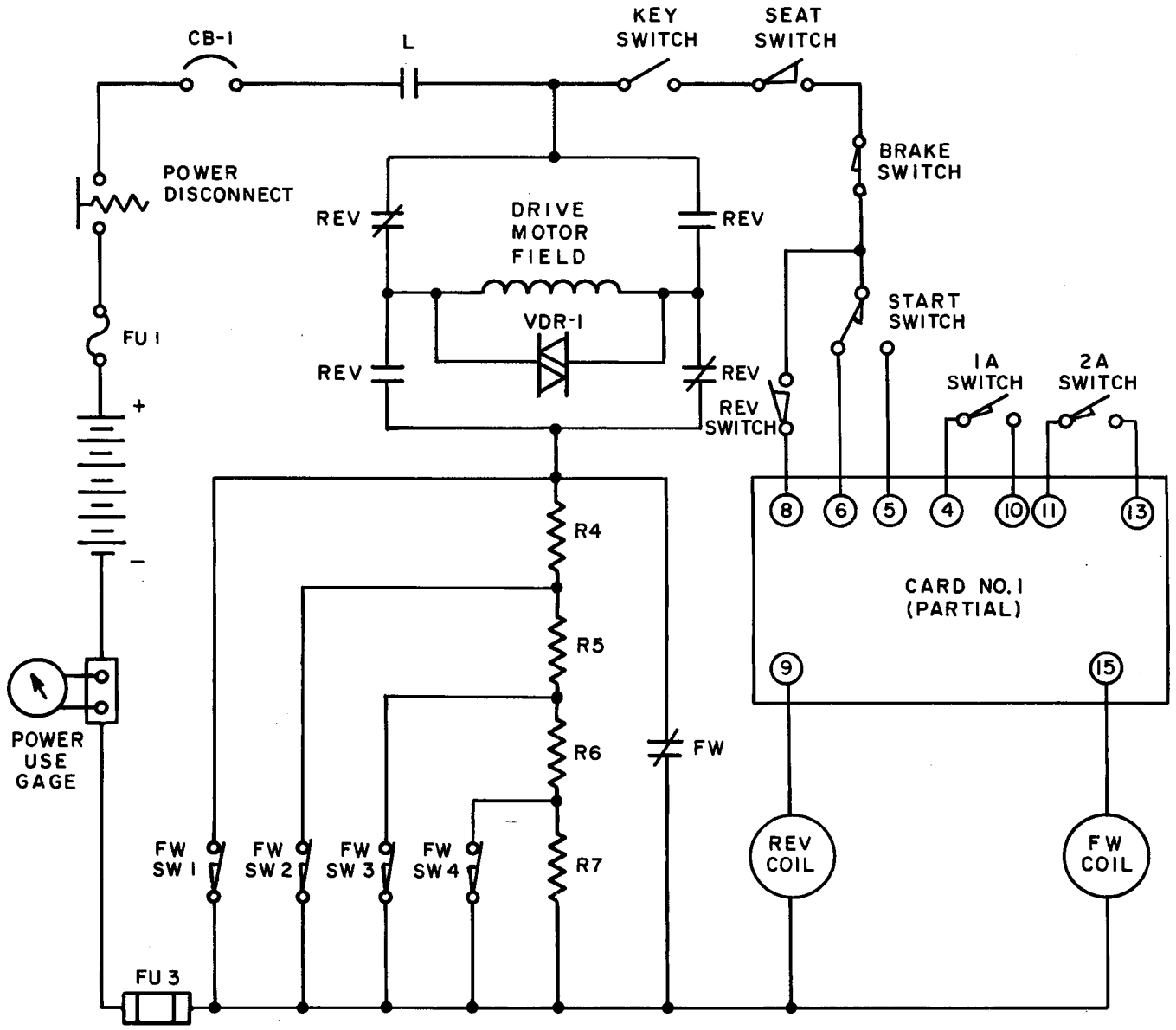
timer is turned to the proper "start" position the switch is closed, the timer motor starts, and the transformer is put into operation. The timer motor drives a cam which causes the contacts to open when the proper time has elapsed.

The secondary winding reduces the line voltage to a usable charging level which is then full wave rectified by the action of diodes CR4 and CR5. The diodes accept the 60 cycle sine wave as an input from the secondary winding and output a pulsating positive DC voltage which charges the power pack. The third winding in conjunction with capacitor CP2 allows the charger to supply a high rate of charge when the power pack is deeply discharged and a low rate of charge when the power pack nears its full charge state.



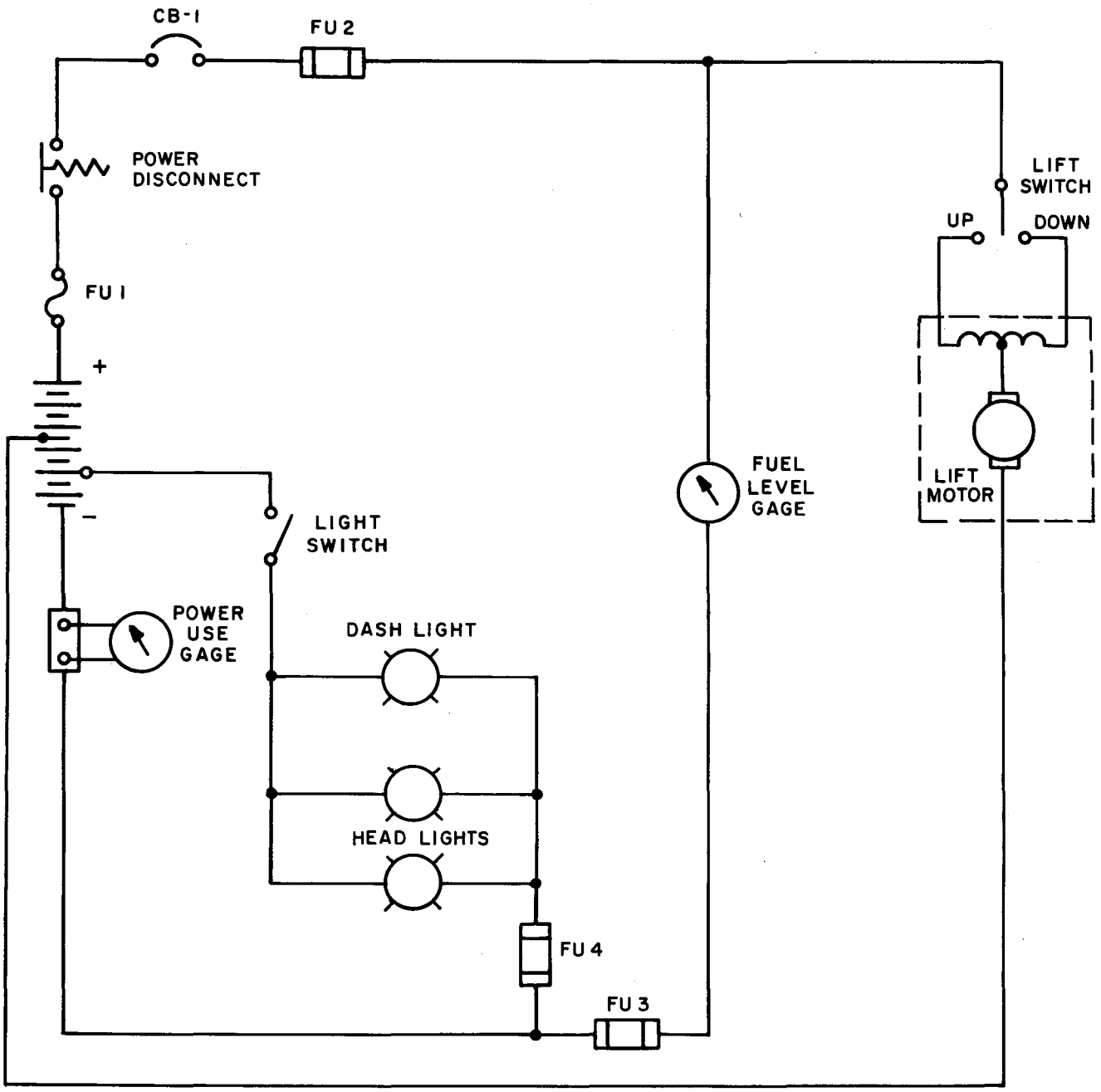
Note: This drawing not for Troubleshooting. See pages 4-19 through 4-33 and Figures 4-1 through 4-20 for Troubleshooting.

Fig. 4-B E15 Drive Motor Armature Control



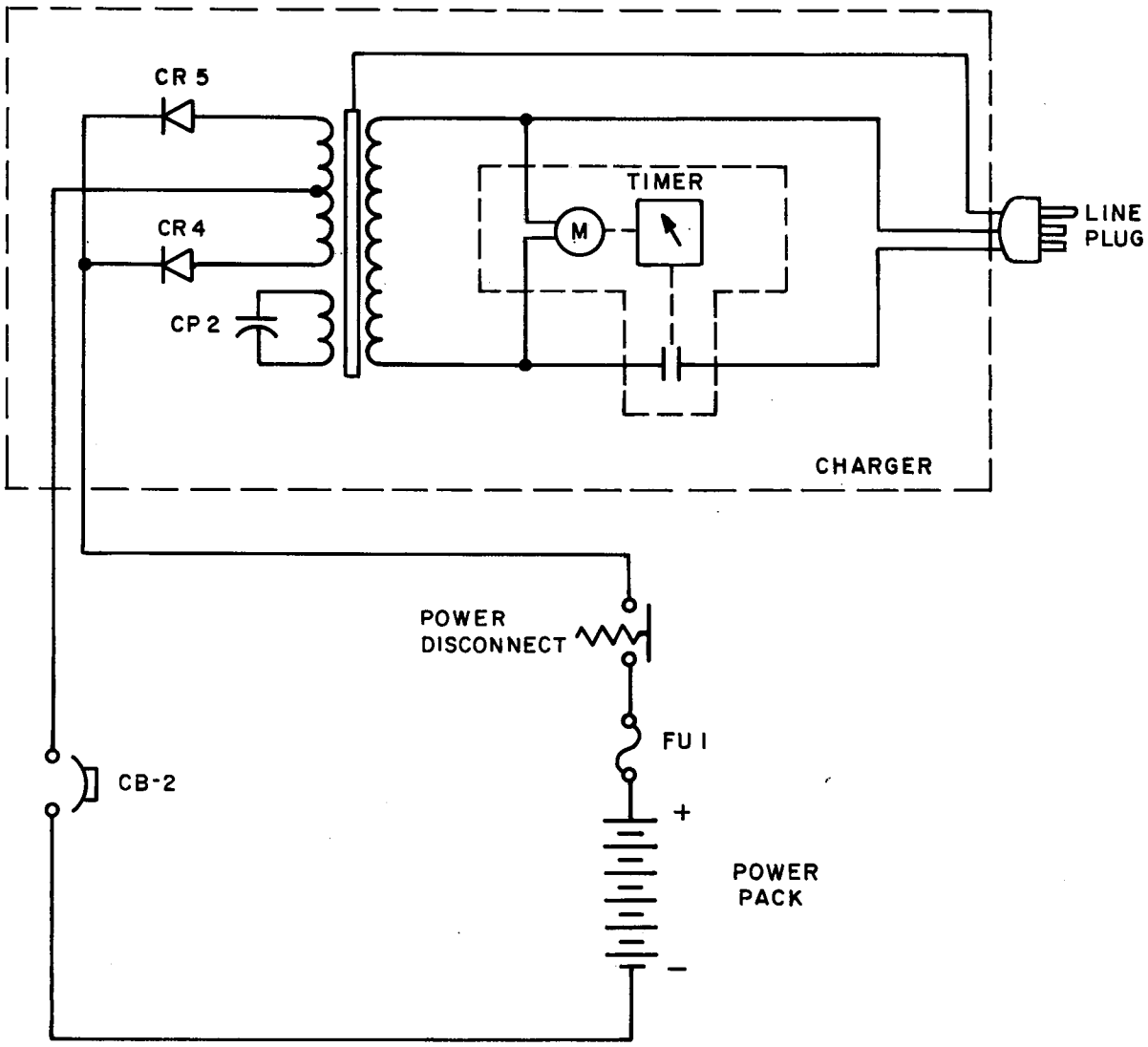
Note: This drawing not for Troubleshooting. See pages 4-19 through 4-33 and Figures 4-1 through 4-20 for Troubleshooting.

Fig. 4-C E15 Drive Motor Field Control



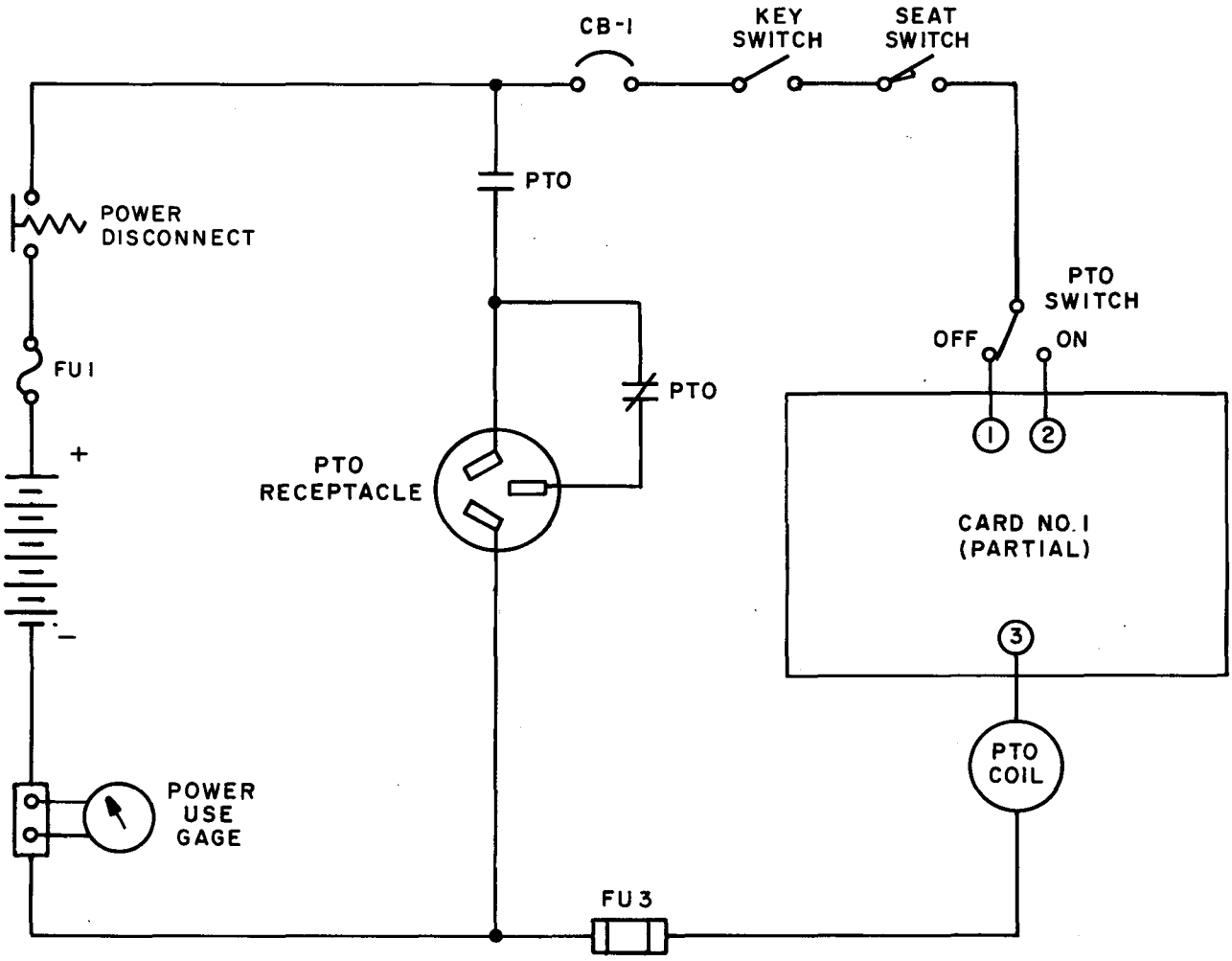
Note: This drawing not for Troubleshooting. See pages 4-19 through 4-33 and Figures 4-1 through 4-20 Troubleshooting.

Fig. 4-D E15 Lift and Light Circuit



Note: This drawing not for Troubleshooting. See pages 4-19 through 4-33 and Figures 4-1 through 4-20 for Troubleshooting.

Fig. 4-E E15 Charger Circuit



Note: This drawing not for Troubleshooting. See pages 4-19 through 4-33 and Figures 4-1 through 4-20 for Troubleshooting.

Fig. 4-F E15 PTO Circuit

4.2 E15 TROUBLESHOOTING SKETCH (Figure 4-1)

The E15 Troubleshooting Sketch is a combination schematic drawing and wiring diagram. It shows not only the electric-electronic circuits of the E15, but the location of wire connections, plug and jack pin identifications, wire number coding, and notes in various areas that aid troubleshooting.

For example, locate fuse FU2 in the lift circuit on the sketch. Immediately, it is determined that the fuse is a 30 amp slo-blow with three wires connected to one end and one wire to the other. In following the wires, it is shown that the single wire is coded "17" and is terminated in P1 pin 1 (P1-1). The three wires at the other end are coded "5". They are terminated at the L contactor, P1-4, and the Fuel Level Gage. Inspection of that fuse in an E15 will verify this information.

Areas of the sketch that are enclosed with either solid or dotted lines are modules or portions of modules; i.e., VR-1 across the drive motor field is a component which is mounted on Card 3.

Knowledge of the currents involved in various circuits will often help in identifying wiring if the same code number occurs on several wires. For instance, 1A contactor contacts terminate three number 6 wires. Since two of these wires supply armature current to the drive motor it is necessary that they be of a heavy gage. The third wire supplies field current so may be a much lighter gage. The PTO and drive motor armature circuits are drawn as heavy lines to represent high current circuits.

4.3 USE OF THE TROUBLESHOOTING GUIDE OF ELECTRICAL FAILURES

The following guide is intended to cover the more common problems that may be encountered with the E15. If a specific problem is not listed, problems listed with similar symptoms may give some insight into possible areas to examine or the procedure to use.

Always charge power pack and check all fuses before beginning troubleshooting procedure.

Many of the tests to be performed and the steps to be taken must be carried out in proper fashion in order to produce reliable results. For instance, measurements to printed circuit terminal pads are quite often required, and if the actual measurement is made to the terminal instead of the pad, the "open" may be at the pad-terminal connection and the card might be replaced unnecessarily. The speed control position called for is also very necessary to produce good results. If the speed control positions are difficult to determine, a spare speed control may be used external to the tractor. Simply disconnect the proper plug-jack connection and connect the temporary speed control jack with the tractor plug. The speed control position can now be very easily determined by observing which switches are being actuated. Many other parts may be substituted temporarily if care is taken to prevent the shorting of wires or connections.

If open wiring is suspected, don't ignore the plug and jack connections involved. These connectors may become unlatched from the housing and cause an open connection. Whenever a test involves opening any connections, close the connections before proceeding to the next step.

The troubleshooting guide utilizes test points that are readily accessible and easily identifiable. Therefore, if multiple failures occur in the same test area, the troubleshooting procedure should be repeated to locate each failure. Wherever voltage test points are called out, the positive point is mentioned first unless otherwise noted.

As a final word of caution, if any component is replaced or rewired and failures are experienced, carefully recheck the wire coding for correct location.

4.4 EXPLANATION OF TERMS USED IN THE TROUBLESHOOTING GUIDE

Drop out - Used in referring to removing power from the coil of a relay or contactor. Generally the opening of contacts.

Energize - The application of power to a relay or contactor coil.

Open - This can be used to refer to a break in a wire or connection, or the positions a switch may be in so as to stop the flow of current in its attached wires.

Overspeed - A characteristic of a motor, which results in abnormally high speed. This is usually due to an open motor field or the field circuit.

Pick up - Used in referring to applying power to the coil of a relay or contactor. Generally the closing of contacts.

ABBREVIATIONS

CC1 thru CC15 - This indicates the pad under consideration between 1 and 15 of the printed circuit Control Card.

FW - Field Weakening

J1-12, P2-3, or P1-1 - Typical identification of a plug or jack and its pin or socket under consideration, i.e., P2-3 means plug housing P2, pin number 3. Note that wire number remains the same after passing through plug and jack connections, and P1 mates J1, P2 mates J2, etc.

NOC - Normal Operating Condition. Power Disconnect is engaged; Key Switch is "ON", brake pedal released, Seat Switch depressed, Range Selector in neutral.

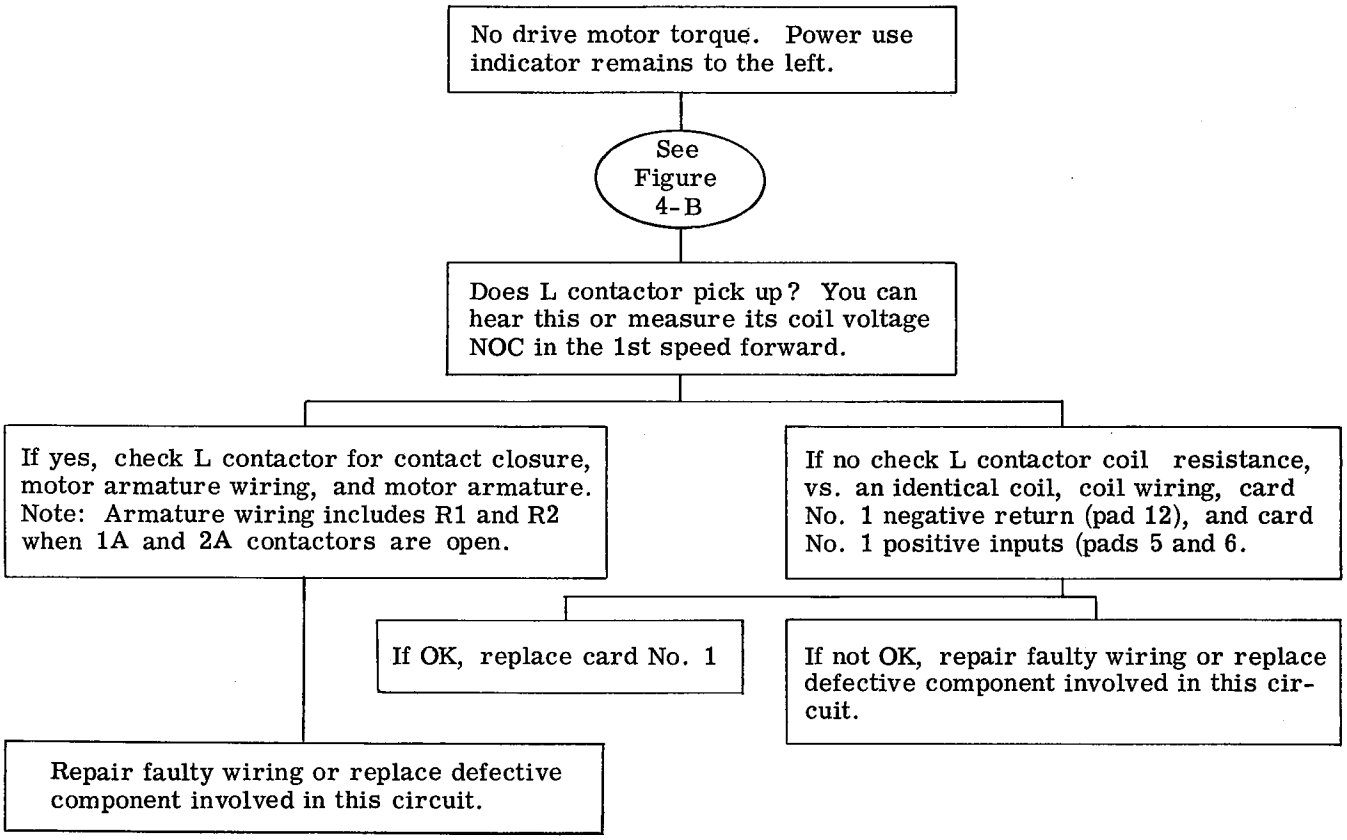
RC1 thru RC7 - This indicates the pad under consideration between 1 and 7 of the printed circuit Resistor Card.

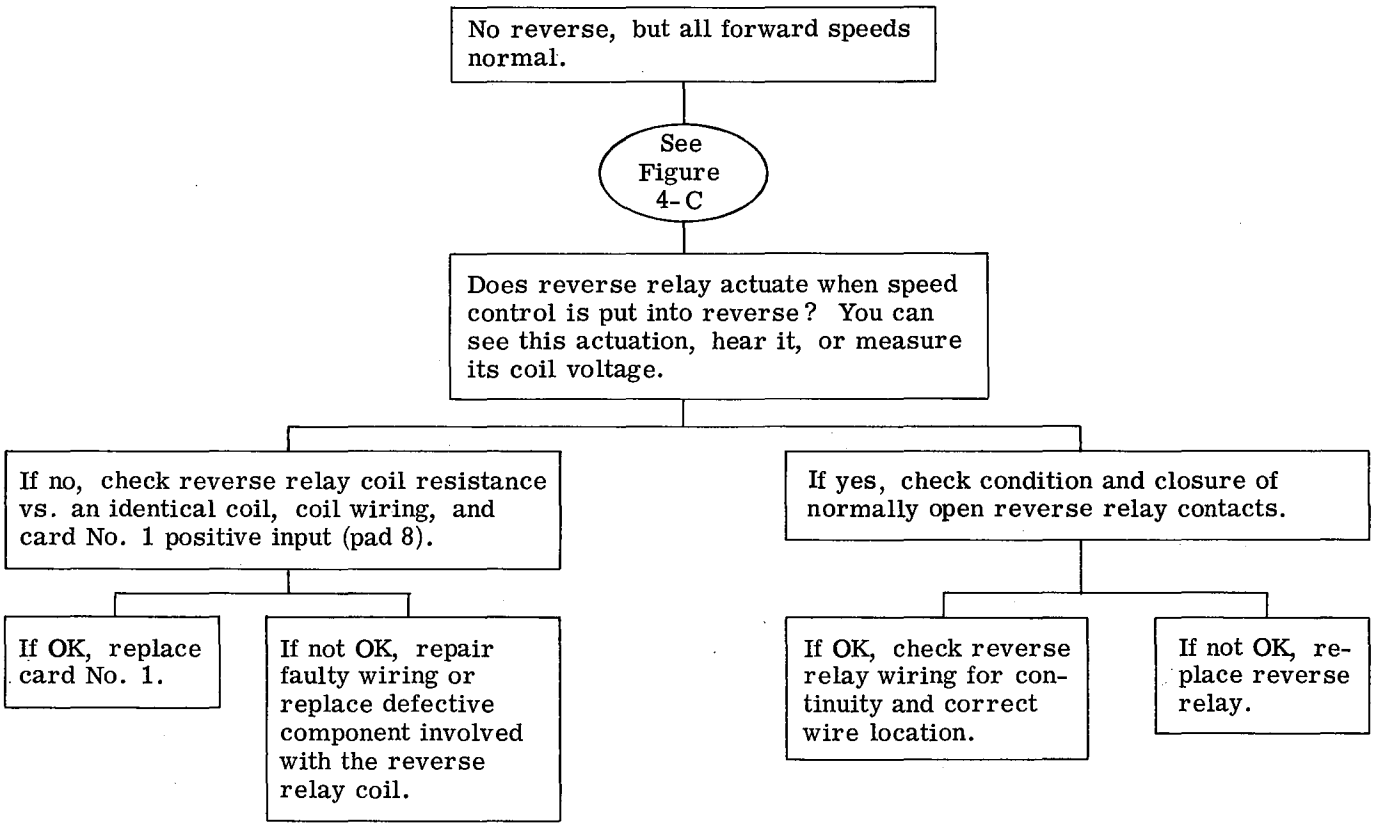
SC0 thru SC7 - Normal forward speeds corresponding to Speed Control positions beginning with neutral. Note: If the tractor is defective, one or more speeds may not be operable, but the speed control position called for in the test should be used.

SC-1 through SC-3 - Normal reverse speeds corresponding to Speed Control positions beginning with neutral, i.e., SC-2 is the second fastest reverse speed which calls for actuation of the following switches: reverse, start, and 1A.

VAC - Volts Alternating Current

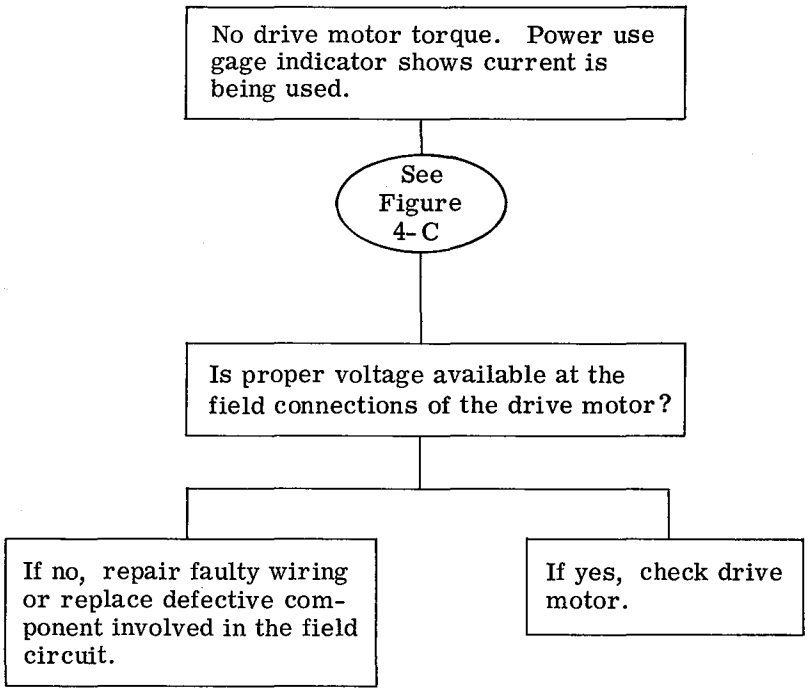
VDC - Volts Direct

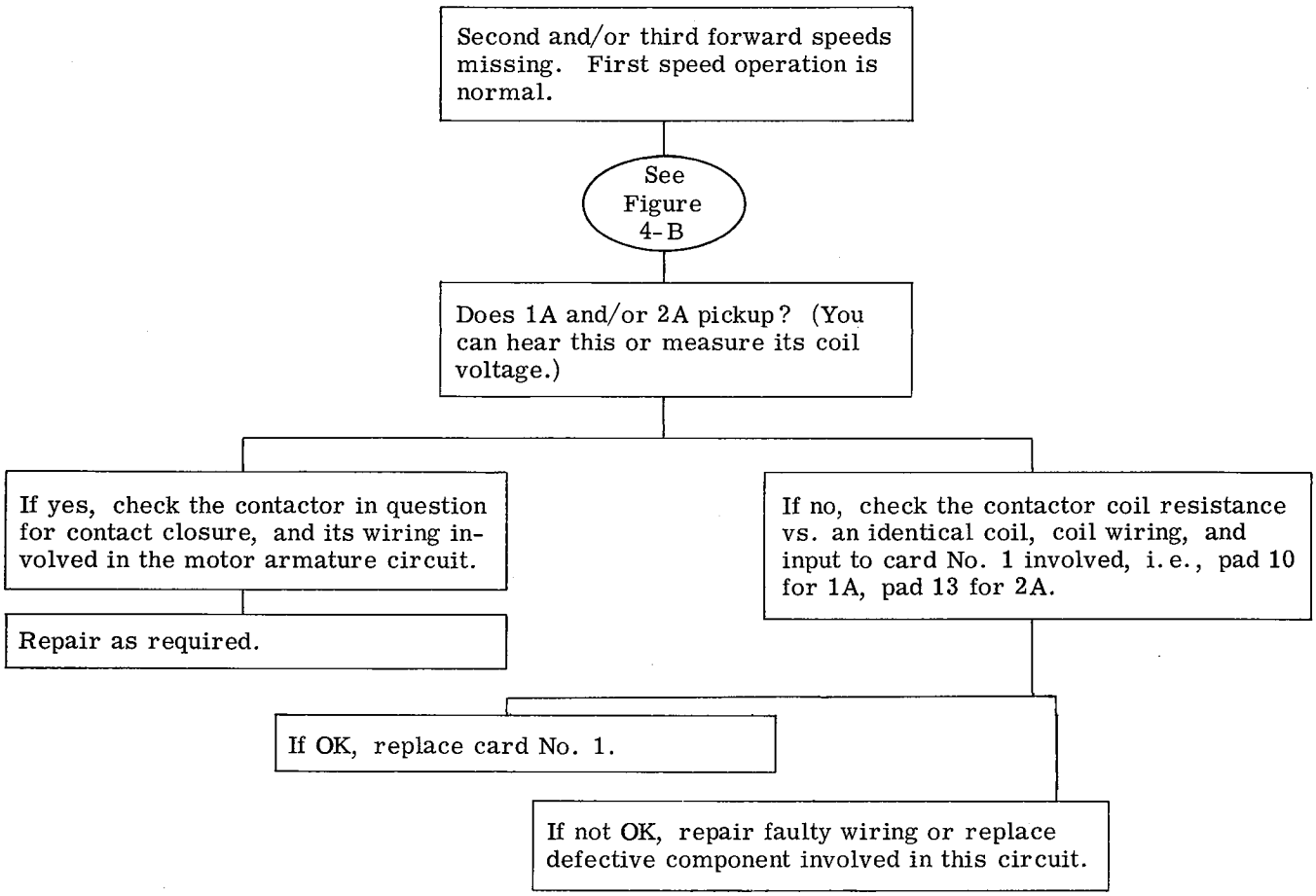

No drive motor torque. Power use indicator remains to the left.
See Figure 4-B
Does L contactor pick up? You can hear this or measure its coil voltage NOC in the 1st speed forward.
If yes, check L contactor for contact closure, motor armature wiring, and motor armature. Note: Armature wiring includes R1 and R2 when 1A and 2A contactors are open.
If no check L contactor coil resistance, vs. an identical coil, coil wiring, card No. 1 negative return (pad 12), and card No. 1 positive inputs (pads 5 and 6.
If OK, replace card No. 1
If not OK, repair faulty wiring or replace defective component involved in this circuit.
Repair faulty wiring or replace defective component involved in this circuit.

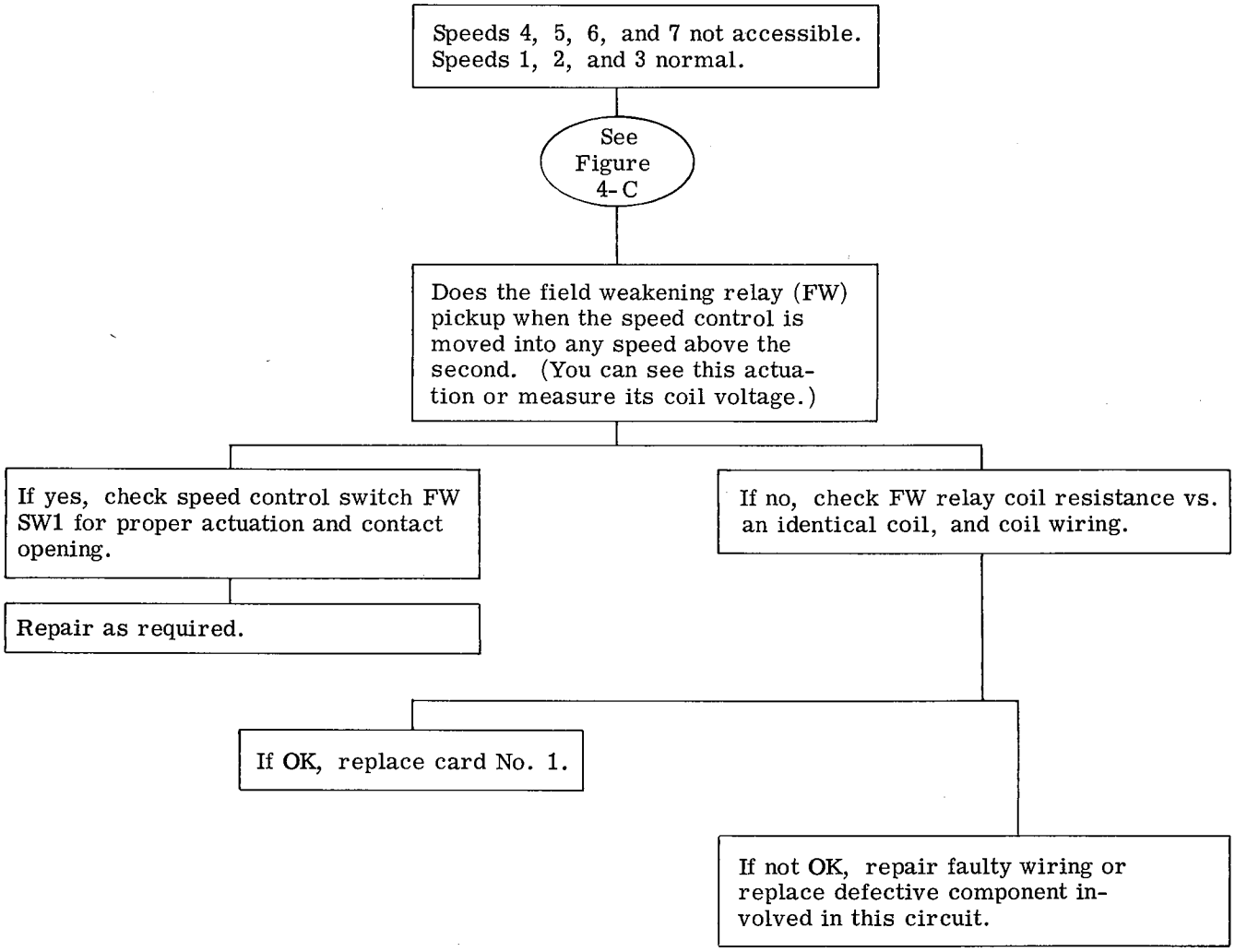

No reverse, but all forward speeds normal.
See Figure 4-C
Does reverse relay actuate when speed control is put into reverse? You can see this actuation, hear it, or measure its coil voltage.
If no, check reverse relay coil resistance vs. an identical coil, coil wiring, and card No. 1 positive input (pad 8).
If yes, check condition and closure of normally open reverse relay contacts.
If OK, replace card No. 1.
If not OK, repair faulty wiring or replace defective component involved with the reverse relay coil.
If OK, check reverse relay wiring for continuity and correct wire location.
If not OK, replace reverse relay.

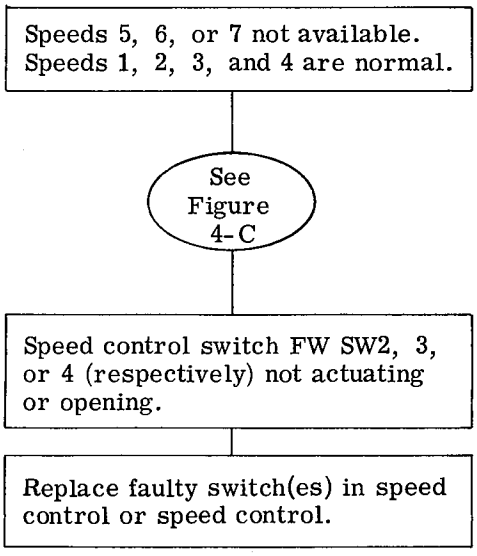
No reverse, and not all forward speeds are available or one or more are abnormal.

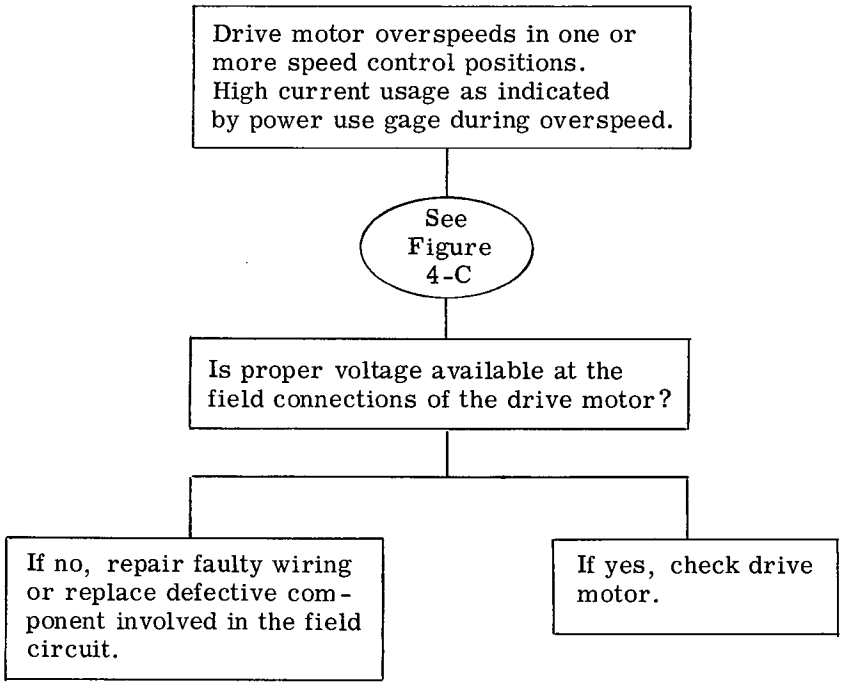
Refer to troubleshooting section which indicates forward speed problems or symptoms.

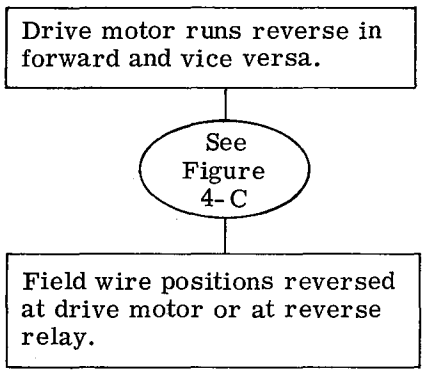

No drive motor torque. Power use gage indicator shows current is being used.
See Figure 4-C
Is proper voltage available at the field connections of the drive motor?
If no, repair faulty wiring or replace defective component involved in the field circuit.
If yes, check drive motor.

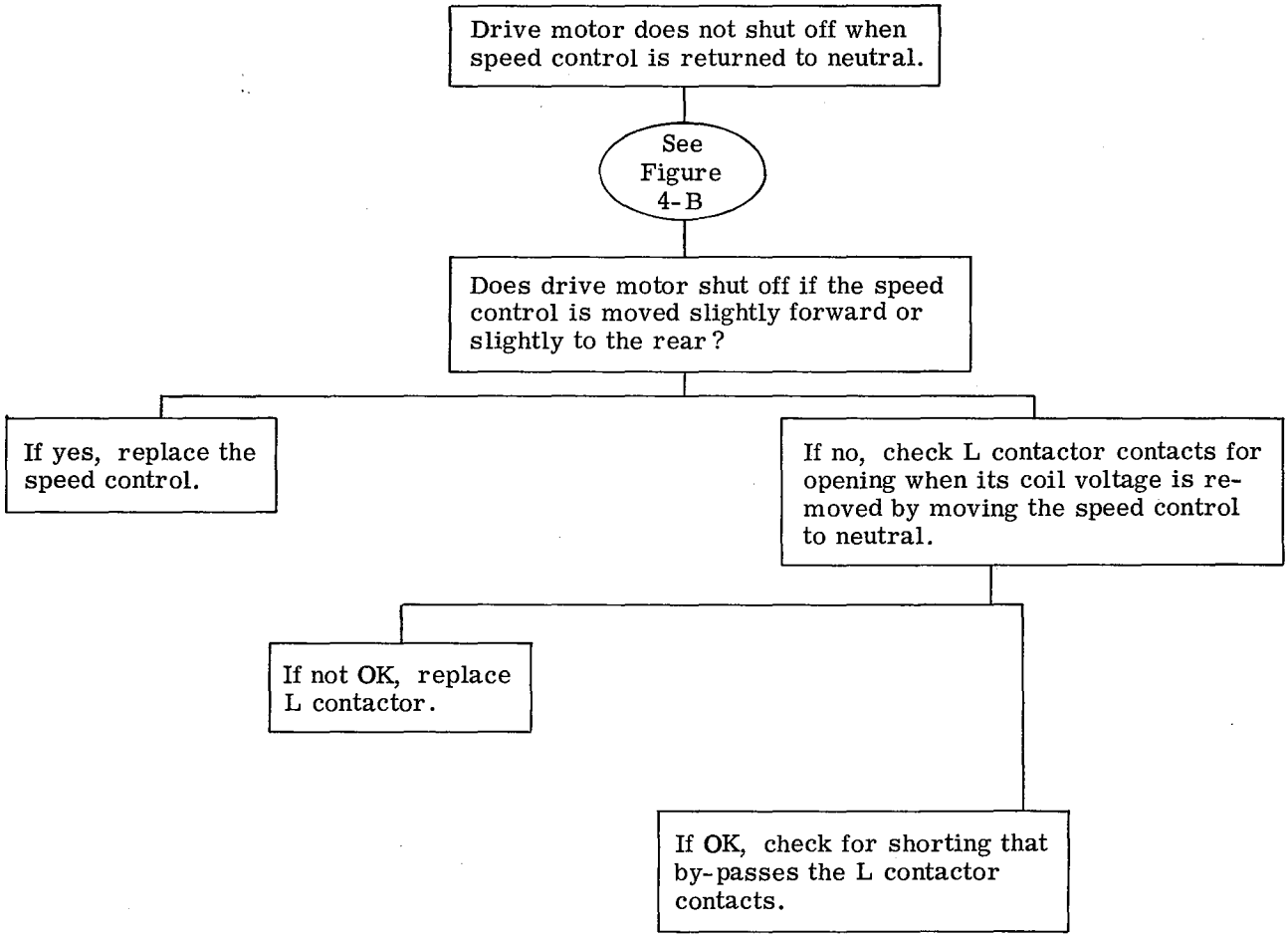

Second and/or third forward speeds missing. First speed operation is normal.
See Figure 4-B
Does 1A and/or 2A pickup? (You can hear this or measure its coil voltage.)
If yes, check the contactor in question for contact closure, and its wiring involved in the motor armature circuit.
Repair as required.
If no, check the contactor coil resistance vs. an identical coil, coil wiring, and input to card No. 1 involved, i.e., pad 10 for 1A, pad 13 for 2A.
If OK, replace card No. 1.
If not OK, repair faulty wiring or replace defective component involved in this circuit.

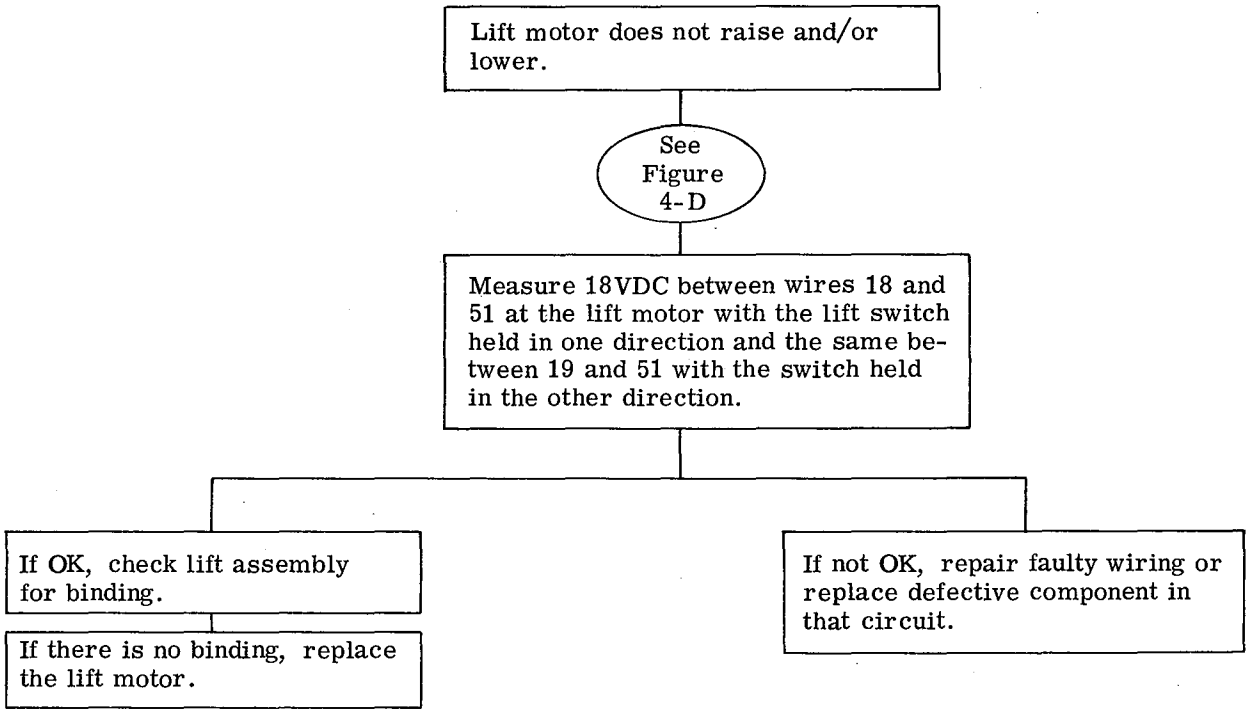

Speeds 4, 5, 6, and 7 not accessible.
Speeds 1, 2, and 3 normal.
See Figure 4-C
Does the field weakening relay (FW) pickup when the speed control is moved into any speed above the second. (You can see this actuation or measure its coil voltage.)
If yes, check speed control switch FW SW1 for proper actuation and contact opening.
Repair as required.
If no, check FW relay coil resistance vs. an identical coil, and coil wiring.
If OK, replace card No. 1.
If not OK, repair faulty wiring or replace defective component involved in this circuit.

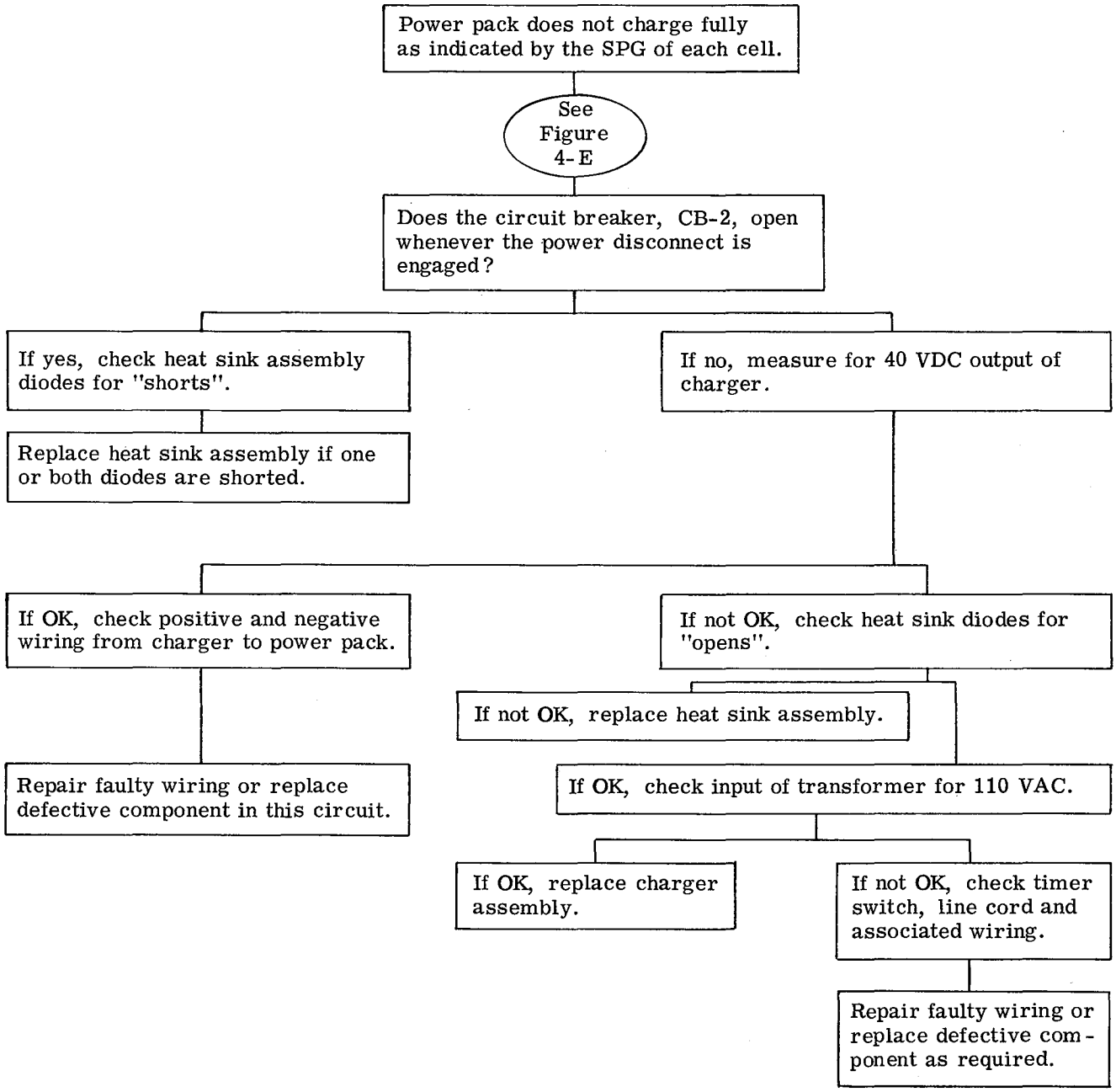

Speeds 5, 6, or 7 not available.
Speeds 1, 2, 3, and 4 are normal.
See Figure 4-C
Speed control switch FW SW2, 3, or 4 (respectively) not actuating or opening.
Replace faulty switch(es) in speed control or speed control.

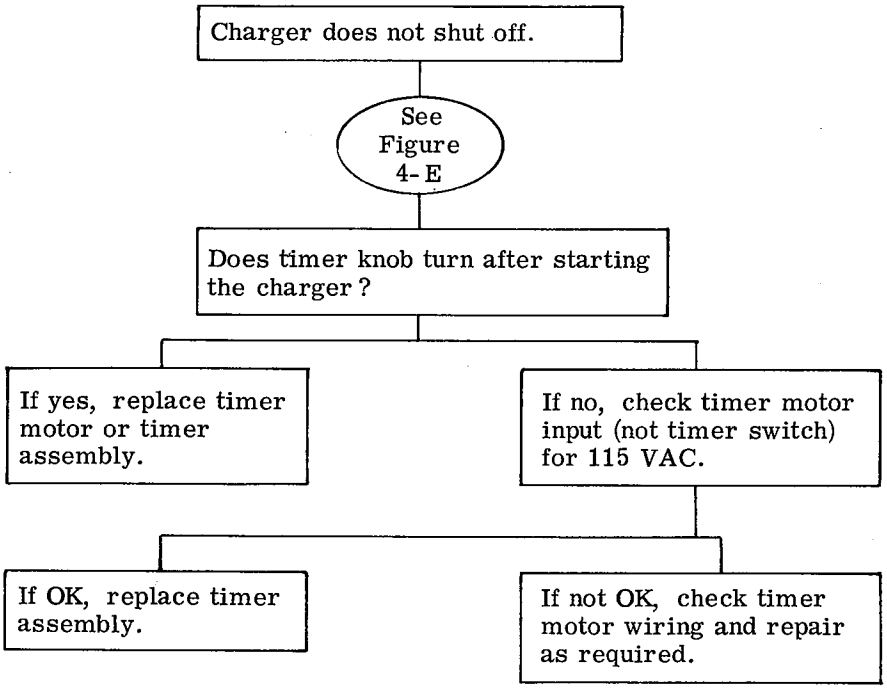

Drive motor overspeeds in one or more speed control positions. High current usage as indicated by power use gage during overspeed.
See Figure 4-C
Is proper voltage available at the field connections of the drive motor?
If no, repair faulty wiring or replace defective component involved in the field circuit.
If yes, check drive motor.

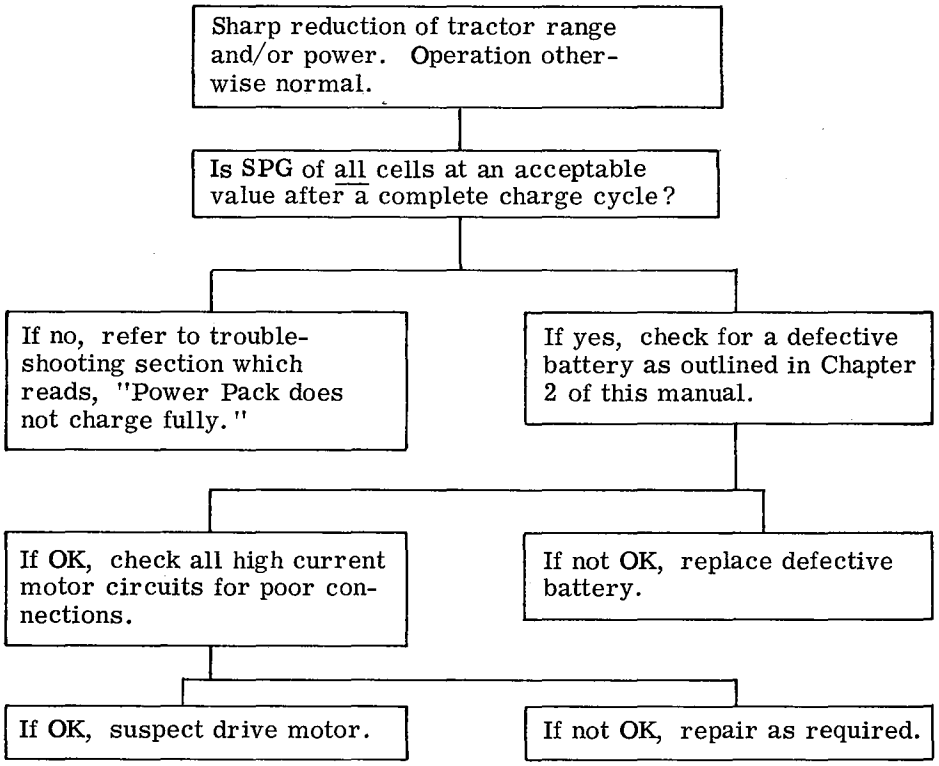

Drive motor runs reverse in forward and vice versa.
See Figure 4-C
Field wire positions reversed at drive motor or at reverse relay.

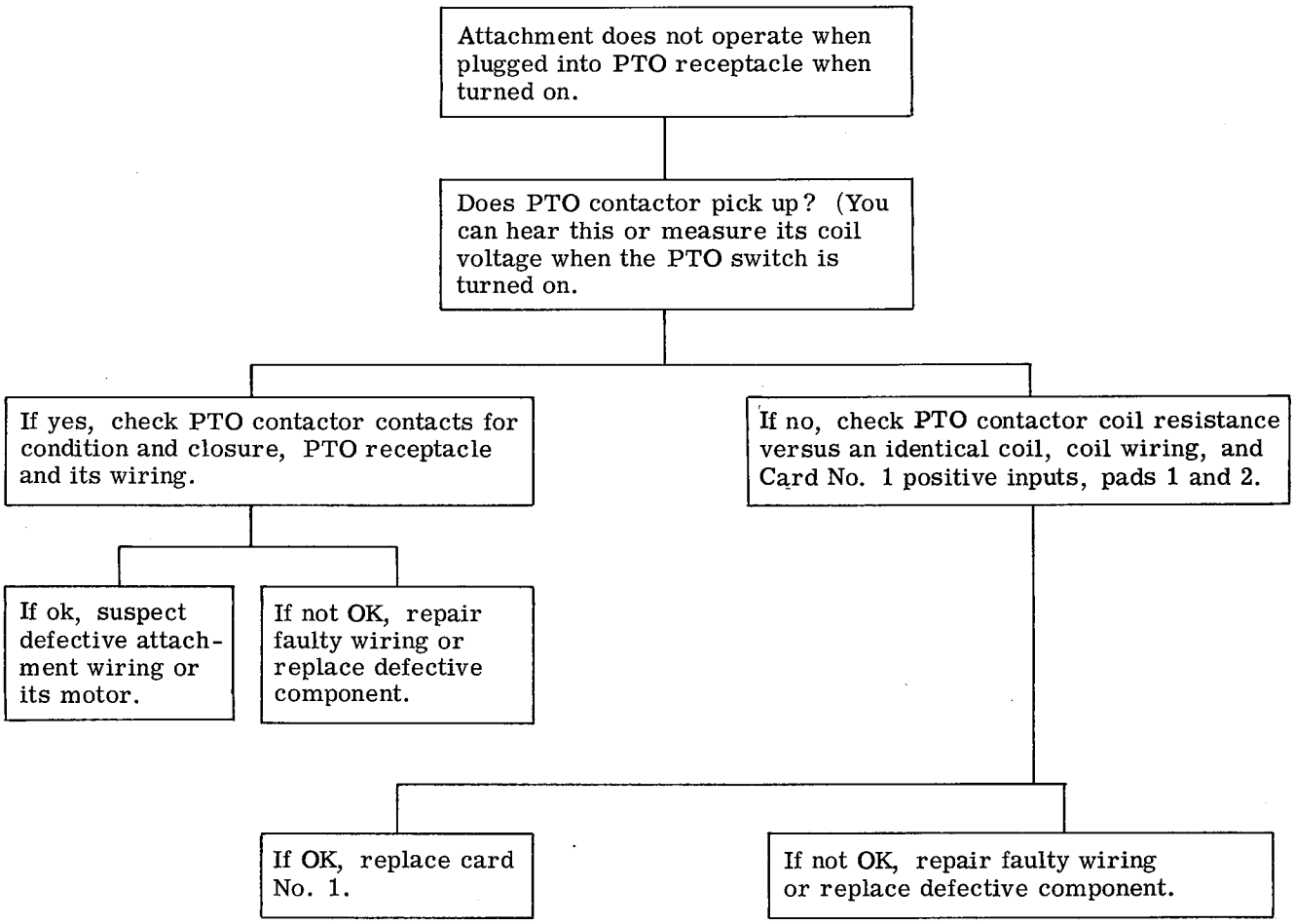

Drive motor does not shut off when speed control is returned to neutral.
See Figure 4-B
Does drive motor shut off if the speed control is moved slightly forward or slightly to the rear?
If yes, replace the speed control.
If no, check L contactor contacts for opening when its coil voltage is removed by moving the speed control to neutral.
If not OK, replace L contactor.
If OK, check for shorting that by-passes the L contactor contacts.


Lift motor does not raise and/or lower.
See Figure 4-D
Measure 18VDC between wires 18 and 51 at the lift motor with the lift switch held in one direction and the same between 19 and 51 with the switch held in the other direction.
If OK, check lift assembly for binding.
If there is no binding, replace the lift motor.
If not OK, repair faulty wiring or replace defective component in that circuit.


Power pack does not charge fully as indicated by the SPG of each cell.
See Figure 4-E
Does the circuit breaker, CB-2, open whenever the power disconnect is engaged?
If yes, check heat sink assembly diodes for "shorts".
Replace heat sink assembly if one or both diodes are shorted.
If no, measure for 40 VDC output of charger.
If OK, check positive and negative wiring from charger to power pack.
Repair faulty wiring or replace defective component in this circuit.
If not OK, check heat sink diodes for "opens".
If not OK, replace heat sink assembly.
If OK, check input of transformer for 110 VAC.
If OK, replace charger assembly.
If not OK, check timer switch, line cord and associated wiring.
Repair faulty wiring or replace defective component as required.


Charger does not shut off.
See Figure 4-E
Does timer knob turn after starting the charger?
If yes, replace timer motor or timer assembly.
If no, check timer motor input (not timer switch) for 115 VAC.
If OK, replace timer assembly.
If not OK, check timer motor wiring and repair as required.


Sharp reduction of tractor range and/or power. Operation otherwise normal.
Is SPG of all cells at an acceptable value after a complete charge cycle?
If no, refer to trouble-shooting section which reads, "Power Pack does not charge fully."
If yes, check for a defective battery as outlined in Chapter 2 of this manual.
If OK, check all high current motor circuits for poor connections.
If not OK, replace defective battery.
If OK, suspect drive motor.
If not OK, repair as required.


Attachment does not operate when plugged into PTO receptacle when turned on.
Does PTO contactor pick up? (You can hear this or measure its coil voltage when the PTO switch is turned on.
If yes, check PTO contactor contacts for condition and closure, PTO receptacle and its wiring.
If no, check PTO contactor coil resistance versus an identical coil, coil wiring, and Card No. 1 positive inputs, pads 1 and 2.
If ok, suspect defective attachment wiring or its motor.
If not OK, repair faulty wiring or replace defective component.
If OK, replace card No. 1.
If not OK, repair faulty wiring or replace defective component.

4.5 BRAKE SERVICE

Mechanical Adjustment - Referring to Figure 4-19, adjust the rear caliper unit of the brake as follows:

1. Release parking brake.
2. Remove cotter pin from caliper unit.
3. Tighten caliper castle nut until a clearance of 0.005 inch as measured with a feeler gauge remains between friction pad and disk on either side of the disk.
4. Replace cotter pin. If it is necessary to align the castle nut slot with the hole in the stud, only loosen the castle nut.
5. Test braking.

Brake Switch Adjustment - The brake switch is adjusted properly when approximately 1/4 inch of brake pedal arm travel remains after drive power has been switched off by the actuation of the brake switch. This 1/4 inch should be measured on a perpendicular line from the brake pedal arm to the contact point on the left foot rest.

With the switch and caliper unit properly adjusted, drive power can be restored while maintaining the mechanical braking of the tractor by slightly releasing the brake pedal. This allows the brake switch to return to its unactuated position. Adjustment is made as follows, referring to Figure 4-19:

1. Loosen shoulder screw, reference number 11.
2. Reposition shoulder screw in slotted pawl and tighten in place. Move screw forward to delay actuation of brake switch.
3. Retest brake and measure for 1/4 inch travel as required.
4. Repeat steps 1 through 4 if required.

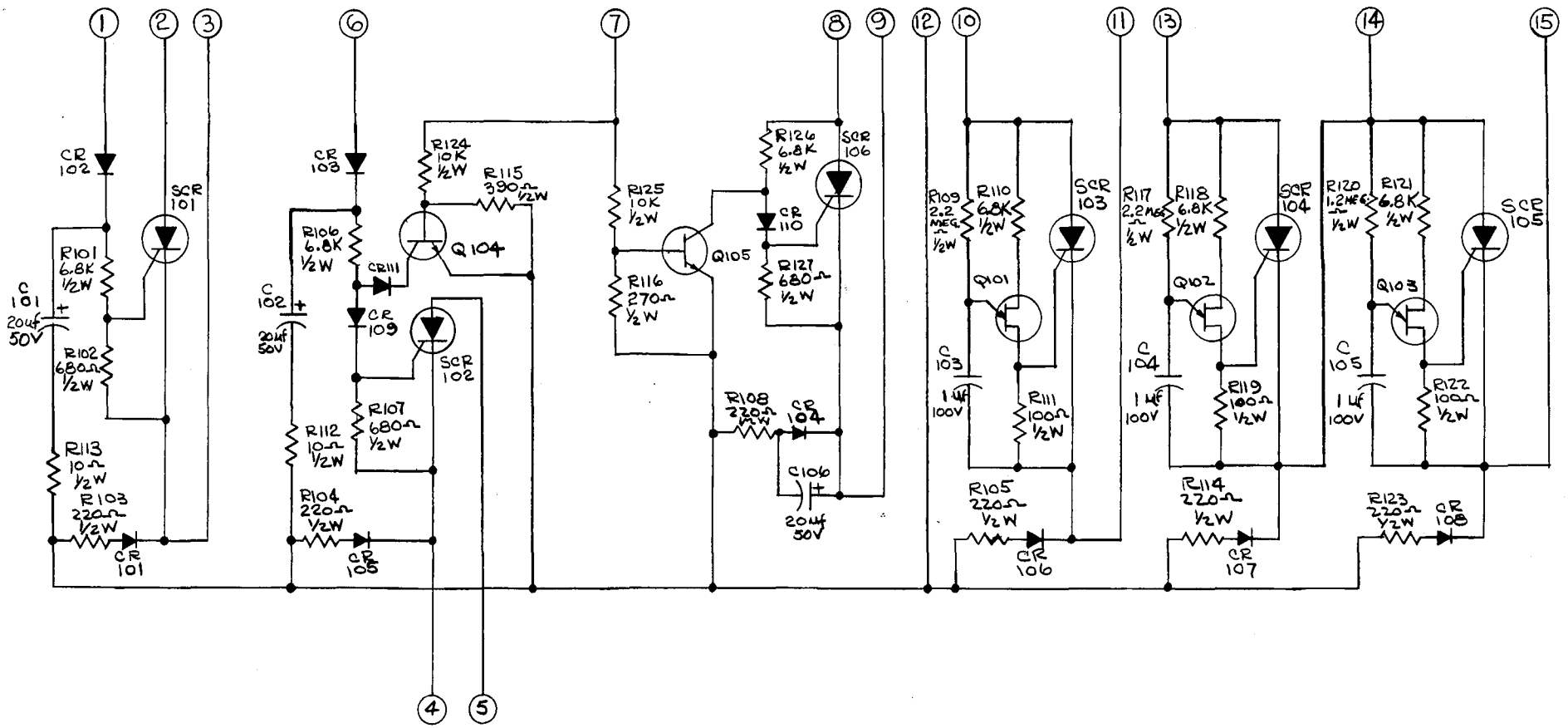


Fig. 4-2 26AE15 Card #1 (Control) Schematic

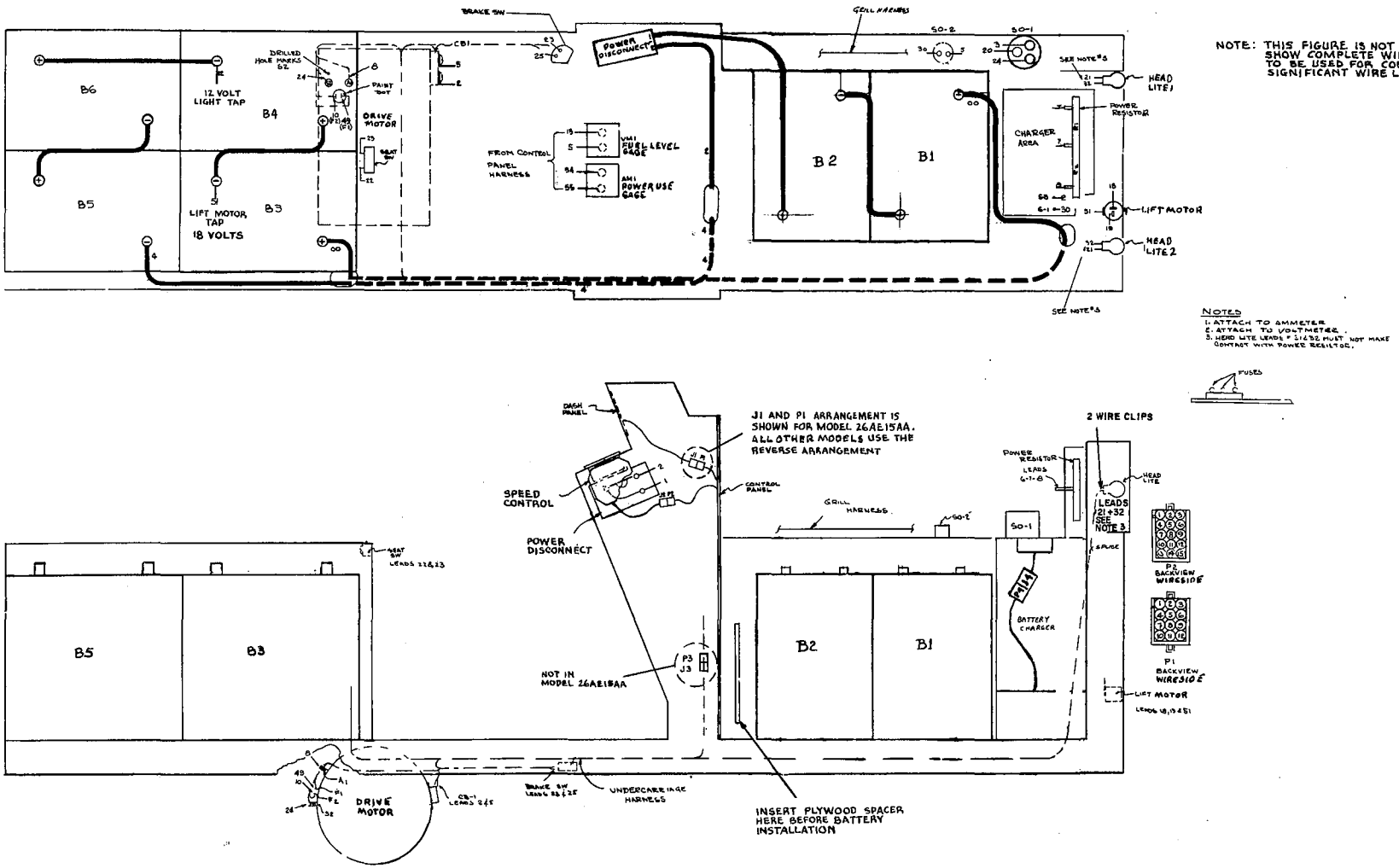
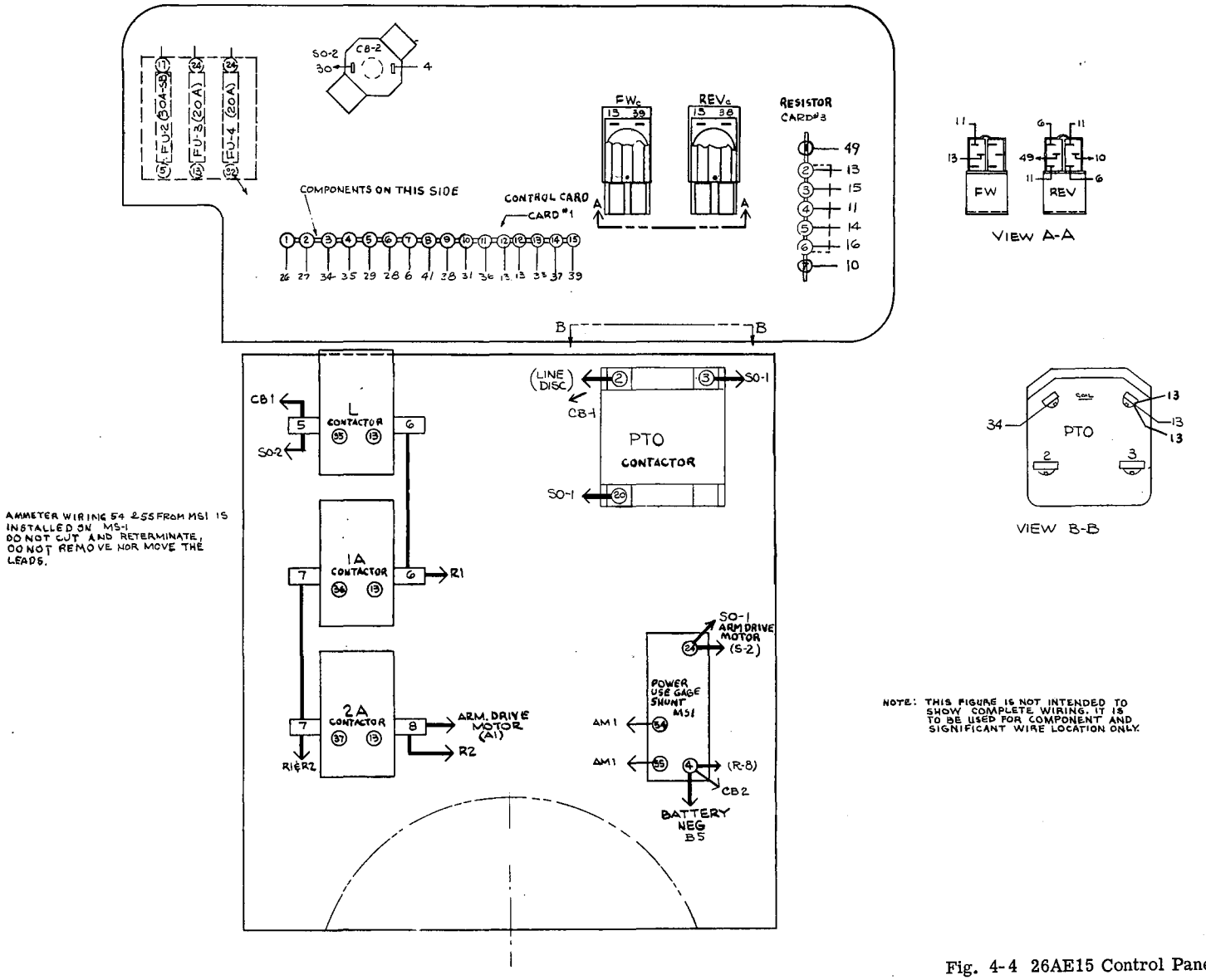


Fig. 4-3 26AE15 Tractor Wiring



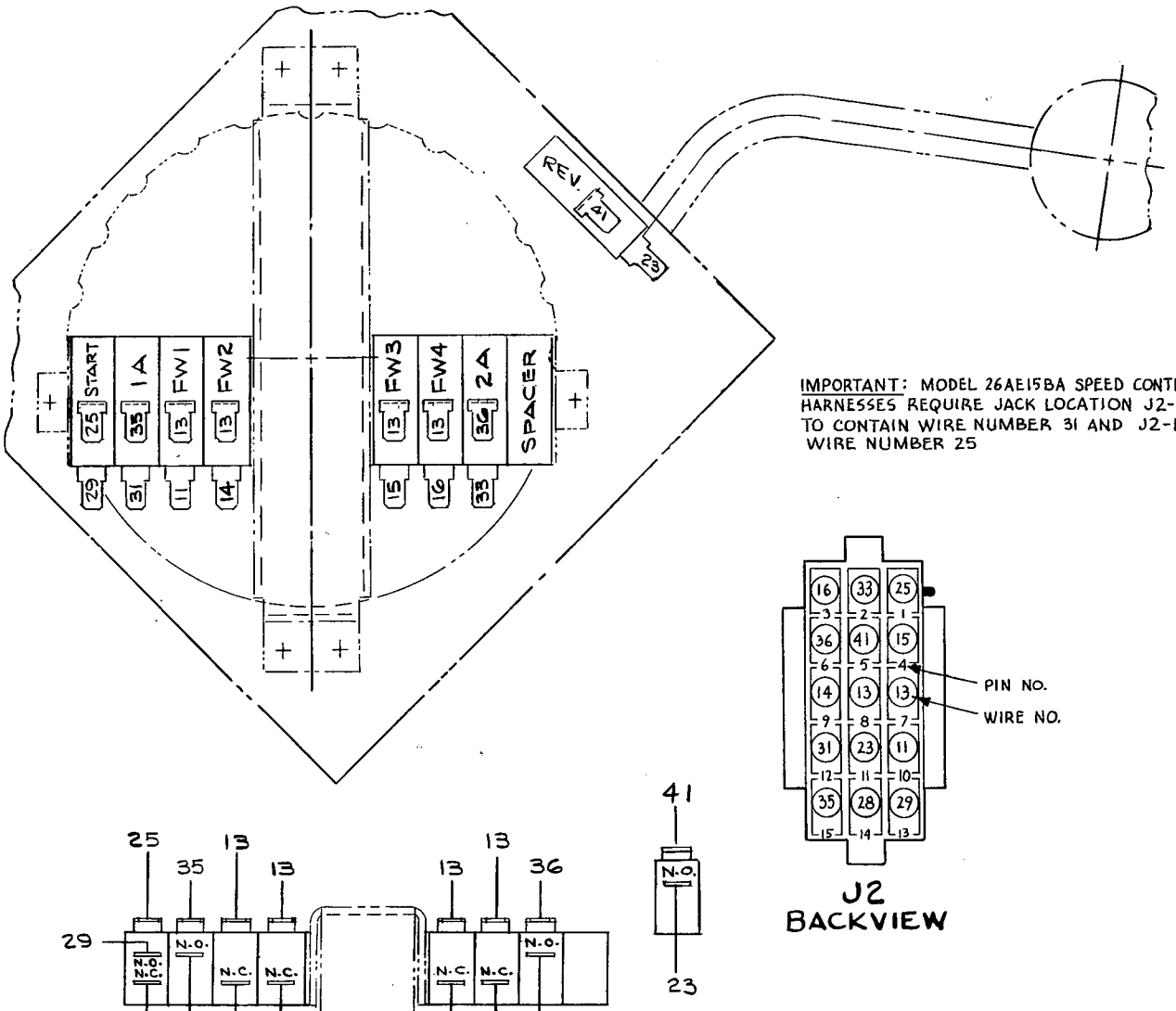
VIEW A-A

VIEW B-B

AMMETER WIRING 54 & 55 FROM MS1 IS INSTALLED ON MS-1 DO NOT CUT AND RETERMINATE. DO NOT REMOVE NOR MOVE THE LEADS.

NOTE: THIS FIGURE IS NOT INTENDED TO SHOW COMPLETE WIRING. IT IS TO BE USED FOR COMPONENT AND SIGNIFICANT WIRE LOCATION ONLY.

Fig. 4-4 26AE15 Control Panel Wiring



IMPORTANT: MODEL 26AE15BA SPEED CONTROL HARNESSES REQUIRE JACK LOCATION J2-1 TO CONTAIN WIRE NUMBER 31 AND J2-12 WIRE NUMBER 25

J2
BACKVIEW

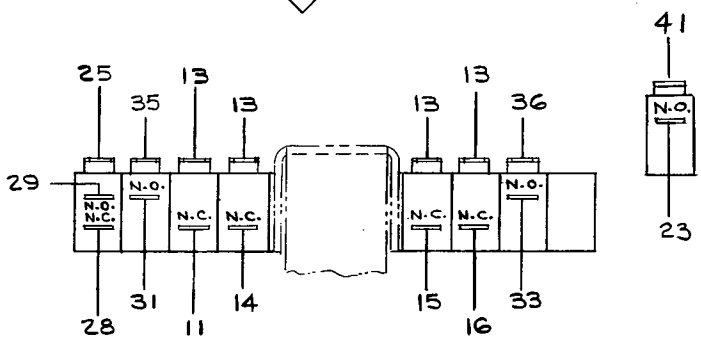
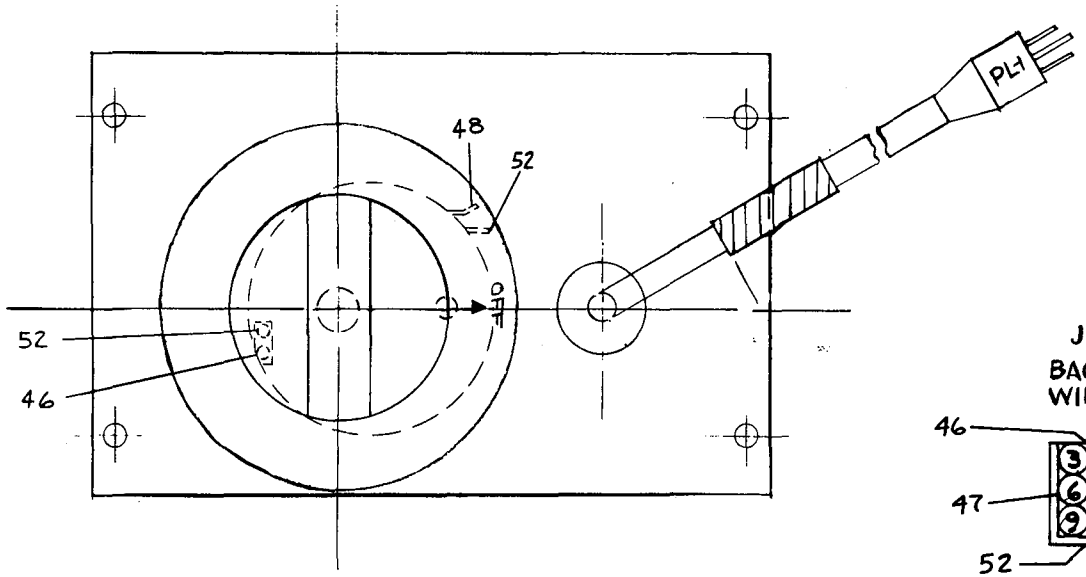
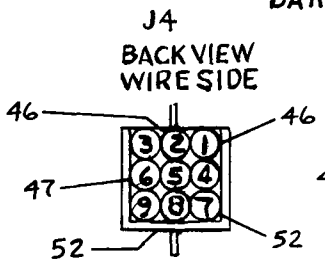


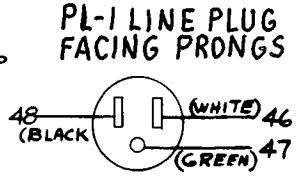
Fig. 4-5 26AE15 Speed Control Wiring



NOTES:

1. J4-1 & J4-2 (LEAD 46) USE COMMONING BAR IN MATING PLUG.
2. J4-7 & J4-8 (LEAD 52) USE COMMONING BAR IN MATING PLUG.





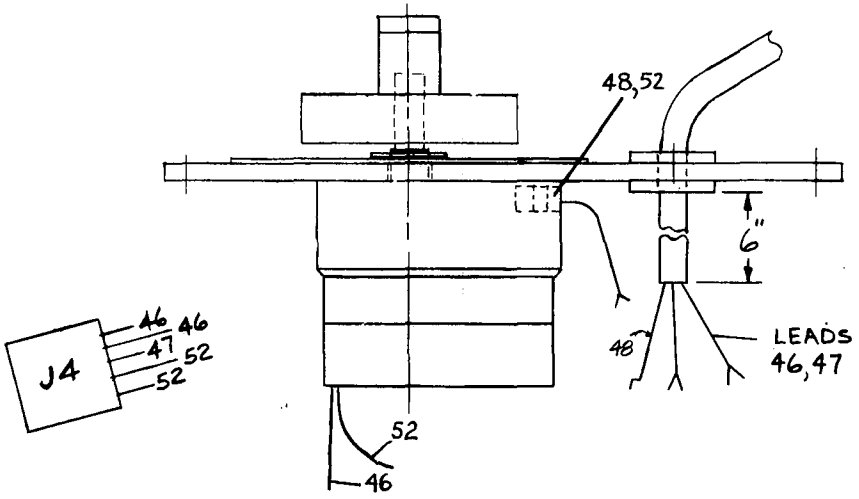
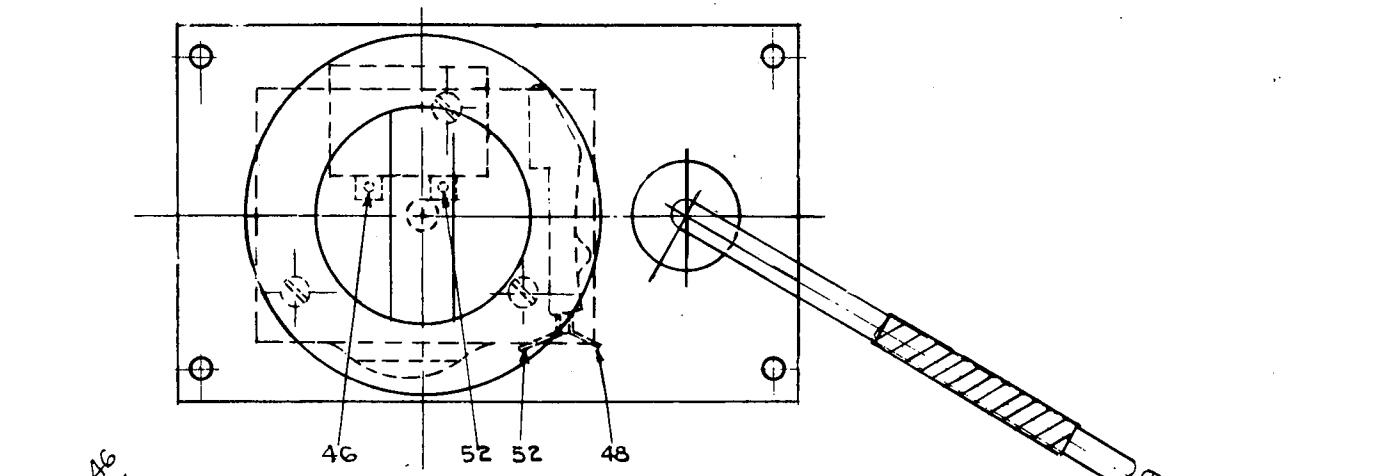
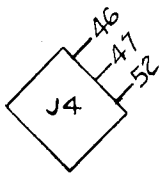
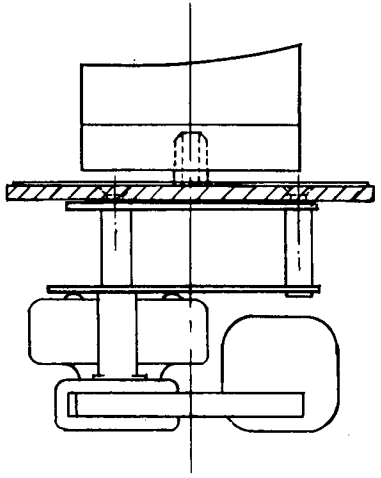
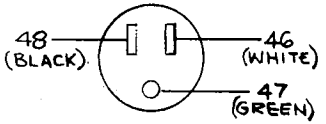


Fig. 4-6 26AE15 Timer Assembly Wiring
Model 26AE15A has alternate methods.
See Fig. 4-7.

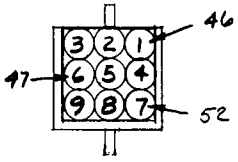








PL-1 LINE PLUG
FACING PRONGS



J4
BACK VIEW
WIRE SIDE

THIS DRAWING FOR WIRING INFORMATION ONLY.
FOR PART REPLACEMENT ORDER TIMER ASSEMBLY, PART.NO. 163B9906G2

Fig. 4-7 26AE15AA* Timer Assembly Wiring
*This is one alternate method. See Fig. 4-6.

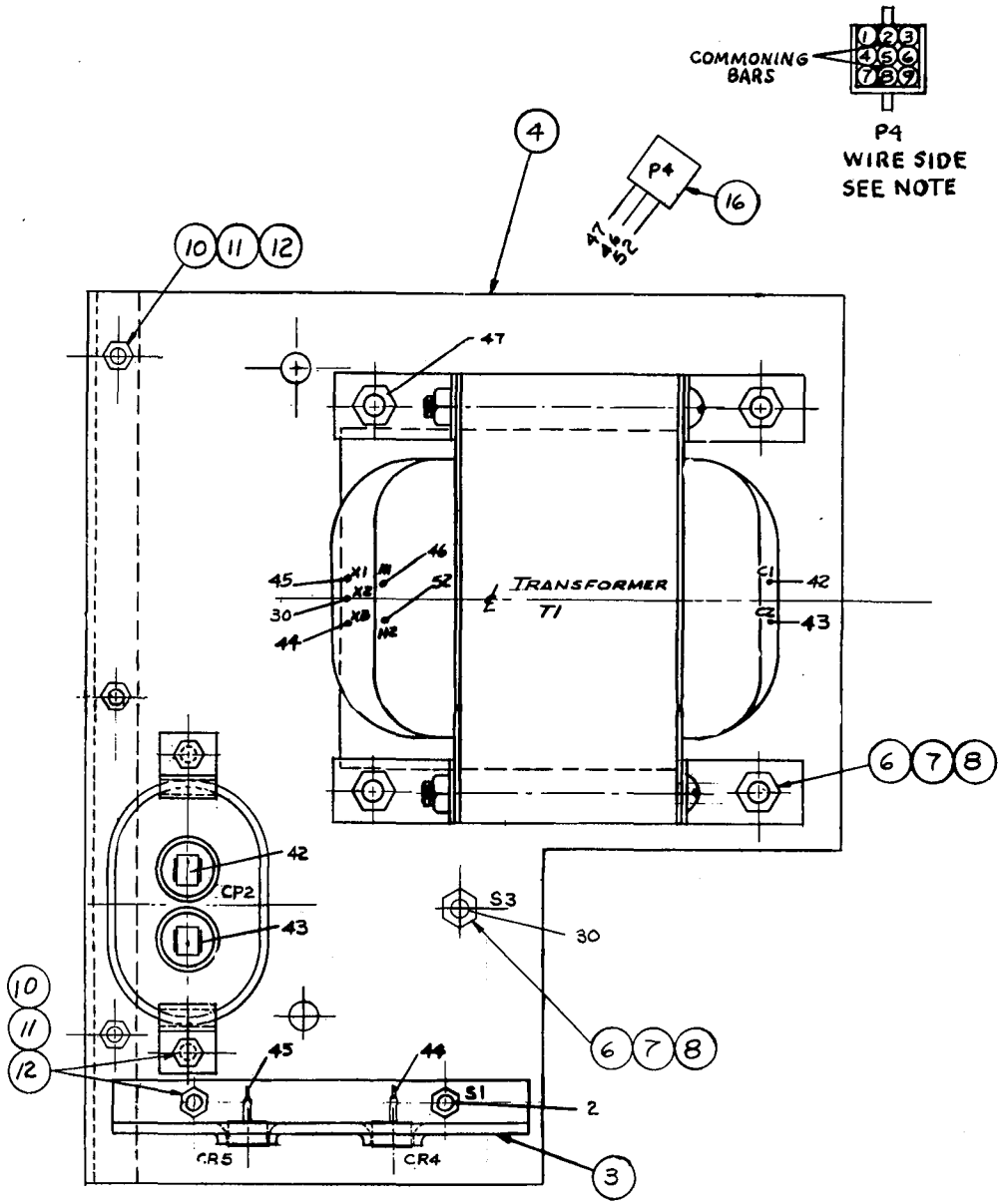
BATTERY CHARGER SUB-ASSEMBLY
Use this list to order replacement parts from Fig. 4-8.

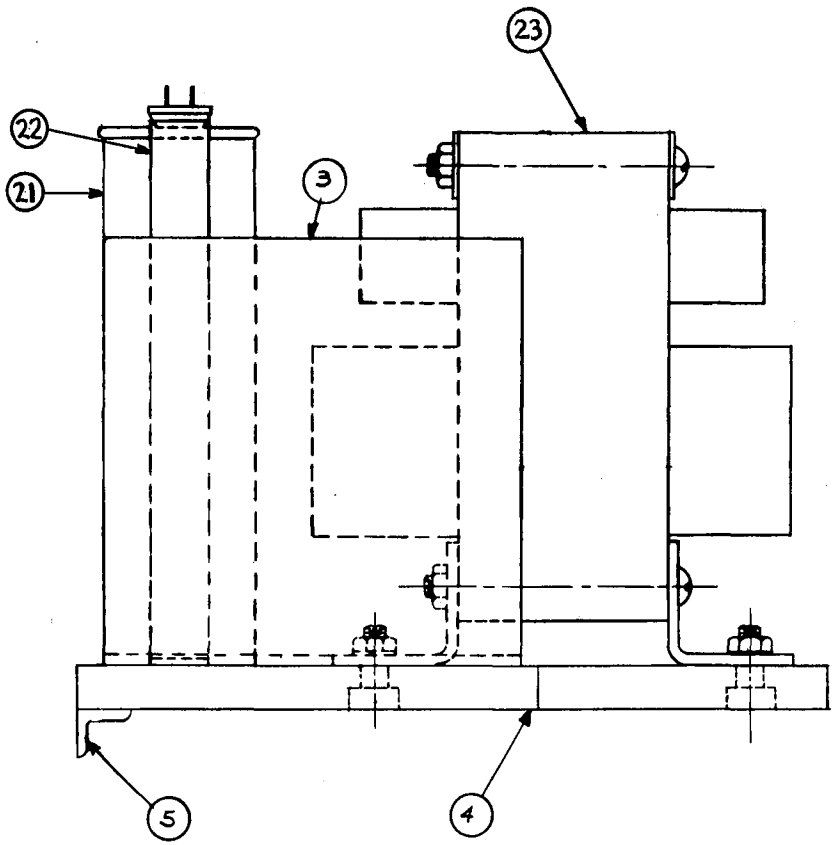
Fig. 4-8, 423D211, Rev 4

P. L. 423D211, Rev 6

Ref. No.	Description	Part Number	26A					
			E12A	E12B	E15A	E15B	E15C	E20A
1	Charger Sub-assembly (All parts as shown)	(3)	X	-	X	X	-	-
23	Transformer	163B9917P1	X	-	X	X	-	-
3	Heat Sink Assembly	163B9905G1	X	-	X	X	-	-
4	Base	(2)	X	-	X	X	-	-
5	Base Support	(2)	X	-	X	X	-	-
6	Hex Cap Screw 1/4-20 x 1	(1)	X	-	X	X	-	-
7	Hex Nut 1/4-20	(1)	X	-	X	X	-	-
8	Spring Washer 1/4"	(1)	X	-	X	X	-	-
10	Hex Machine Screw 10-32 x 1 1/8	(1)	X	-	X	X	-	-
11	Hex Nut 10-32	(1)	X	-	X	X	-	-
12	Spring Washer #10	(1)	X	-	X	X	-	-
16	Plug P4	243A4564P3	X	-	X	X	-	-
21	Capacitor	243A4514P1	X	-	X	X	-	-
22	Bracket	211A3510P1	X	-	X	X	-	-
A	Base (Molded). Replaces Ref. 4 and 5	541C932P1	X	-	X	X	-	-
B	Charger Sub-Assembly	423D225G1	X	X	X	X	X	X

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.
(2) Order part listed under Reference Number A.
(3) Order part listed under Reference Number B.





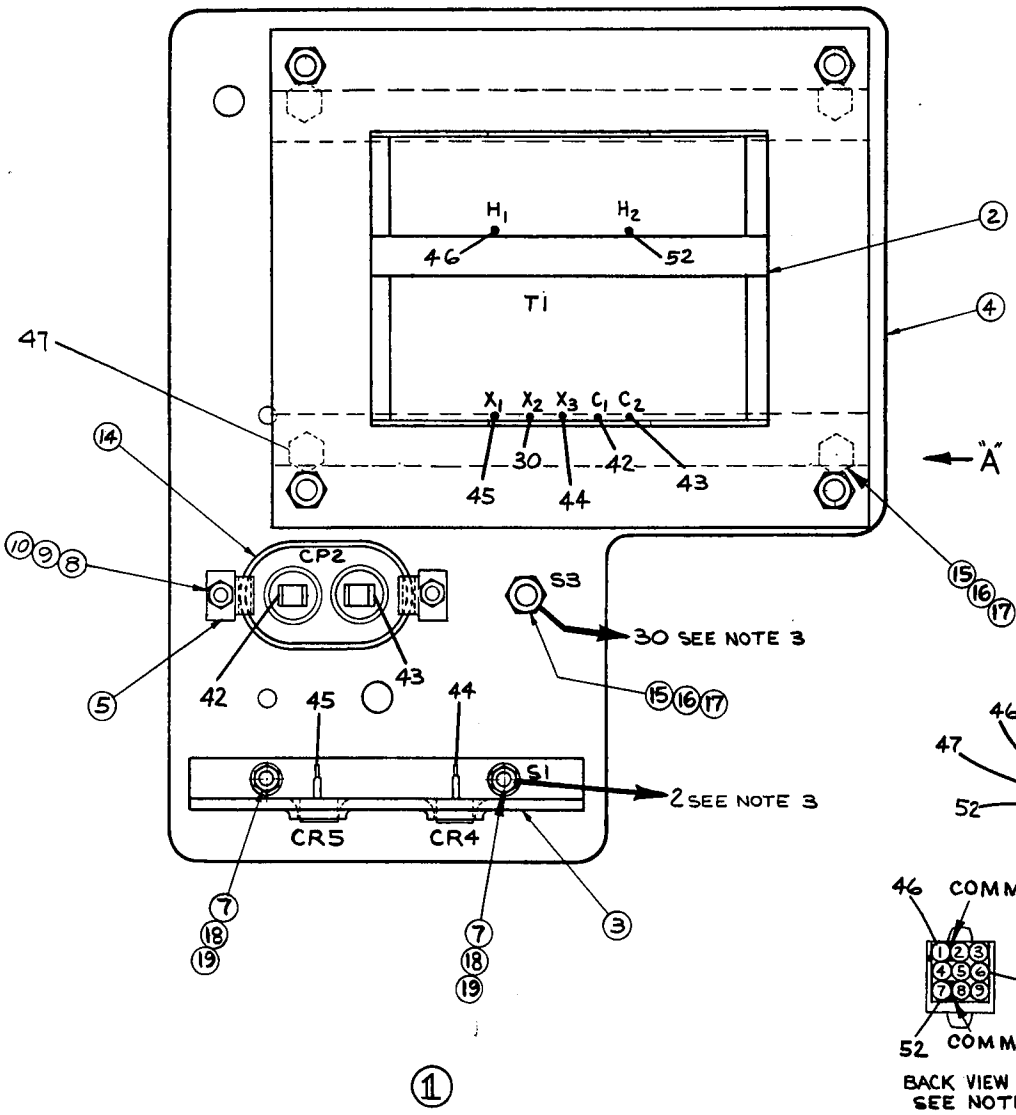
NOTE: COMMON PINS P4-1 TO P4-2 & P4-7 TO P4-8 IN P4

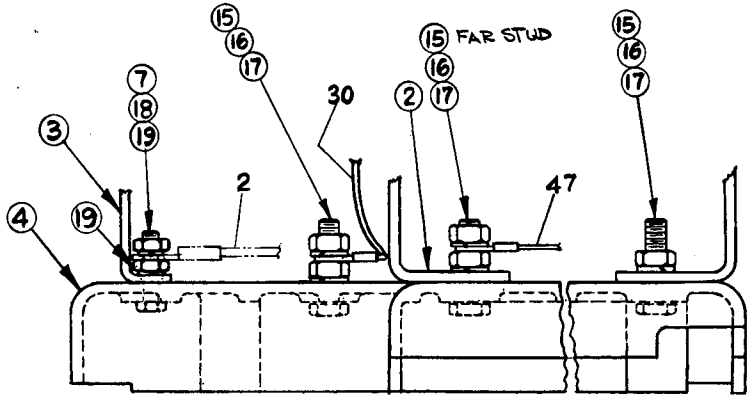
Fig. 4-8 26AE15 Battery Charger Sub-Assembly
Also see Fig. 4-8.1.

BATTERY CHARGER SUB-ASSEMBLY
Use this list to order replacement parts from Fig. 4-8.1

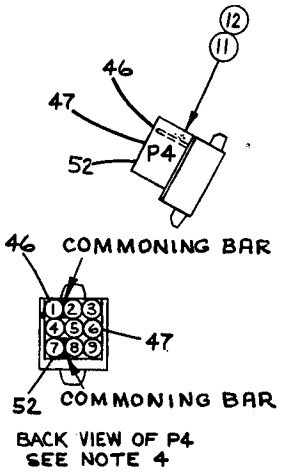
Ref. No.	Description	Part Number	26A						
			E12A	E12B	E15A	E15B	E15C	E20A	E20B
1	Assembly (All parts as shown)	423D225G1	-	X	-	-	X	X	X
2	Transformer	163B9955P1	-	X	-	-	X	X	X
3	Heat Sink Assembly	163B9905G1	-	X	-	-	X	X	X
4	Base	541C932P1	-	X	-	-	X	X	X
5	Bracket	211A3510P2	-	X	-	-	X	X	X
7	Machine Screw Hex Head 10-32 x 7/8	(1)	-	X	-	-	X	X	X
8	Machine Screw Hex Head 8-32 x 3/4	(1)	-	X	-	-	X	X	X
9	Hex Nut 8-32	(1)	-	X	-	-	X	X	X
10	Lock Washer #8	(1)	-	X	-	-	X	X	X
11	Plug P4	243A4564P3	-	X	-	-	X	X	X
14	Capacitor	243A4653P1	-	X	-	-	X	X	X
15	Lock Washer 1/4	(1)	-	X	-	-	X	X	X
16	Bolt, Hex Head 1/4-20 x 1	(1)	-	X	-	-	X	X	X
17	Nut, Hex 1/4-20	(1)	-	X	-	-	X	X	X
18	Lock Washer #10	(1)	-	X	-	-	X	X	X
19	Nut, Hex 10-32	(1)	-	X	-	-	X	X	X

(1) Not stocked, order locally. For bolt and screw replacement, use Grade 5 or better.





VIEW AT "A"



NOTES:

1. WIRES FROM S1 & S3 TO TRACTOR ARE INCLUDED IN TRACTOR WIRE HARNESS.
2. USE LEADS & TERMINALS SUPPLIED WITH TRANSFORMER.
3. PLACE WIRE BETWEEN TWO NUTS.
4. COMMON PINS P4-1 TO P4-2 & P4-7 TO P4-8 IN P4
5. SOLDER WIRE NO'S 44 & 45 FROM TRANSFORMER TO HEAT SINK DIODES.
6. ➡ INDICATES CONNECTION TO BE MADE UPON INSTALLATION OF CHARGER IN TRACTOR.

Fig. 4-8.1 26AE15 Battery Charger Sub-Assembly
Also see Fig. 4-8.

DASH ASSEMBLY

Use this list to order replacement parts from Fig. 4-9.

Fig. 4-9, 163B9972G1, Rev 0

P. L. 163B9822, Rev 2

Ref. No.	Description	Part Number	26A					
			E12A	E12B	E15A	E15B	E15C	E20A
3	Dash Panel	163B9821P1	X	X	X	X	X	X
4	Lift Switch	243A4531P2	X	X	X	X	X	X
5	PTO Switch	243A4531P1	X	X	X	X	X	X
6	Light	243A4574P1	X	X	X	X	X	X
7	Lamp	211A3591P1	X	X	X	X	X	X
8	Key Switch	243A4573P1	X	X	X	X	X	X
9	Light Switch	243A4531P3	X	X	X	X	X	X
10	Dash Harness	541C955G1	X	X	X	X	X	-
10	Dash Harness	541C994G1	-	-	-	-	-	X
11	Tubing	211A3551P1	X	X	X	X	X	X

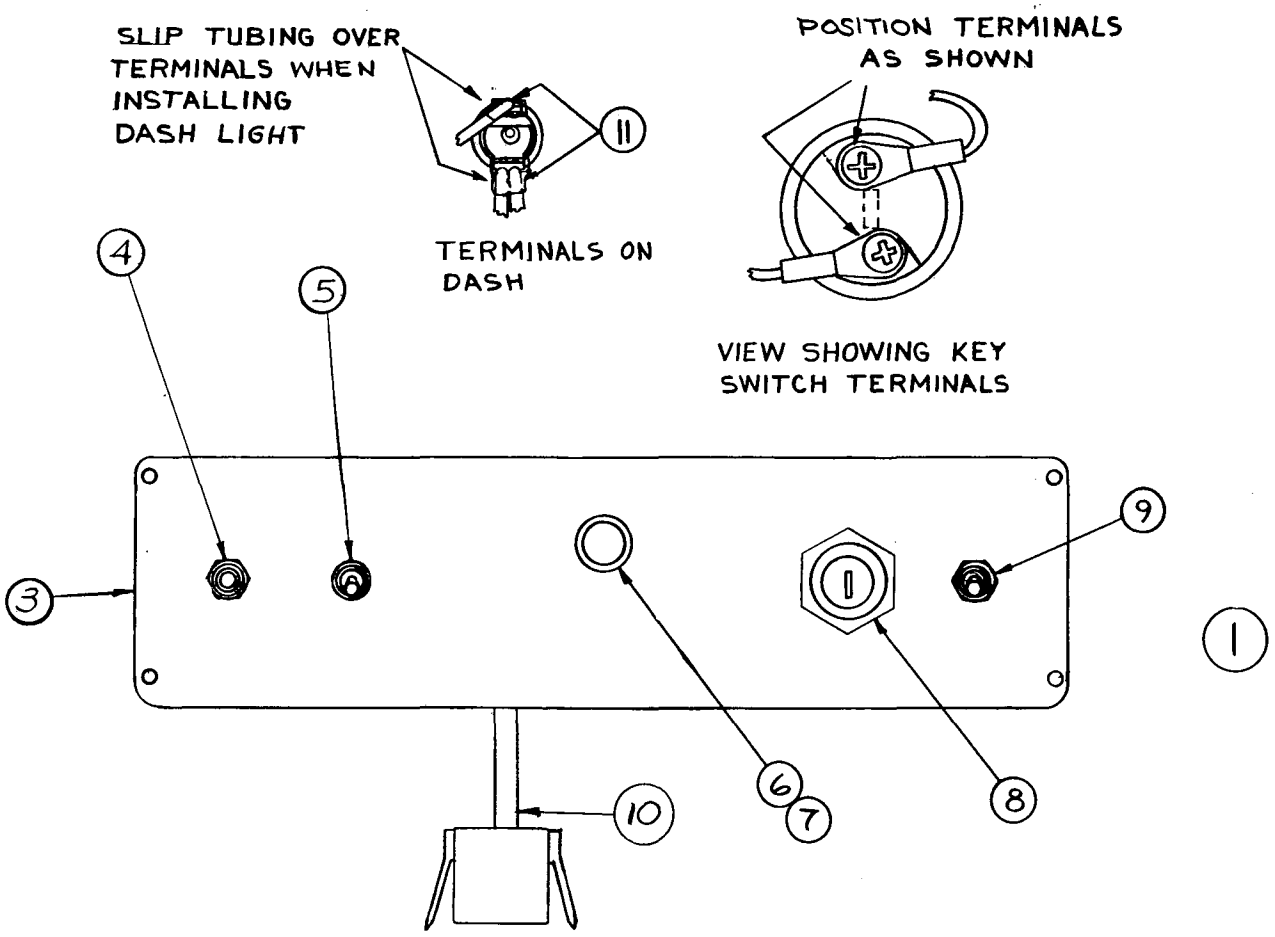


Fig. 4-9 26AE15 Dash Assembly

Fig. 4-10, 422D831, Rev 8

P.L. 422D831, Rev 6, 4

CONTROL PANEL ASSEMBLY

Use this list to order replacement parts from Fig. 4-10.

Ref. No.	Description	Part Number	26A						
			E12A	E12B	E15A	E15B	E15C	E20A	E20B
5	Card #1 (Control)	163B9814G1	-	-	X	X	X	-	-
6	Circuit Breaker (Manual Reset)	243A4719P1	-	-	X	X	X	-	-
7	Card #3 (Field Resistor)	211A3162G1	-	-	X	X	X	-	-
8	Contactor, (PTO)	243A4524P1	-	-	X	X	X	-	-
9	Pan Hd. Phillips Screw 10-32 x 3/8	(1)	-	-	X	X	X	-	-
10	Shunt Assembly (Less Power Use Gage)	211A3164G1	-	-	X	X	X	-	-
11	Fuse Board	243A4591P1	-	-	X	X	X	-	-
12	Contactor	211A3567P1	-	-	X	X	X	-	-
13	Pan Hd. Phillips Screw 6-32 x 3/8	(1)	-	-	X	X	X	-	-
14	Lockwasher #6	(1)	-	-	X	X	X	-	-
15	Pan Hd. Phillips Screw 8-32 x 3/8	(1)	-	-	X	X	X	-	-
16	Lockwasher #8	(1)	-	-	X	X	X	-	-
17	Self Tap Phillips Screw 6-32 x 1/2	(1)	-	-	X	X	X	-	-
18	Hex Head Screw 1/4-20 x 3/8	(1)	-	-	X	X	X	-	-
19	Lockwasher #10	(1)	-	-	X	X	X	-	-
20	Self Tap Phillips Screw 10-32 x 1/2	(1)	-	-	X	X	X	-	-
22	Relay	243A4562P1	-	-	X	X	X	-	-
25	Lockwasher 1/2"	(1)	-	-	X	X	X	-	-
26	Fuse (FU3, FU4) 3AG20A	243A4657P1	-	-	X	X	X	-	-
27	Fuse (FU2) 3AG30ASB	243A4597P1	-	-	X	X	X	-	-
28	Pan Hd. Phillips Screw 10-32 x 3/8	(1)	-	-	X	X	X	-	-
29	Hex Nut 10-32	(1)	-	-	X	X	X	-	-
30	Washer #10	(1)	-	-	X	X	X	-	-
31	Control Panel Harness	423D216G1	-	-	X	-	-	-	-
31	Control Panel Harness	423D236G1	-	-	-	X	-	-	-
31	Control Panel Harness	423D245G1	-	-	-	-	X	-	-
32	Grill Harness	541C924G1	-	-	X	-	-	-	-
32	Grill Harness	541C958G1	-	-	-	X	X	-	-

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

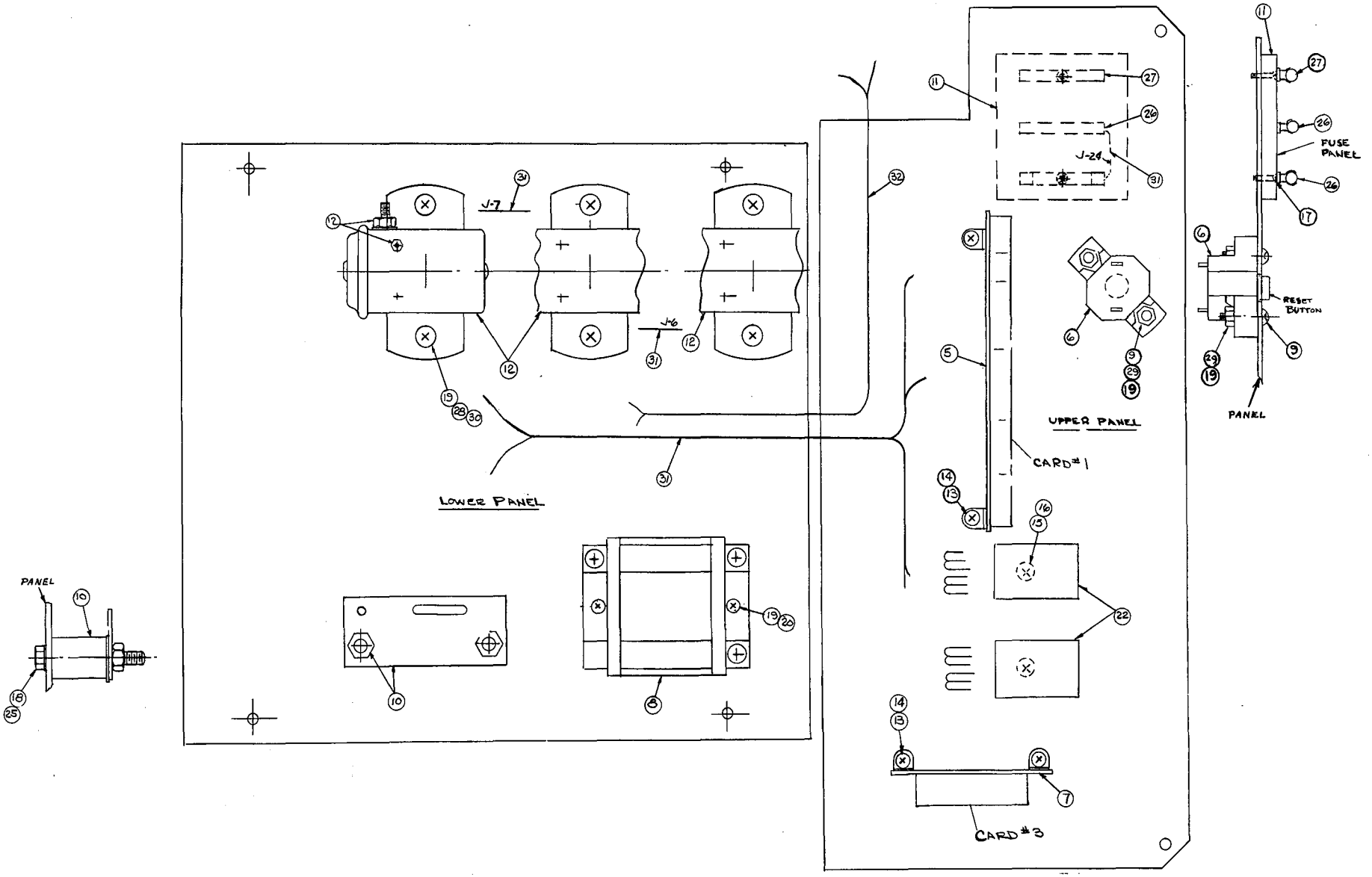


Fig. 4-10 26AE15 Control Panel Assembly

SPEED CONTROL ASSEMBLY

Use this list to order replacement parts from Fig. 4-11.

Fig. 4-11, 423D213, Rev 3

Ref. No.	Description	Part Number	26A					
			E12A	E12B	E15A	E15B	E15C	E20A
1	Speed Control Assembly (All parts as shown)	423D213G1	-	-	X	-	X	-
1	Speed Control Assembly (All parts as shown)	423D213G3	X	X	-	-	-	-
1	Speed Control Assembly (All parts as shown)	423D213G2	-	-	-	X	-	-
10	Knob	211A3249P1	X	X	X	X	X	-
11	Switch (Start)	211A3198P1	X	X	X	X	X	-
12	Switch (1A, 2A)	211A3198P2	X	X	X	X	X	-
13	Switch (FW SW 1-4)	211A3198P3	X	X	X	X	X	-
19	Switch (Reverse)	211A3558P1	X	X	X	X	X	-
25	Self-Tapping Screw 6-32 x 1/4	(1)	X	X	X	X	X	-
26	Flat Hd. Screw 4-40 x 3/4	(1)	X	X	X	X	X	-
27	Pan Hd. Screw 4-40 x 1 3/4	(1)	X	X	X	X	X	-
29	Lockwasher, Internal Tooth #6	(1)	X	X	X	X	X	-
30	Lockwasher, Internal Tooth #4	(1)	X	X	X	X	X	-
36	Lockwasher, Spring #4	(1)	X	X	X	X	X	-
37	Hex Nut 4-40	(1)	X	X	X	X	X	-
38	Speed Control Harness	541C919G1	-	-	X	-	X	-
39	Speed Control Harness	541C957G1	X	X	-	X	-	-

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

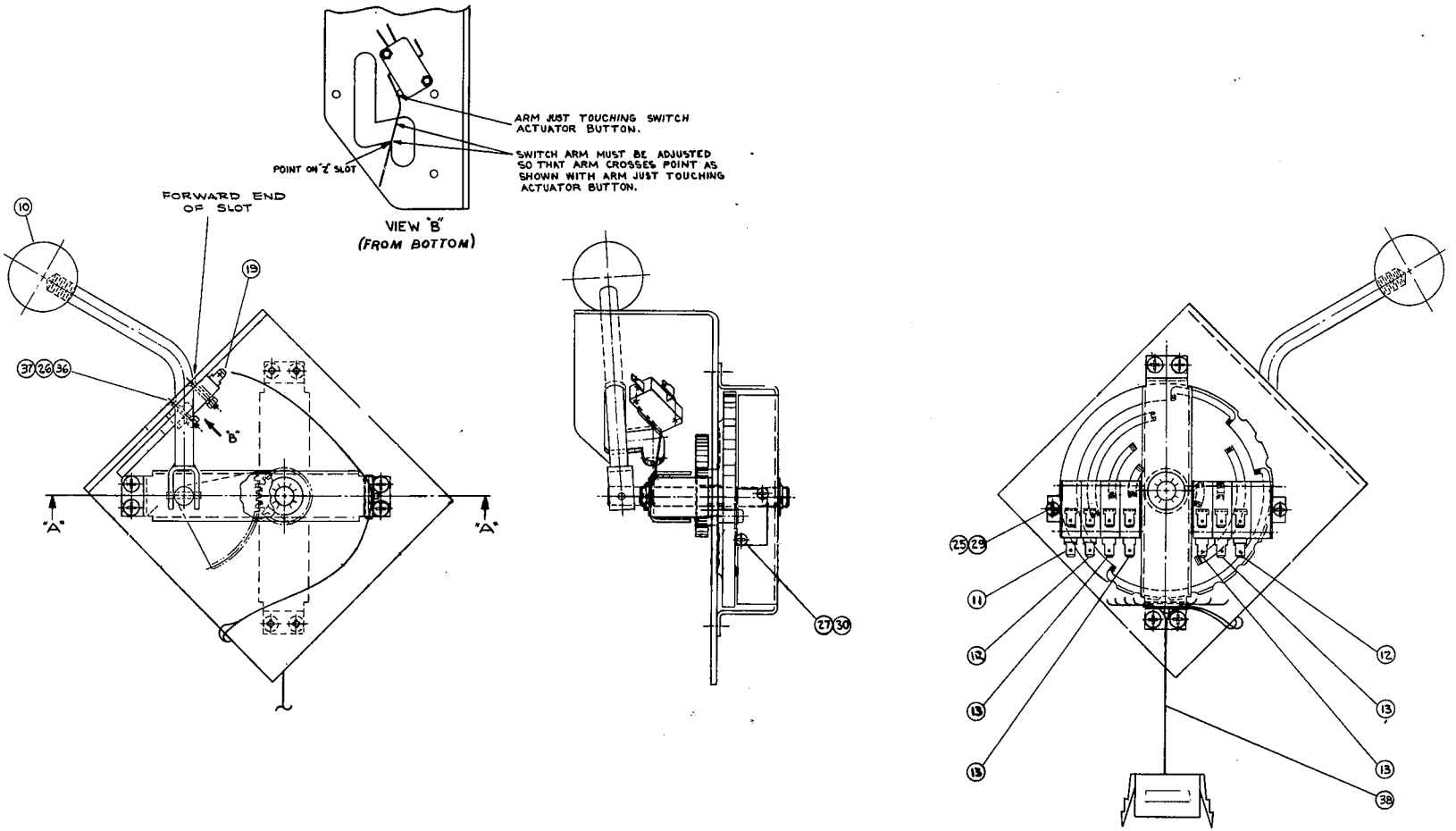


Fig. 4-11 26AE15 Speed Control Assembly

CHARGER COVER ASSEMBLY

Use this list to order replacement parts from Fig. 4-12.

Ref. No.	Description	Part Number	26A						
			E12AA	E12B	E15A	E15B	E15C	E20A	E20B
2	Timer Assembly	163B9906G2	X	X	X	X	X	-	-
3	Power Resistor Assembly	163B9904G1	X	X	X	X	X	-	-
4	Cover	541C917P1	X	X	X	X	X	-	-
5	Pan Hd. Phillips Screw 10-24 x 3/8	(1)	X	X	X	X	X	-	-
6	Speed Nut	211A3562P1	X	X	X	X	X	-	-
A	Timer Knob	243A4549P1	X	X	X	X	X	-	-
B	Charger Cord Assembly	211A3555G1	X	X	X	X	X	-	-

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

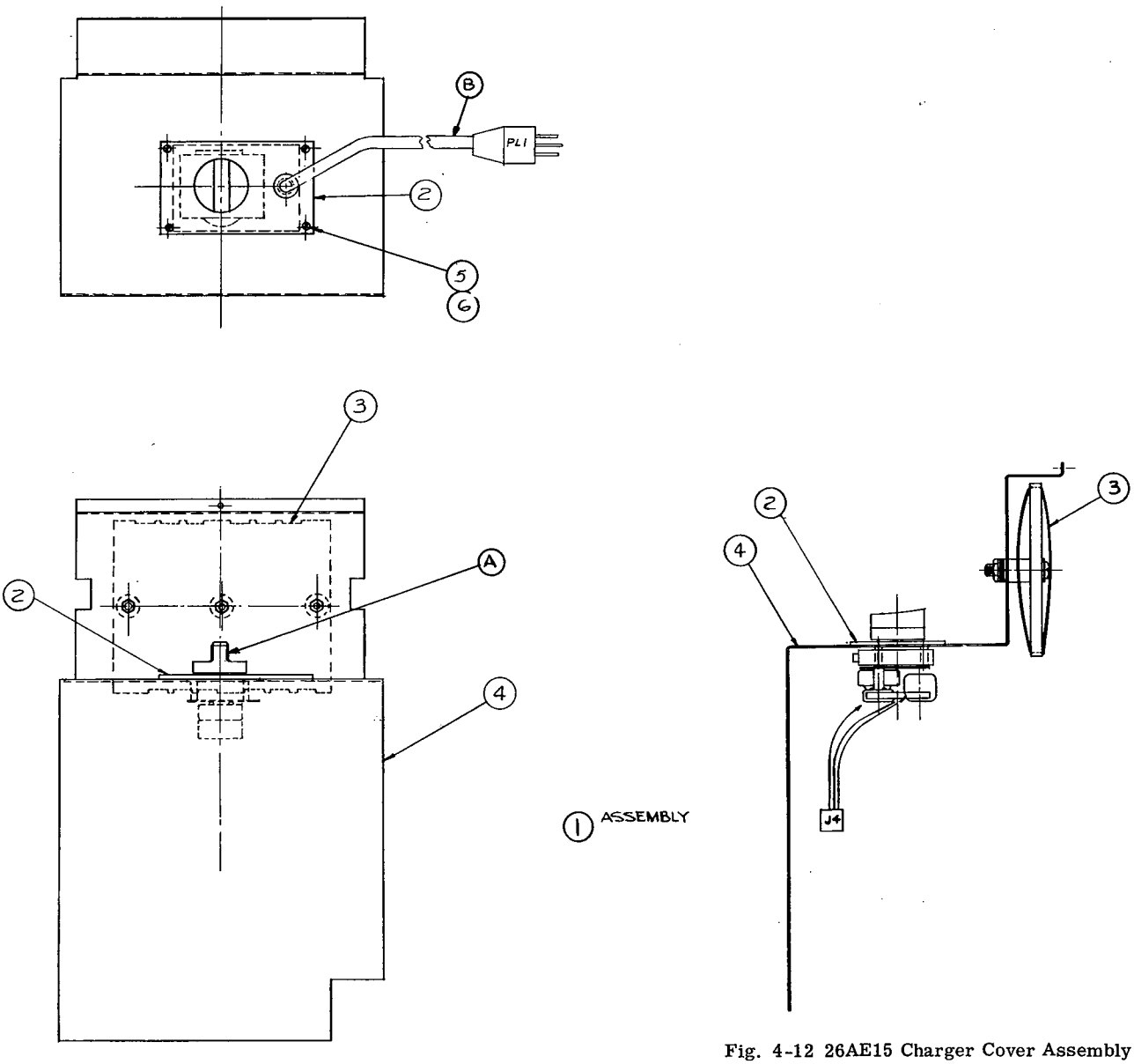


Fig. 4-12 26AE15 Charger Cover Assembly

FRONT AXLE ASSEMBLY

Use this list to order replacement parts from Fig. 4-13.

Ref. No.	Description	Part Number	26A						
			E12A	E12B	E15A	E15B	E15C	E20A	
2	Front Axle	541C685P1	X	X	X	X	X	X	
5	Snap Ring	N922P75C6	X	X	X	X	X	X	
6	Thrust Washer	243A4587P1	X	X	X	X	X	X	
7	Grease Fitting	243A4609P1	X	X	X	X	X	X	
8	Washer 3/8"	(1)	X	X	X	X	X	X	
9	Hex Hd. Locking Screw	243A4592P1	X	X	X	X	X	X	
10	Pivot Pin (Headless)	211A3284P1	X	X	X	X	X	X	
15	Roll Pin 1/8 x 1" (2 Required)	N533P1316	X	X	X	X	X	X	
C	Spindle (Left)	211A3595P1	X	X	X	X	X	X	
D	Spindle (Right)	211A3595P2	X	X	X	X	X	X	

(1) Not stocked, order locally. For bolt and screw replacement, use Grade 5 or better.

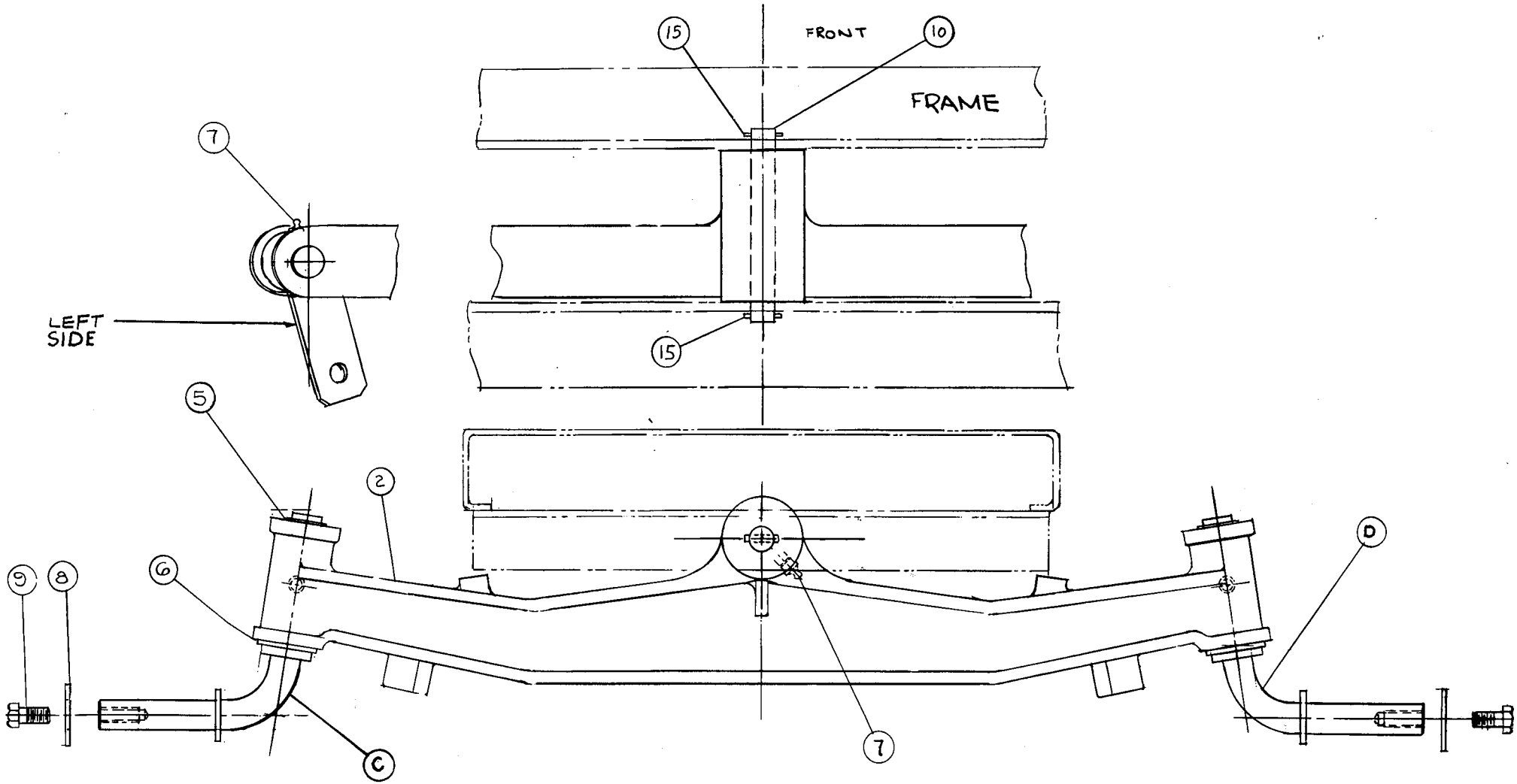


Fig. 4-13 26AE15 Front Axle Assembly

STEERING ASSEMBLY

Use this list to order replacement parts from Fig. 4-14.

Ref. No.	Description	Part Number	26A						
			E12A	E12B	E15A	E15B	E15C	E20A	E20B
2	Gear and Sector Assembly	542C898G1	X	X	X	X	X	X	X
3	Steering Shaft and Pinion	211A3416G1	X	X	X	X	X	-	-
3	Steering Shaft and Pinion	211A3416G2	-	-	-	-	-	X	X
4	Bearing	243A4561P1	X	X	X	X	X	X	X
5	Mounting Bracket	541C902P1	X	X	X	X	X	X	X
6	Plain Washer	N402AP18B6	X	X	X	X	X	X	X
7	Shim Washer	243A4613P1	X	X	X	X	X	X	X
8	Collar	243A4547P1	X	X	X	X	X	-	-
8	Collar	243A4547P2	-	-	-	-	-	X	X
9	Cap Screw 5/16-18 x 1	(1)	X	X	X	X	X	X	X
10	Nut, Hex 5/16-18	(1)	X	X	X	X	X	X	X
11	Lockwasher 5/16"	(1)	X	X	X	X	X	X	X
13	Tie Rod	(2)	X	X	X	X	X	X	X
14	Ball Joint	(2)	X	X	X	X	X	X	X
15	Lockwasher 1/2"	(1)	X	X	X	X	X	X	X
16	Nut, Hex 1/2-20	(1)	X	X	X	X	X	X	X
17	Cotter Pin 1/8 x 1 1/4	(1)	X	X	X	X	X	X	X
18	Bearing	243A4590P1	X	X	X	X	X	X	X
F	Bearing	211A3101P1	X	X	X	X	X	-	-
F	Bearing	211A3101P2	-	-	-	-	-	X	X
G	Lockwasher 5/16"	(1)	X	X	X	X	X	X	X
H	Cap Screw 5/16-18 x 1/2	(1)	X	X	X	X	X	X	X
J	Tie Rod & Ball Joint - Right	541C950P1	X	X	X	X	X	X	X
K	Tie Rod & Ball Joint - Left	541C950P2	X	X	X	X	X	X	X

(1) Not stocked, order locally. For bolt and screw replacement, use Grade 5 or better.

(2) Not available. Order parts designated by references J or K as required. These are non-adjustable tie rod - ball joint assemblies that replace all previous adjustable assemblies.

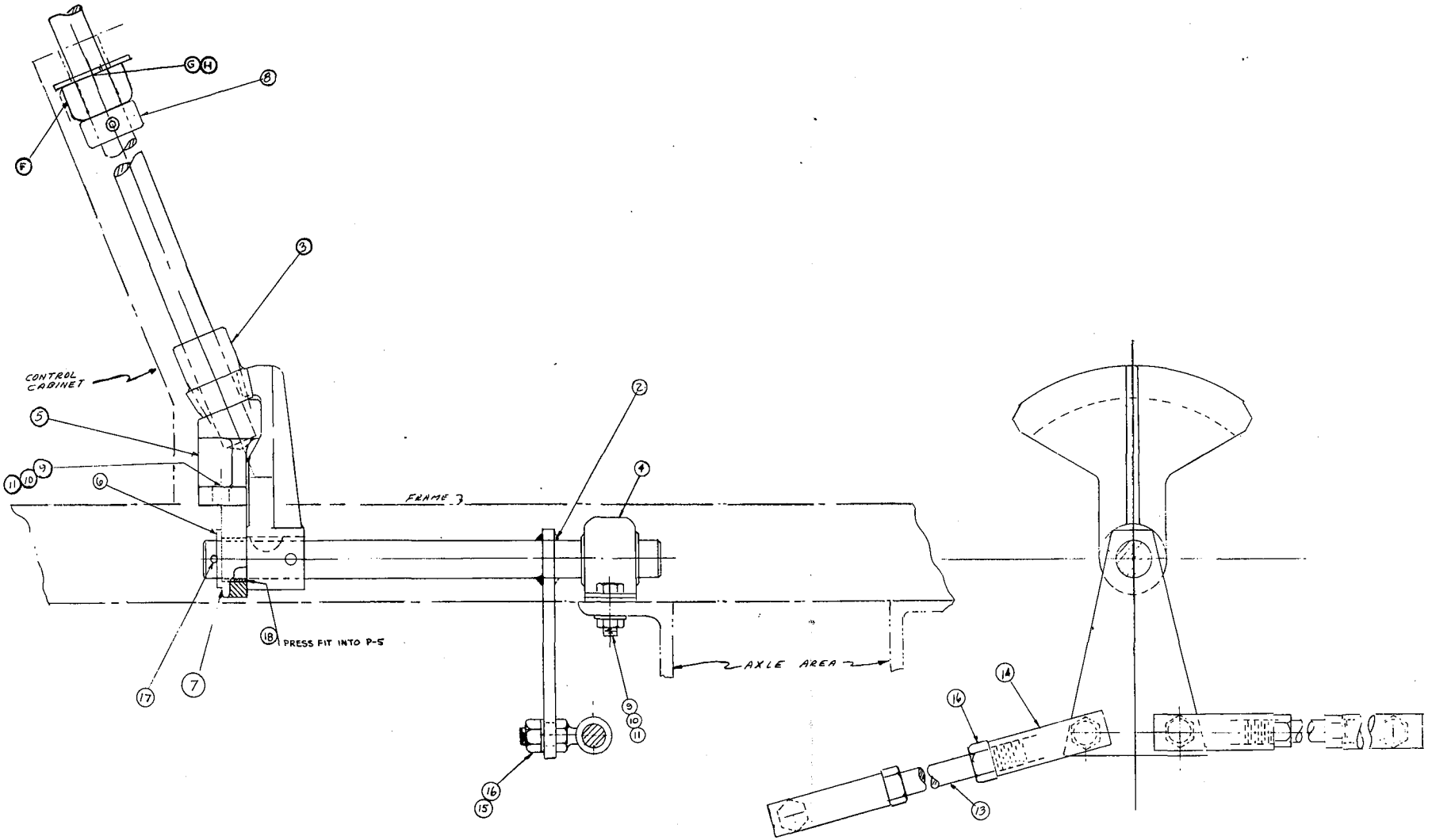


Fig. 4-14 26AE15 Steering Assembly

REAR AXLE ASSEMBLY

Use this list to order replacement parts from Fig. 4-15.

Ref. No.	Description	Part Number	26A						
			E12A	E12B	E15A	E15B	E15C	E20A	
2	Transaxle	422D818P1	X	X	X	X	X	X	
3	Hub	211A3107P1	X	X	X	X	X	X	
4	Key, Woodruff	N3400P809	X	X	X	X	X	X	
5	Set Screw, Sq. Head	(2)	X	X	X	X	X	X	
7	Key, Woodruff	N3400P606	X	X	X	X	X	X	
10	Pulley (Driven)	163B9877P1	-	-	X	X	X	X	
10	Pulley (Driven)	243A4675P1	X	X	-	-	-	-	
12	Hex Hd. Screw 3/8-16 x 3/4	(1)	X	X	X	X	X	X	
13	Hex Hd. Screw 3/8-16 x 1 3/4	(1)	X	X	X	X	X	X	
14	Lockwasher 3/8"	(1)	X	X	X	X	X	X	
15	Hex Nut 3/8-16	(1)	X	X	X	X	X	X	
16	Set Screw, Hex Socket, 5/16-18 x 3/4	(1)	-	-	X	X	X	X	
16	Set Screw, Hex Socket, 1/4-20 x 1/2	(1)	X	X	-	-	-	-	
17	Hex Nut, Jam 5/16-18	(2)	X	X	X	X	X	X	
A	Set Screw, Hex Socket 5/16-18 x 3/8	N70P2306C6	X	X	X	X	X	X	
			-						

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

(2) Replace parts referenced 5 and 17 by part referenced A. Use double screws in each hole (four per h

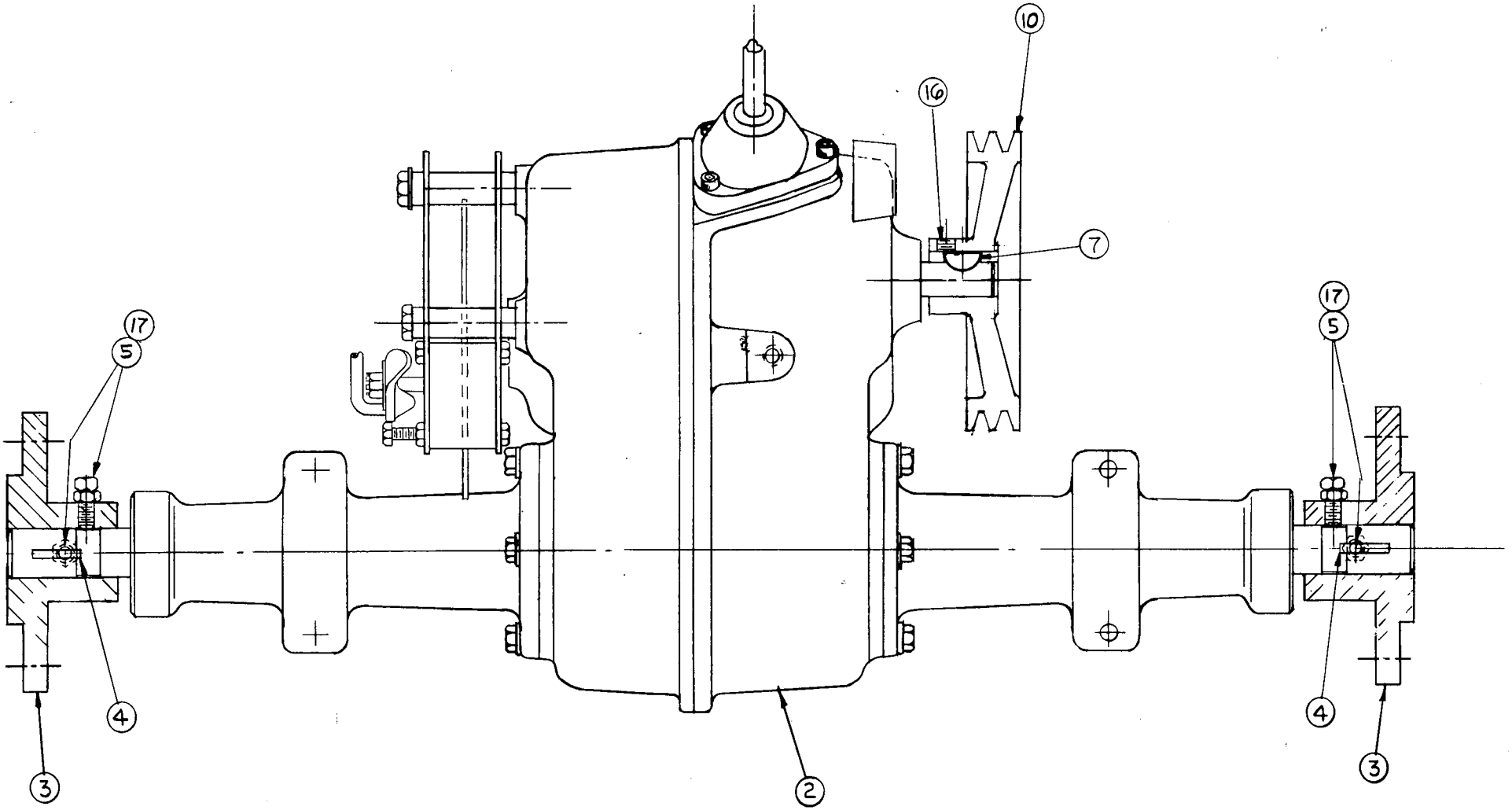


Fig. 4-15 E15 Rear Axle Assembly

ELEC-TRAC 2318 TRANSAXLE
Use this list to order replacement parts from Fig. 4-16

Fig. 4-16, PBA-71295, Rev 0

P. L. 243A4500, Rev 0

Ref. No.	Description	Models: 26AE12A, 26AE12B 26AE15A, 26AE15B 26AE15C, 26AE20A 26AE20B	
		Peerless Part No.	GE Part No.
1	Lever, Housing Assy., Shift (Incl. Nos. 2 thru 7)	784110	243A4500P1
2	Ring, Snap	792016	243A4500P2
3	Ring, Quad	792001	243A4500P3
4	Pin, Roll	792002	243A4500P4
5	Housing, Shift Lever	784093	243A4500P5
6	Keeper, Shift Lever	784094	243A4500P6
7	Lever, Shift	784111	243A4500P7
8	Rod Assy., Shift (Incl. Nos. 9 thru 12 & 24)	784054	243A4500P8
9	Spring	792003	243A4500P9
10	Ball, Steel	792004	243A4500P10
11	Fork, Shifter	784004	243A4500P11
12	Rod, Shifter (3rd & 4th)	784055	243A4500P12
13	Rod Assy., Shift (Incl. Nos. 9, 10, 11 & 14)	784056	243A4500P13
14	Rod, Shifter (Low)	784057	243A4500P14
15	Axle	774188	243A4500P15
16	Washer, Thrust	780042	243A4500P16
17	Screw, Hex Hd. Cap, 1/4-20 x 2-1/2	792005	243A4500P17
18	Lockwasher, 1/4	792006	243A4500P18
19	Gear, Ring	778033	243A4500P19
20	Pin, Drive	786019	243A4500P20
21	Block Drive	786027	243A4500P21
22	Pinion, Bevel	778065	243A4500P22
23	Shaft & Gear, Brake	776029A	243A4500P23
24	Ring, Snap	792017	243A4500P24
25	Shaft & Bearing Assy., Piston (Incl. No. 26)	776026	243A4500P25
26	Bearing	780018	243A4500P26
27	Gear Cluster Assy. (Incl. No. 28)	778034	243A4500P27
28	Bushing	780053	243A4500P28
29	Stop, Shifter	784074	243A4500P29
30	Gasket, Case & Cover	788023	243A4500P30
31	Gasket, Shift Lever Housing	788022	243A4500P31
32	Gear, Shifting (3rd & 4th)	778019	243A4500P32
33	Gear, Shifting (1st, 2nd & Rev.)	778020	243A4500P33
34	Gear, Bevel	778066	243A4500P34
35	Gear, Idler	778037	243A4500P35
36	Gear Cluster Assy. (Incl. No. 28)	778035	243A4500P36
37	Spacer	786024	243A4500P37
38	Ring, Snap	792018	243A4500P38
39	Shaft, Input	776027	243A4500P39
40	Spur Gear, Input Shaft	778024	243A4500P40
41	Washer, Thrust	780052	243A4500P41
42	Seal and Retainer Assy., Oil (Incl. No. 45)	788021	243A4500P42
43	Gear, Output	778036	243A4500P43
44	Pinion, Output	776028	243A4500P44
45	Seal, Oil	788008	243A4500P45
46	Housing, Axle	782025	243A4500P46
47	Cover Assy., Transaxle (Inc. Nos. 54, 55, 57, 59 & 63)	772040	243A4500P47
48	Case Assy., Transaxle (Incl. Nos. 54, 55, 57 & 63)	770012	242A4500P48
49	Screw, Socket Hd. Cap, 1/4-20 x 3/4	792007	243A4500P49
50	Pin Dowel	786026	243A4500P50
51	Screw, Hex Hd. 5/16-18 x 7/8	792028	243A4500P51
52	Plug, Magnetic drain	792019	243A4500P52
53	Lockwasher, Split 5/16"	792029	243A4500P53

Ref. No.	Description	Peerless Part No.	GE Part No.
54	Bearing, Needle	780049	243A4500P54
55	Bearing, Needle	780022	243A4500P55
56	Bearing, Ball	780024	243A4500P56
57	Bearing, Needle	780047	243A4500P57
58	Bearing, Ball	780050	243A4500P58
59	Bearing, Needle	780046	243A4500P59
60	Seal, Oil	788025	243A4500P60
61	Washer	780001	243A4500P61
62	Shaft & Pinion	776031	243A4500P62
63	Bearing, Needle	780048	243A4500P63
67	Spur Gear (22 teeth)	778038	243A4500P67
68	Bearing, Thrust	780039	243A4500P68
69	Carrier Assy., Differential (Incl. No. 71)	774072	243A4500P69
70	Carrier Assy., Differential (Incl. No. 71)	774071	243A4500P70
71	Bushing	780041	243A4500P71
72	"O" Ring	788024	243A4500P72
73	Washer, Thrust	780007	243A4500P73
74	Washer, Thrust	780051	243A4500P74
75	Plug, Pipe	792010	243A4500P75
76	Race, Thrust	780075	243A4500P76

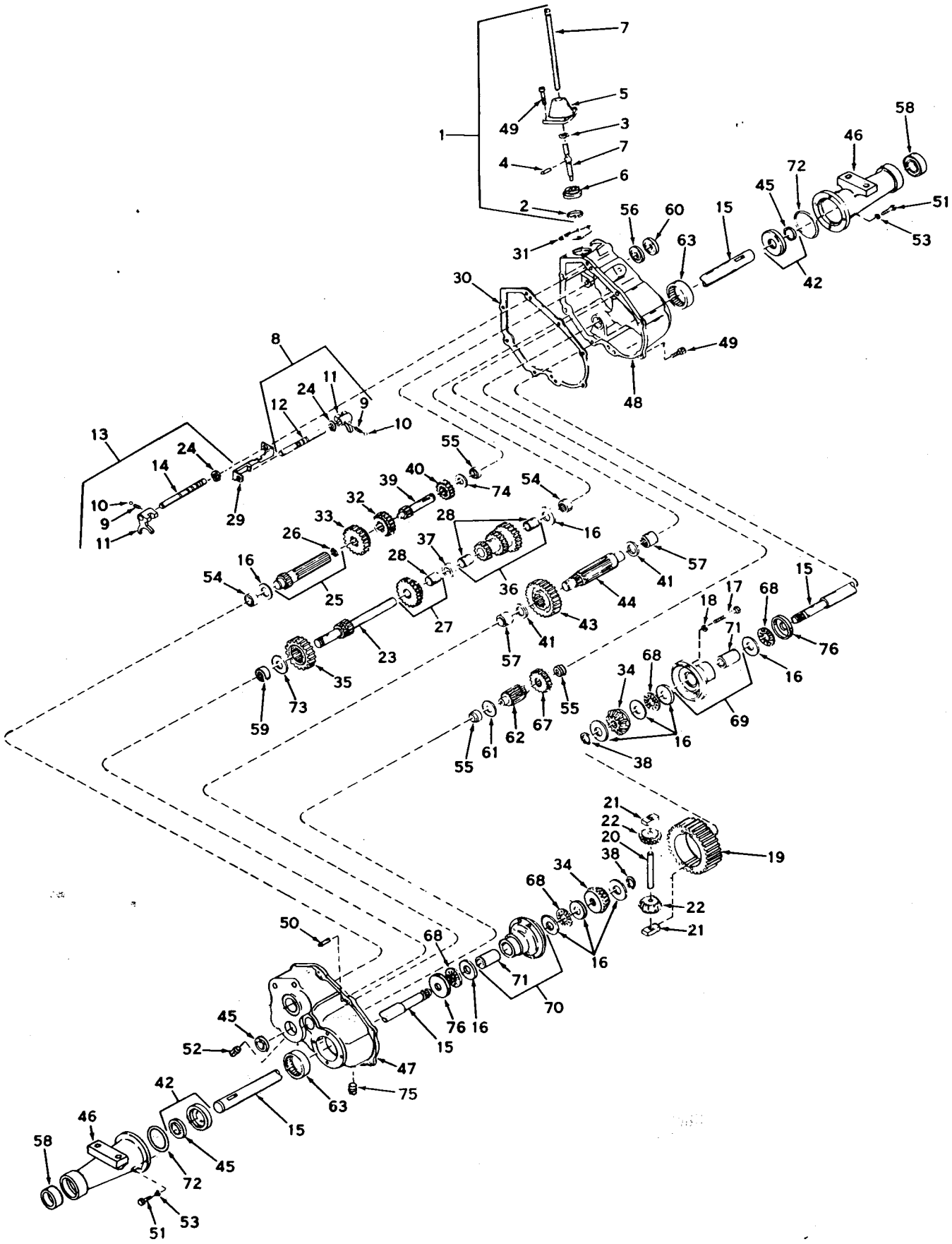


Fig. 4-16 E15 Elec-Trak 2318 Transaxle

Fig. 4-17, 163B9908, Rev 1

P.L. 163B9908, Rev 2
P.L. 163B9957, Rev 1

DRIVE MOTOR AND MOUNTING

Use this list to order replacement parts from Fig. 4-17.

Ref. No.	Description	Part Number	26A						
			E12A	E12B	E15A	E15B	E15C	E20A	E20B
3	Motor Plate	541C915P1	X	X	X	X	X	-	-
4	Carriage Bolt 5/16-18 x 1	(1)	X	X	X	X	X	-	-
5	Washer, Plain 5/16"	(1)	X	X	X	X	X	-	-
6	Lockwasher, 5/16"	(1)	X	X	X	X	X	-	-
7	Nut, Hex 5/16-18	(1)	X	X	X	X	X	-	-
8	Bolt, Hex Hd. 5/16-18 x 5/8	(1)	X	X	X	X	X	-	-
9	Pulley (Drive)	243A4675P2	X	X	-	-	-	-	-
9	Pulley (Drive)	211A3254P1	-	X	X	X	X	-	-
10	Key 3/16" sq. x 1	N3402P6032	X	X	X	X	X	-	-
11	Set Screw, Hex Socket 5/16-18 x 3/4	(1)	-	X	X	X	X	-	-
11	Set Screw, Hex Socket 5/16-18 x 3/4	(2)	X	-	-	-	-	-	-
12	Belt	211A3226P2	X	-	-	-	-	-	-
12	Belt (2 Required)	211A3226P4	-	-	X	X	X	-	-
I	Motor	163B9862P1	X	X	X	X	X	-	-
J	Circuit Breaker CB1	211A3244P1	X	X	X	X	X	-	-

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

(2) Set screw furnished with pulley, not available separately.

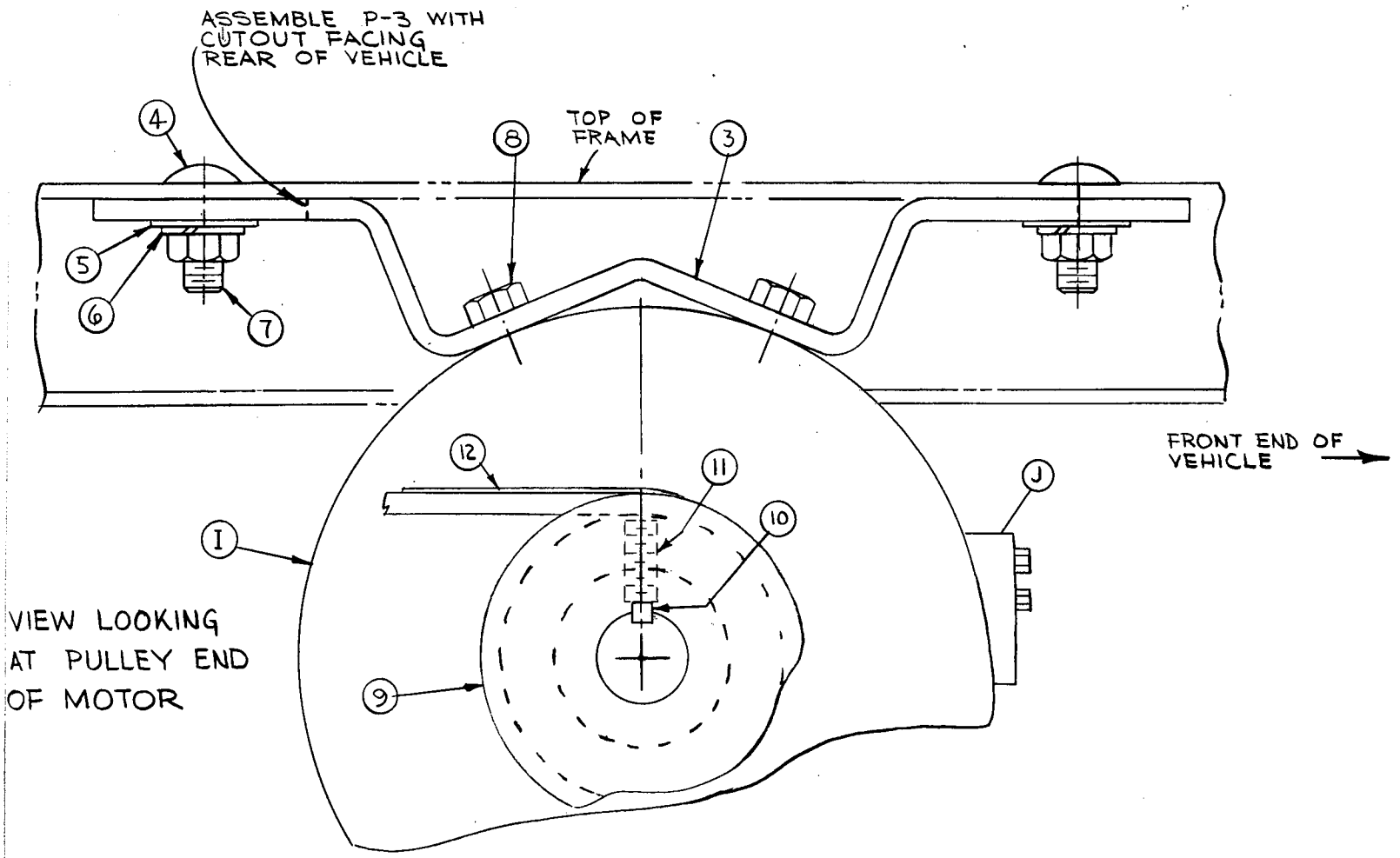


Fig. 4-17 E15 Drive Motor and Mounting

BRAKE ASSEMBLY

Use this list to order replacement parts from Fig. 4-18.

Ref. No.	Description	Part Number	26A						
			E12AA	E12B	E15A	E15B	E15C	E20A	E20B
2	Brake Pedal Assembly	163B9876G1	X	X	X	X	X	-	-
2	Brake Pedal Assembly	163B9876G2	-	-	-	-	-	X	X
3	Lever (Parking Brake)	211A3467P1	X	X	X	X	X	X	X
4	Plain Washer	(1)	X	X	X	X	X	X	X
5	Spring Dowel Pin 5/32 x 1 1/8	N533P1618	X	X	X	X	X	X	X
6	Locking Pan Hd. Phillips Screw	211A3583P1	X	X	X	X	X	-	-
6	Rivet	243A4773P1	-	-	-	-	X	X	X
7	Curved Washer	211A3484P1	X	X	X	X	X	X	X
8	Brake Switch	211A3481P1	X	X	X	X	X	X	X
9	Pan Hd. Screw 10-32 x 3/8	(1)	X	X	X	X	X	X	X
10	Lockwasher #10	(1)	X	X	X	X	X	X	X
11	Shoulder Screw	211A3504P1	X	X	X	X	X	X	X
12	Locking Nut, Hex 1/4-20	N264P21B6	X	X	X	X	X	X	X
13	Spring Clip (Push Nut)	211A3488P1	X	X	X	X	X	X	X
15	Disk Brake (Caliper Unit)	211A3153P1	X	X	X	X	X	X	X
16	Disk and Hub	211A3154G1	X	X	X	X	X	X	X
17	Brake Rod	211A3468P1	X	X	X	X	X	X	X
18	Bracket	211A3469P1	X	X	X	X	X	X	X
19	Spacer	211A3470P1	X	X	X	X	X	X	X
20	Cap Screw, Hex Hd. 3/8-16 x 2 3/4	(1)	X	X	X	X	X	X	X
21	Plain Washer 3/8"	(1)	X	X	X	X	X	X	X
22	Cap Screw, Hex Hd. 5/16-18 x 2 3/4	(1)	X	X	X	X	X	X	X
23	Nut, Hex 5/16-18	(1)	X	X	X	X	X	X	X
24	Cap Screw, Hex Hd. 5/16-18 x 1 7/8	(1)	X	X	X	X	X	X	X
25	Locking Nut, Hex 5/16-18	211A3582P1	X	X	X	X	X	X	X
26	Spring Clip (Push Nut)	211A3488P1	X	X	X	X	X	X	X
27	Return Spring	211A3489P1	X	X	X	X	X	X	X
28	Key, Woodruff	N3400P606	X	X	X	X	X	X	X
30	Mounting Base	243A4585P1	X	X	X	X	X	X	X
31	Washer, Belleville (3 Required)	243A4582P3	X	X	X	X	X	X	X
32	Washer (50 mil)	243A4642P1	X	X	X	X	X	X	X

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

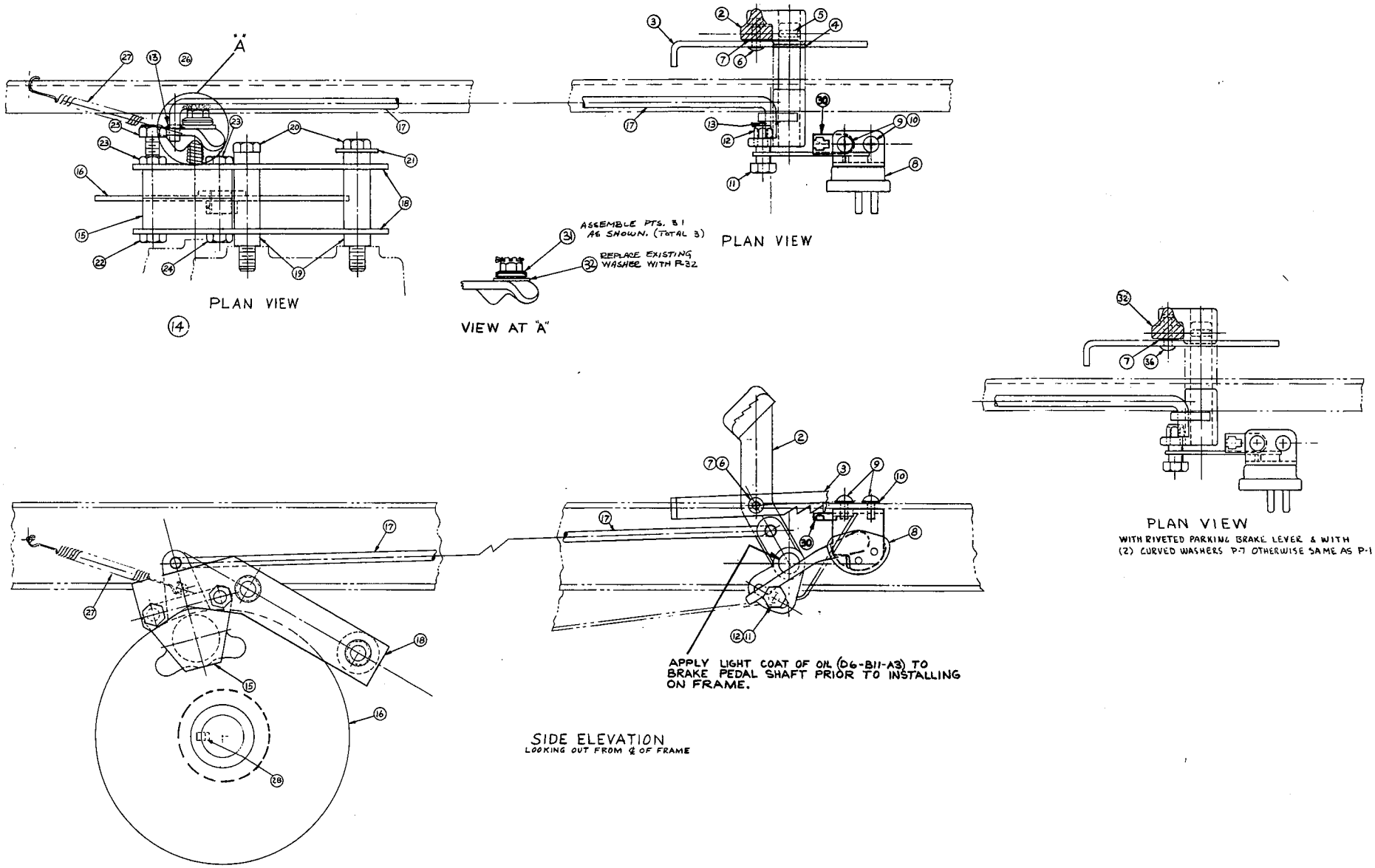


Fig. 4-18 E15 Brake Assembly

LIFT ASSEMBLY

Use this list to order replacement parts from Fig. 4-19

Ref. No.	Description	Part Number	26A						
			E12AA	E12B	E15A	E15B	E15C	E20A	E20B
1	Lift Assembly (All parts as shown)	423D217G1	X	X	X	X	X	X	X
2	Support (Right)	541C668P1	X	X	X	X	X	X	
3	Support (Left)	541C668P2	X	X	X	X	X	X	
4	Spacer	243A4550P2	X	X	X	X	X	X	
5	Spacer	243A4550P1	X	X	X	X	X	X	
6	Motor	211A3561P1	X	X	X	X	X	X	
7	Push Nut	243A4554P2	-	-	X	X	X	X	
8	Bolt, Hex Hd. 1/4-20 x 7/8	(1)	X	X	X	X	X	X	
9	Lockwasher 1/4	(1)	X	X	X	X	X	X	
10	Bolt, Hex Hd.	(1)	X	X	X	X	X	X	
11	Nut, Hex 1/4-20	(1)	X	X	X	X	X	X	
12	Bearing (Flanged)	211A3540P1	X	X	X	X	X	X	
13	Bearing (Flanged)	211A3540P3	X	X	X	X	X	X	
14	Gear Assembly	211A3539G1	X	X	X	X	X	X	
15	Shaft	211A3134P1	X	X	-	-	-	-	-
15	Shaft	211A3542P1	-	X	-	X	X	X	
16	Cotter Pin 3/32 x 1	(1)	X	X	X	X	X	X	
17	Sleeve	211A3543P1	X	X	X	X	X	X	
18	Lift Strap and Clip	163B9802P1	X	X	X	X	X	X	
20	Gear Cover	541C907P1	-	-	X	X	X	X	
23	Bolt, Carriage 5/16-18 x 1	(1)	X	X	X	X	X	X	
24	Lockwasher 5/16	(1)	X	X	X	X	X	X	
25	Nut, Hex 5/16-18	(1)	X	X	X	X	X	X	
26	Washer	211A3520P1	X	X	X	X	X	X	
A	Washer (Fiber)	243A4649P1	X	X	X	X	X	X	
B	Lift Yoke Assembly (Includes Bumper and Yoke)	163B9872G1	X	X	X	X	X	X	
C	Shaft	211A3494P1	X	X	X	X	X	X	
D	Cotter Pin 1/16 x 1	(1)	X	X	X	X	X	X	
E	Washer, Plain 1/2"	(1)	X	X	X	X	X	X	
F	Hair Pin Cotter	211A3256P3	X	X	X	X	X	X	
G	Tube	243A4648P1	X	X	X	X	X	X	
H	Lift Strap Guard	541C997P1	-	X	-	-	X	X	X
H	Lift Strap Guard	541C997P2	X	-	X	X	-	-	-

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

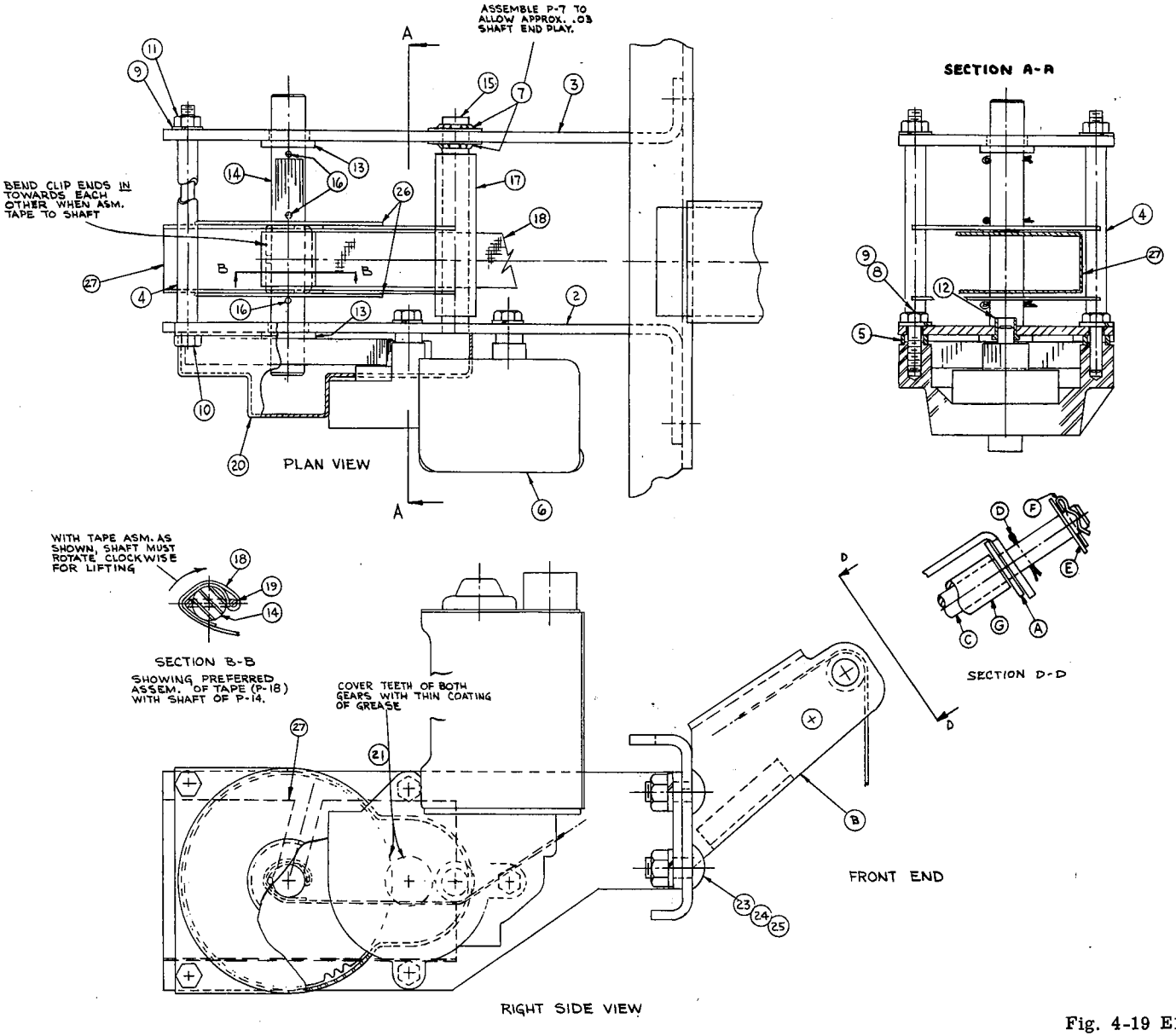


Fig. 4-19 E15 Lift Mounting

FRAME AND BODY MOUNTED PARTS
Use this list to order replacement parts from Fig. 4-20.

Ref. No.	Description	Part Number	26A						
			E12A	E12B	E15A	E15B	E15C	E20A	E20B
1	Seat (Complete)	211A3209G2	X	X	X	X	X	-	-
1	Seat (Complete	211A3209G3	-	-	-	-	-	X	X
2	Knob, Gearshift	211A3249P3	X	X	X	X	X	X	X
3	Wheel and Tire (Rear)	541C658P1	X	X	-	-	-	-	-
3	Wheel and Tire (Rear)	541C658P2	-	-	X	X	X	-	-
3	Wheel and Tire (Rear)	243A4857G1	-	-	-	-	-	X	X
4	Wheel and Tire (Front)	541C951P1	X	X	-	-	-	-	-
4	Wheel and Tire (Front)	163B9707P1	-	-	X	X	X	-	-
4	Wheel and Tire (Front)	163B9707P1	-	-	-	-	-	X	X
5	Clevis Pin	211A3505P2	X	X	X	X	X	X	X
6	Hair Pin Cotter	211A3256P2	X	X	X	X	X	X	X
7	Headlight Lens	211A3413P1	X	X	X	X	X	X	X
8	Reflector and Socket	163B9879P1	X	X	X	X	X	X	X
9	Lamp (Headlight)	211A3592P1	X	X	X	X	X	X	X
10	Steering Wheel	163B9843P1	X	X	X	X	X	-	-
10	Steering Wheel	423D255P1	-	-	-	-	-	X	X
11	Cap Assembly	542C892G2	X	X	X	X	X	-	-
11	Cap Assembly	243A4828G1	-	-	-	-	-	X	X
12	Bearing, Front Wheel	243A4640P1	X	X	X	X	X		X
13	Hood (With Decals)	541C940G3	X	X	-	-	-	-	-
13	Hood (With Decals)	587E922G1	-	-	X	X	X	-	-
13	Hood (With Decals)	541C940G2	-	-	-	-	-	X	X
14	Rear Battery Box Cover	541C938G1	X	X	X	X	X	X	X
15	Cushion (Back)	243A4800P1	X	X	X	X	X	X	X
16	Pan	243A4799P1	X	X	X	X	X	X	X
17	Cushion (Bottom)	178B8003P2	X	X	X	X	X	-	-
17	Cushion (Bottom)	178B8003P1	-	-	-	-	-	X	X
18	Wing Knob	243A4801P1	X	X	X	X	X	X	X

Other frame, body sheet metal parts, and body castings are available only from the factory on special order.

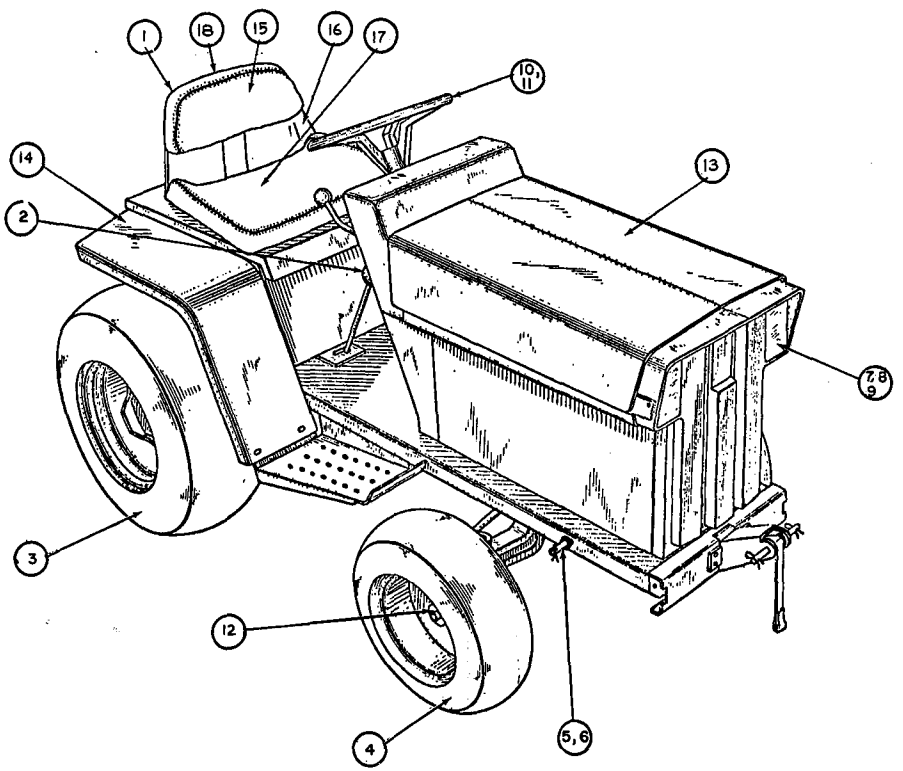


Fig. 4-20 E15 Frame and Body Mounted Parts

MISCELLANEOUS PARTS

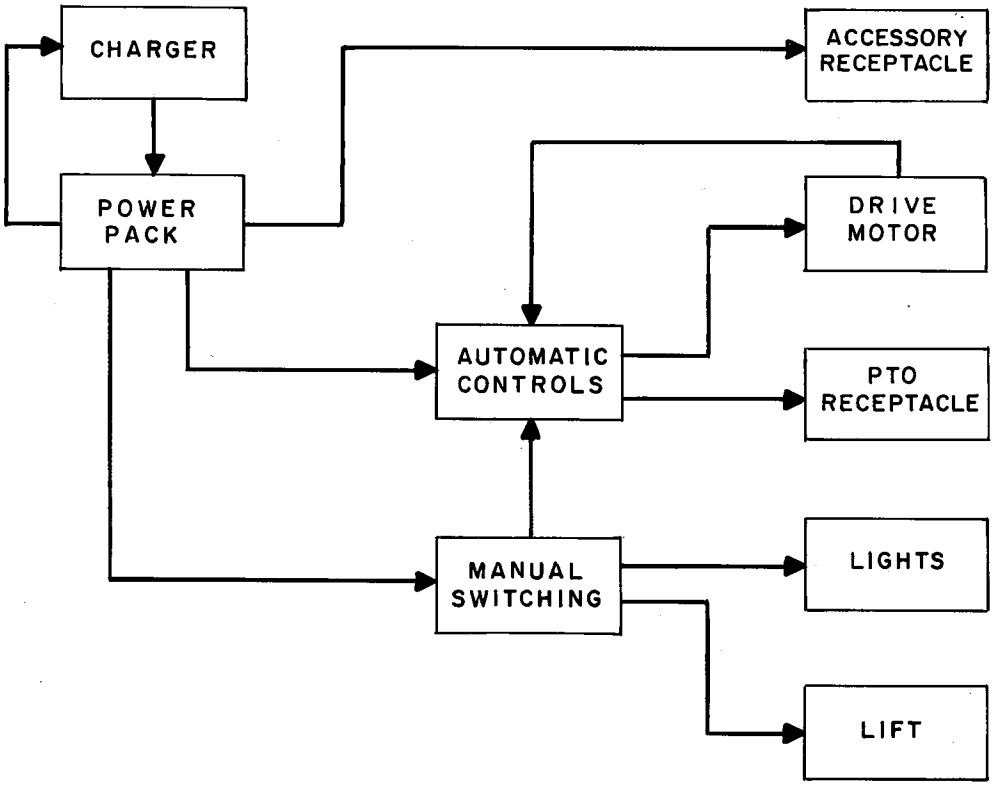
Ref. No.	Description	Part Number	26A						
			E12A	E12B	E15A	E15B	E15C	E20A	E20B
	Undercarriage Harness	423D234G2	X	X	-	-	-	-	-
	Undercarriage Harness	423D215G1	-	-	X	-	-	-	-
	Undercarriage Harness	423D234G1	-	-	-	X	X	-	-
	Undercarriage Harness	423D275G1	-	-	-	-	-	X	X
	Battery Clamp Assembly (Front)	163B9887G1	X	X	X	X	X	X	X
	Battery Clamp (Rear)	163B9875G1	X	X	X	X	X	X	X
	Battery Tray (Front)	541C699P1	X	X	X	X	X	X	X
	Battery Tray (Rear)	541C698P1	X	X	X	X	X	X	X
	Battery Cover (Front)	541C696P1	X	X	X	X	X	X	X
	Battery Cover (Rear)	423D202P1	X	X	X	X	X	X	X
	Instruction Decal (Under Hood)	541C922P1	X	X	X	X	X	X	X
	Artwork (Dash)	541C681P1	X	X	X	X	X	X	X
	Fuse Decal	211A3528P1	X	X	X	X	X	X	X
	Parking Brake Decal	211A3247P1	X	X	X	X	X	X	X
	Hood Decal (Right Hand)	423D239P1	X	X	-	-	-	-	-
	Hood Decal (Right Hand)	422D848P3	-	-	X	X	X	-	-
	Hood Decal (Right Hand)	422D848P7	-	-	-	-	-	X	X
	Hood Decal (Left Hand)	423D239P2	X	X	-	-	-	-	-
	Hood Decal (Left Hand)	422D848P4	-	-	X	X	X	-	-
	Hood Decal (Left Hand)	422D848P8	-	-	-	-	-	X	X
	Caution Decal (Battery Areas)	211A3511P1	X	X	X	X	X	X	X
	Tail Reflector	211A3250P1	X	X	X	X	X	-	-
	Tail Reflector	243A4870P1	-	-	-	-	-	X	X
	Battery Cable (Interconnecting)	211A3531G1	X	X	X	X	X	X	X
	Socket SO-1 (PTO)	243A4572P1	X	X	X	X	X	X	X
	Socket SO-2 (Accessory)	243A4542P1	X	X	X	X	X	X	X
	Fuel Level Gage	243A4629G1	X	X	X	X	X	X	X
	Power Use Gage	243A4630G1	X	X	X	X	X	X	X
	Power Disconnect Assembly	163B9923G1	X	X	X	X	X	X	X
	Fusible Link FU1	211A3448G1	X	X	X	X	X	X	X
	Knob (Power Disconnect)	243A4502P1	X	X	X	X	X	X	X
	Plug (12-position)	423D216P4	X	X	X	X	X	X	X
	Jack (12-position)	243A4568P4	X	X	X	X	X	X	X
	Plug (15-position)	423D216P3	X	X	X	X	X	X	X
	Jack (15-position)	243A4568P5	X	X	X	X	X	X	X
	Jack (9-position)	243A4568P3	X	X	X	X	X	X	X
	Friction Pad Set (Brake Caliper)	211A3593P1	X	X	X	X	X	X	X
	Seat Switch Assembly	211A3420G1	X	X	X	X	X	-	-
	Seat Switch Assembly	243A4790P1	-	-	-	-	-	X	X
	Spring (Seat)	211A3577P8	X	X	X	X	X	X	X
	Rivet (Seat Spring)	211A3191P1	X	X	X	X	X	X	X
	Convenience Hitch Assembly (Extension)	211A3546G1	X	X	-	X	X	X	X
	Battery Liner, Front (Poly Bag)	155C8005P1	X	X	X	X	X	X	X
	Battery Liner, Rear (Poly Bag)	155C8006P1	X	X	X	X	X	X	X
	Post Clamp (Battery)	243A4521P1	X	X	X	X	X	X	X

E20 ELEC-TRAK TRACTOR

5.1 THEORY OF OPERATION

A block diagram showing the major functional areas of the E20 will make the detailed information easier to understand. The interconnecting lines between the blocks show dependency of one area on another and also show the direction of control. Notice that house voltage is fed into the charger, changed to an appropriate d-c voltage and is then fed to the power pack to recharge the cells. The connecting line returning to the charger indicates that battery condition is sampled by the charger to properly meter the charging rate. This sampling results in a high charging rate when the power pack is deeply discharged and a low charging rate when the fully charged state is attained. This rate change is fully automatic.

The accessory receptacle is wired directly to the power pack and is shown that way in Figure 5-A. Actually, the power disconnect, fuse FU1, two circuit breakers, and a shunt wire, MS-1, are in this circuit, but are not considered essential elements in the block diagram.



Note: This drawing not for Troubleshooting. See pages 5-13 through 5-26 and Figures 5-1 through 5-17 for Troubleshooting.

Figure 5-A. E20 Block Diagram

Light and lift circuits are also powered by the power pack, but manual switching must be performed to operate these devices. The line drawn from the manual switching block to the automatic control block represents the control of all other manual switches. These include the key, PTO, seat, brake, reverse, cruise control, and the eight switches of the foot pedal speed control. All of these switches control functions of the E20. Detailed operation of these switches is covered in the following pages.

Successful troubleshooting of the E20 Elec-Trak tractor requires an understanding of the performance involved in normal operation. Areas that the service man should become completely familiar with are: 1) foot pedal speed control, 2) armature current sensing circuitry, and 3) the cruise control. These areas will be examined individually, but with attention directed to the overall tractor response.

Foot Pedal Speed Control

The foot pedal speed control is basically a mechanical device which actuates switches in an orderly sequence. The switches are actuated as the pedal is depressed which causes the cam (wedge plate) to slide across the switch buttons. When the pedal is released the spring loaded cam returns to its neutral position.

The speed control contains three types of switches:

Single pole-double throw. Used as the start switch. It has two current carrying positions.

Single pole-single throw - Normally open. Used as 1A, 2A, and 3A switches. When actuated the switch closes.

Single pole-single throw - Normally closed. Used as FW1, FW2, FW3, and FW4 switches. When actuated the switch opens.

Locate each of these switches in the schematics and note that they are shown in their unactuated position.

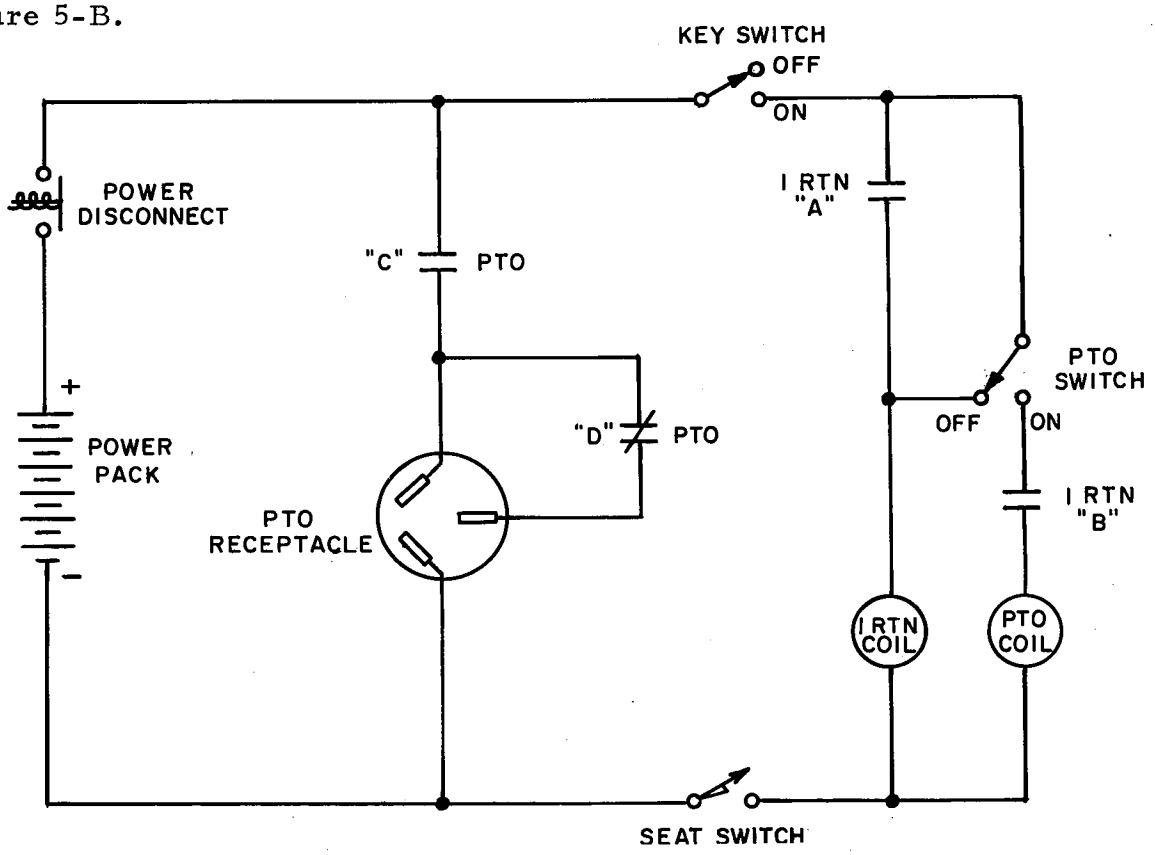
As the speed control pedal is depressed the switches are actuated in the following order:

1. Start switch
2. 1A switch
3. 2A switch
4. 3A switch
5. FW1 switch
6. FW2 switch
7. FW3 switch
8. FW4 switch

Once any switch is actuated, it is held actuated in all the following speed control positions. As the pedal is released the switches are released in the reverse sequence of their actuation. For example, if the tractor were being operated in the fourth forward speed, abbreviated SC4, the Start, 1A, 2A, and 3A switches would all be actuated.

PTO

For instruction purposes, let's consider the PTO circuit simplified in Figure 5-B.



Note: This drawing not for troubleshooting. See pages 5-13 through 5-26 and Figures 5-1 through 5-17 for troubleshooting.

Figure 5-B. E20 PTO Circuit

Assume the power disconnect is engaged (closed), an operator is on the seat, and the PTO switch is in the "Off" position. When the key switch is turned "On", a circuit is completed carrying current through the key switch, the PTO switch, the 1RTN coil, the seat switch, and back to the power pack. Notice that this current through 1RTN coil energizes or actuates it which closes its normally open contacts "A" and "B". With the pair of contacts labeled "A" closed, the PTO switch can be moved to "On" and the 1RTN coil will still be supplied with current. This action is referred to as "sealing in."

With the 1RTN coil sealed in the PTO switch can now be placed in the "On" position and another closed current path is produced through 1RTN "B" and the PTO coil. Current through this coil closes contacts "C" and opens contacts "D". These contacts supply the PTO operated attachment with power and dynamic braking respectively.

Should the operator get off the seat, with the mower running, the seat switch opens and interrupts the 1RTN coil and PTO coil current. Both coils are de-energized and the mower is dynamically braked. To restart the mower, the PTO switch must be turned to "Off" to seal in the 1RTN coil and then to "On" to energize the PTO coil.

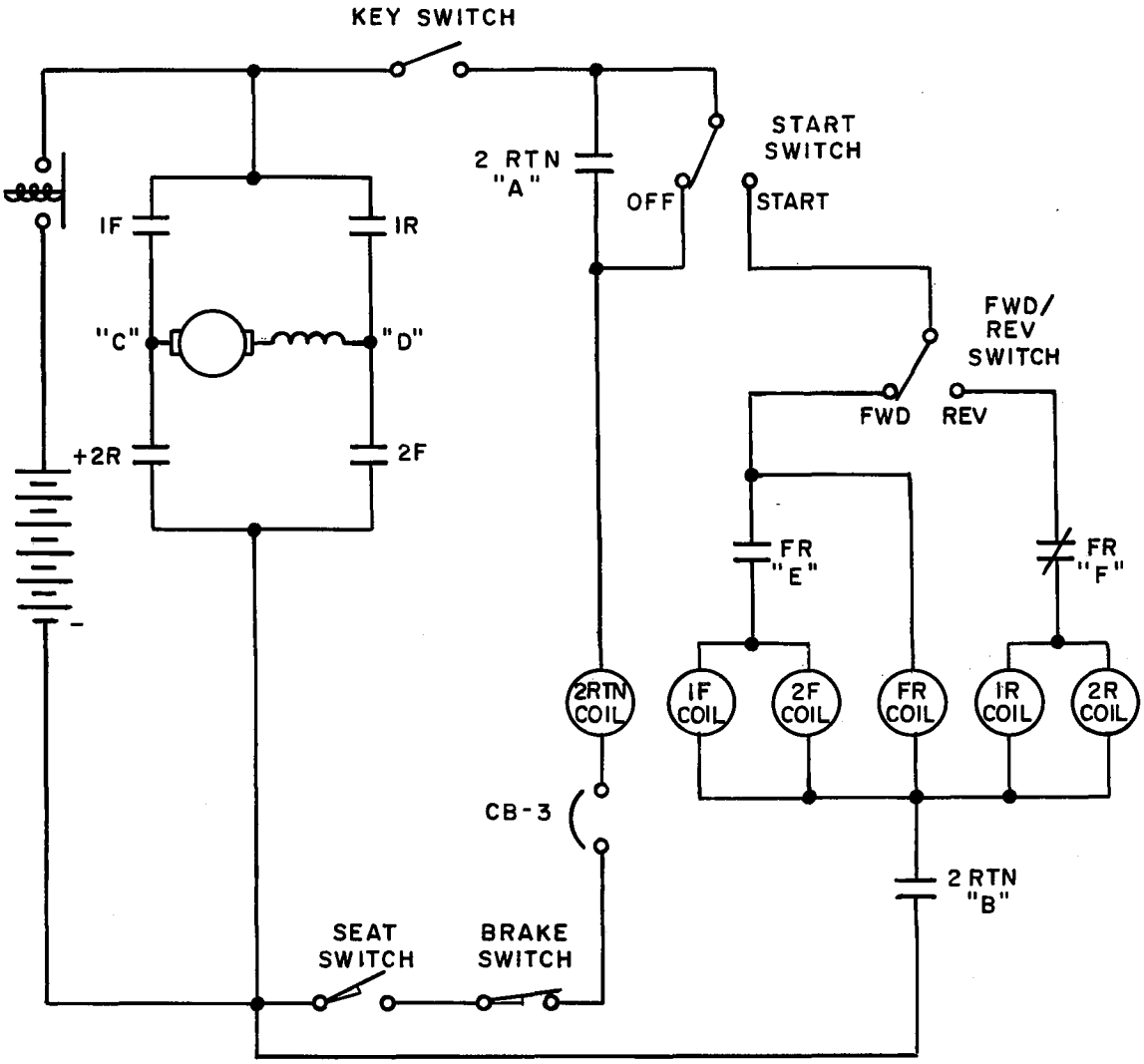
Foot Speed Control

Start

In examining the "Start" circuit, it is seen the sealing-in circuit is repeated, but there are three coils to be actuated in the "On" position when the forward-reverse switch is in forward; namely, 1F, 2F, and FR. Coils 1F and 2F energize only after FR coil energizes when its normally open contact "E" close. This relay (FR) is a safety relay that gives a time delay to switching, assures positive control of direction, and 1F, 2F coil pick-up and drop-out (i. e., actuation and release).

In Figure 5-C it is seen that when 1F and 2F are energized, a closed "path" is made for the drive motor armature which causes current to flow from point "C" to "D". If the control panel is examined it will be found that 1F and 2R, and 2F and 1R are mechanically interlocked. That is, if 1F coil is energized its contacts close and 2R contacts are open and cannot be closed.

The opposite occurs if 2R coil is energized. The same is true for 2F and 1R. This guarantees a closed circuit through the armature and prevents short circuiting in forward-reverse switching.



Note: This drawing not for troubleshooting. See pages 5-13 through 5-36 and Figures 5-1 through 5-17 for troubleshooting.

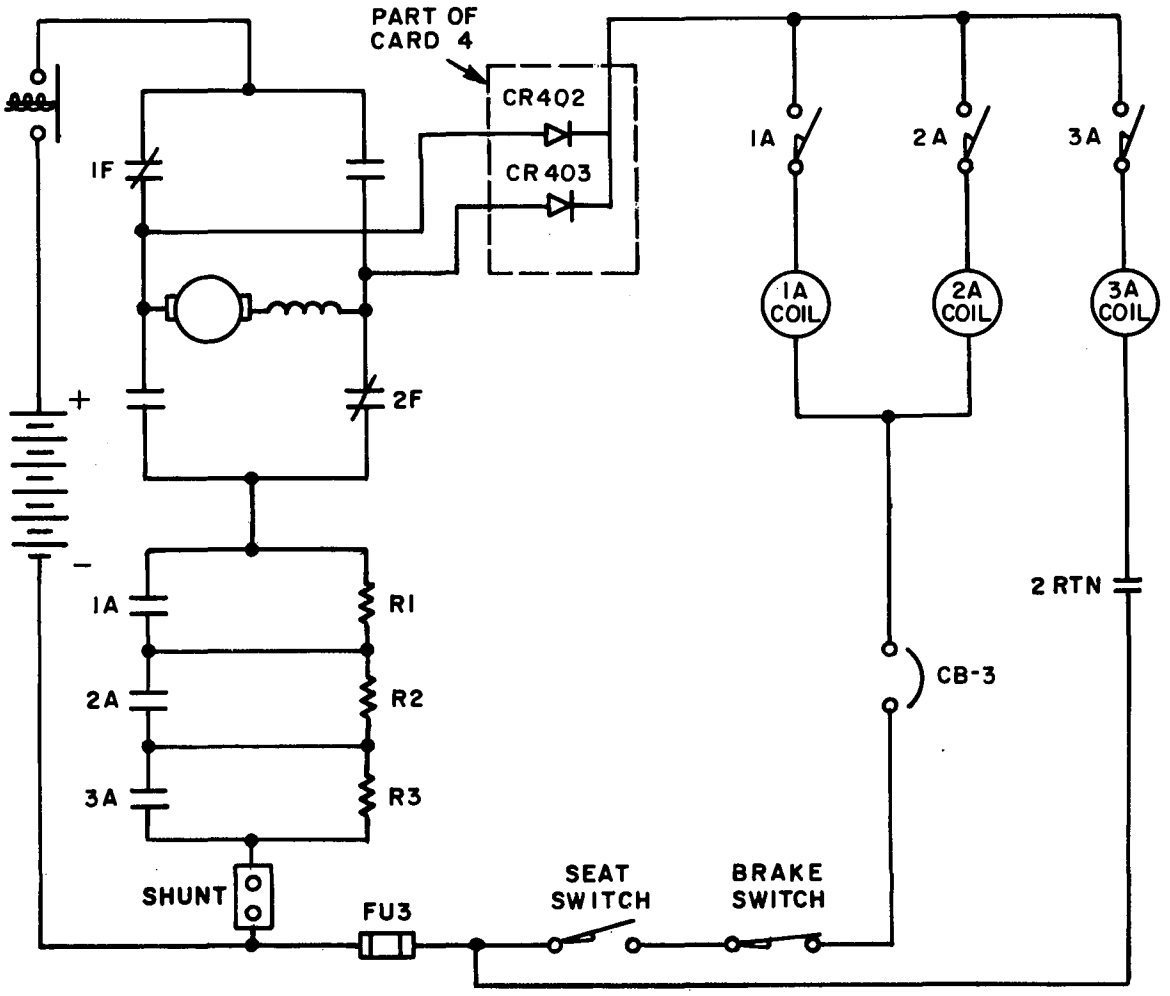
Figure 5-C. E20 Drive Motor Armature Circuit and Control

When the forward-reverse switch is moved to reverse, FR contacts "E" are open and "F" are closed, which allow coils 1R and 2R to energize. Their corresponding contacts 1R and 2R close forcing contacts 1F and 2F open. Now armature current flows from "D" to "C" resulting in reversing drive motor rotation. Observe that if the seat or brake switch opens, the sealed-in 2RTN coil de-energizes and interrupts current to 1F, 2F, and FR, or 1R and 2R which

removes power from the drive motor since the double solenoids seek a neutral or center position when no voltage is applied to either of its coils.

1A, 2A, 3A

Developing the circuitry further, let's investigate speeds 2, 3 and 4. Assume the drive motor has been started and is running forward in Figure 5-D, so 1F and 2F contacts are closed.



Note: This drawing not for troubleshooting. See pages 5-13 through 5-26 and Figures 5-1 through 5-17 for troubleshooting.

Figure 5-D. Drive Motor Armature Speed Control

Further depression of the foot speed control pedal closes switch 1A which energizes 1A coil. This causes 1A contacts to close and by-pass R1 which increases armature voltage and so increases motor speed. Similar action occurs when switches 2A or 3A are closed. (Note that 1A and 2A can be de-energized

by opening CB-3, FU3, brake or seat switch.)

FW1, 2, 3, 4

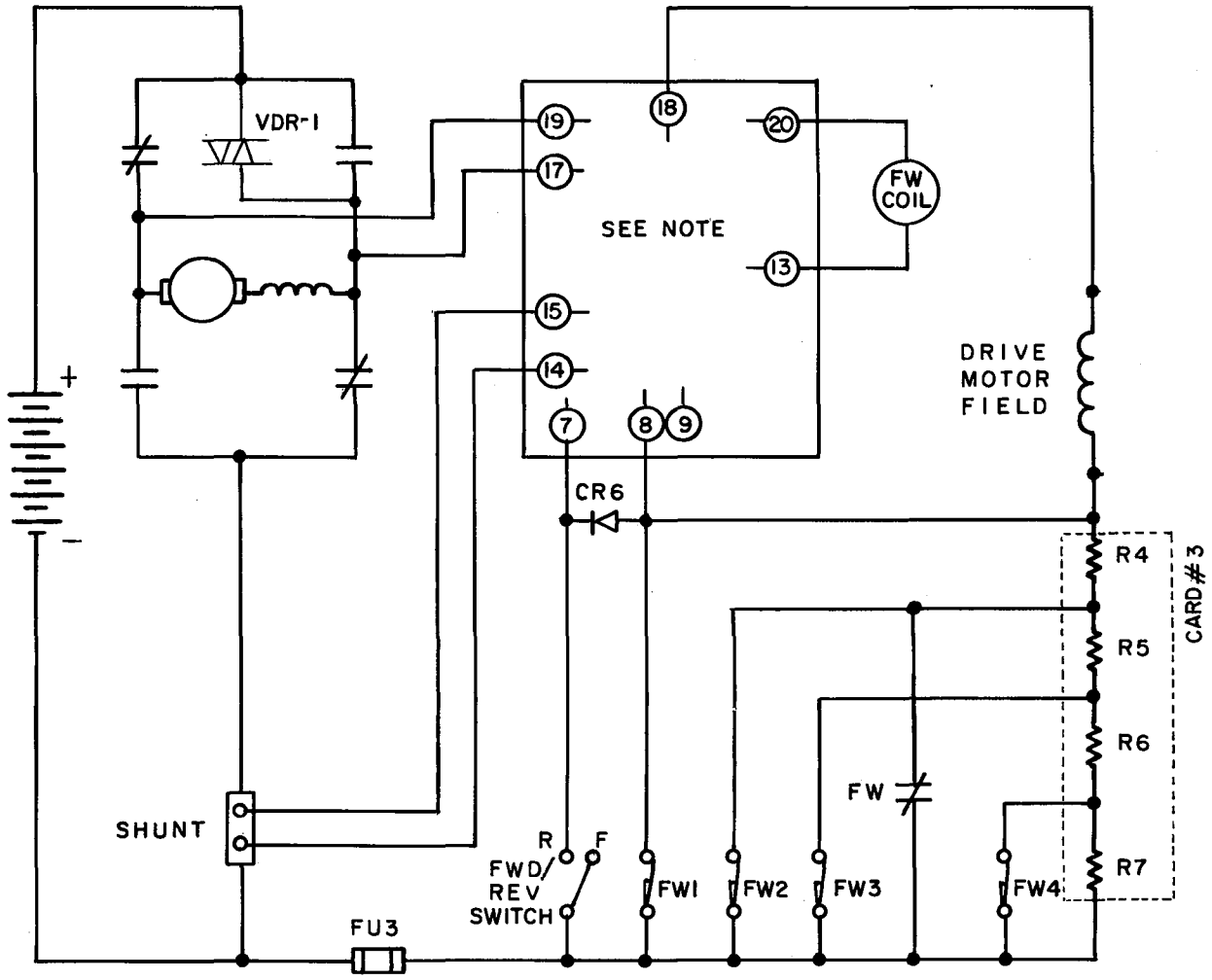
Speeds 5, 6, 7 and 8 are obtained in much the same way as the last four speeds are obtained in the E15. Figure 5-E illustrates the circuitry, again with the motor running forward. When switch FW1 is actuated with the speed control pedal, it opens and removes the by-pass from R4, allowing it to be in series with the drive motor field. Operation of the other FW switches is exactly the same as FW1, but relay FW contacts must open before speed changes can occur in speed control positions 6, 7, and 8. This coil will not energize if armature current, as sensed by the shunt, exceeds a predetermined limit. The sensed current is acted on by portions of Card 4. When shunt current is low, the voltage at pads 20 and 13 energizes the FW coil opening FW contacts. When the shunt current is high due to unusual loading of the drive motor, the FW contacts remain closed and prevent operation of the 6th, 7th, and 8th speeds.

Cruise Control

The cruise control circuit seals in the 4th speed forward when activated. The circuitry involved is shown in Figure 5-F.

This circuitry demands that 3A switch and FW1 switch be closed before it can be activated. The only speed control pedal position that meets this requirement is the 4th speed forward or reverse. In this position, + 36 volts are available at point "A" and the -36 volt circuit is established through the closed FW1 switch. The current path is through CR411 diode and the 270 ohm resistor to the CC light causing it to illuminate which indicates the circuit is ready for activation.

While the CC light is on, the CC switch can be pushed which causes current to flow through the CC coil closing both CC contacts. Contacts "C" seal in the CC coil the same as previously mentioned sealed in processes occurred. Contacts "B" seal in coils 1A, 2A, and 3A. The same voltage available to the CC coil is available through diode CR407 (Card 4) to 1F, 2F, and FR coils, or 1R and 2R coils depending on the position of the forward/reverse switch. Now the CC switch button and the foot speed control can be released and the tractor continues to operate in the 4th forward speed until the speed control is depressed past the 4th forward speed position, or the seat, brake, or key switch are opened.



NOTES: PAD 18 HAS 36 VDC AVAILABLE FOR THE FIELD WHEN THE MOTOR STARTS.
FW COIL VOLTAGE 36 VDC UNLESS HIGH CURRENT FLOWS THROUGH SHUNT.

Note: This drawing not for troubleshooting. See pages 5-13 through 5-26 and Figures 5-1 through 5-17 for troubleshooting.

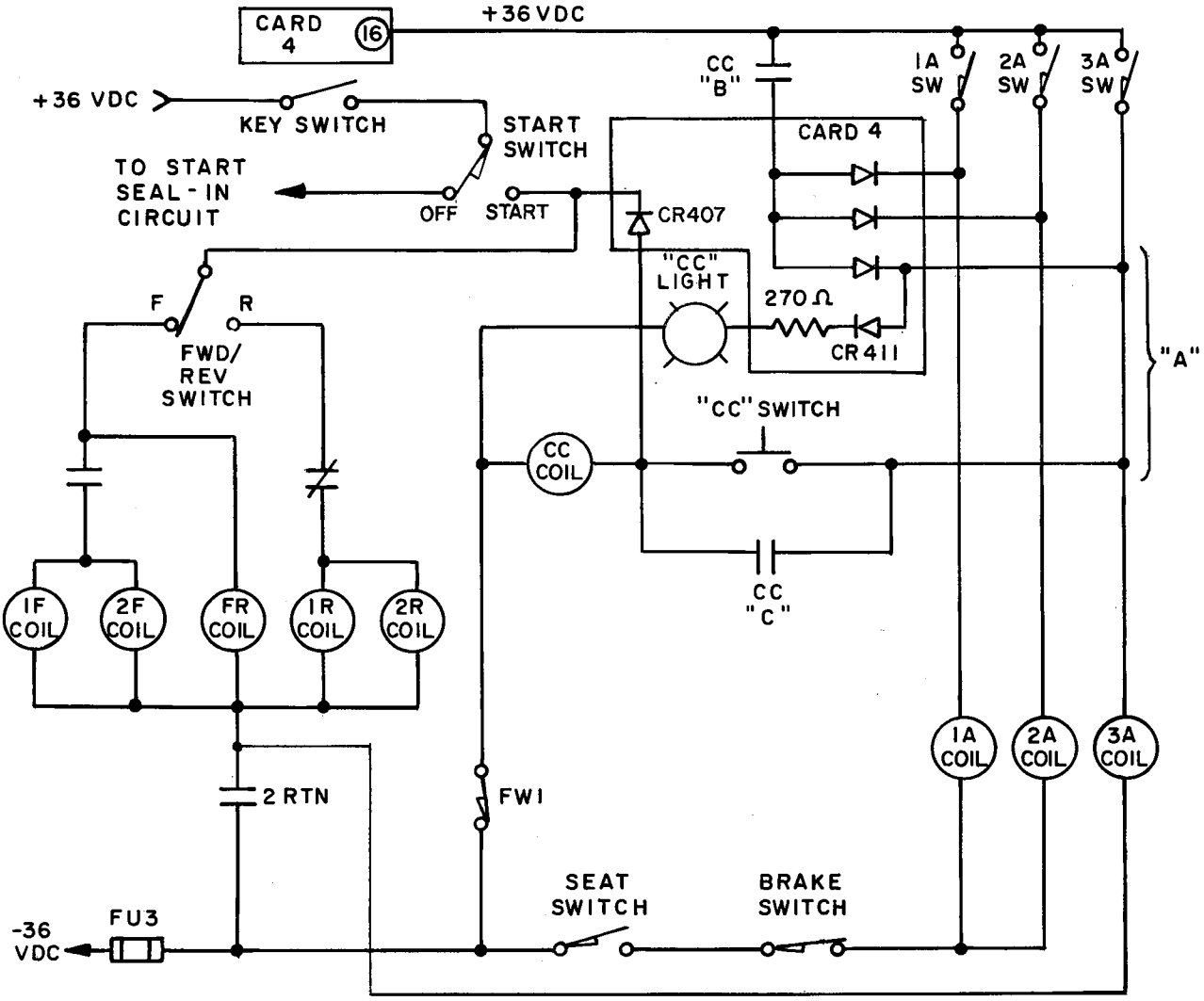
Figure 5-E. Drive Motor Field Control

Charger, Lift, Lights

The charger, lift, and light circuits are identical to those of the E15 except for wire numbering and some of the physical wire connection points. Refer to the E15 section for operation information and the E20 section for troubleshooting information.

Forward/Reverse

In addition to the operation of the forward/reverse switch already discussed, another function is illustrated in Figure 5-E. This half of the



Note: This drawing not for troubleshooting. See pages 5-13 through 5-26 and Figures 5-1 through 5-17 for troubleshooting.

Figure 5-F. Cruise Control Circuit

switch is open in the forward position and allows full control in forward. When the switch is in the reverse position, R4, 5, 6 and 7 are by-passed and the field weakening positions are not accessible. Diode CR6 is in this circuit for control of the reverse light and serves no function in the reverse by-pass circuit except to complete the circuit.

Circuit Breaker CB-3

Circuit breaker protection for the drive motor is provided in the armature circuit by circuit breaker CB-1, but the E20 motor also contains an automatic

circuit breaker, CB-3, that senses internal motor temperature (See Figures 5-C and 5-D). If the drive motor is overloaded for a long period of time, so that its temperature exceeds a certain value, CB-3 opens resulting in 2RTN, 1A and 2A dropping out (de-energizing). This interrupts all drive motor power. After a short time the circuit breaker will automatically reset and the drive motor power can be restored by releasing the foot speed control and then depressing it. The circuit breaker leads are accessible in plug P6.

E20 Drive Motor

The E20 drive motor is similar to that of the E15. Major differences are: physical size, available torque, the heat sensing circuit breaker, and field connection plug. The open circuit field resistance is approximately 15 ohms as is the E15's. Other servicing procedures for this motor are the same as for the E15.

5.2 USE OF THE TROUBLESHOOTING GUIDE

For those who have had relatively little experience in the troubleshooting of the Elec-Trak tractor, additional information is offered to clarify some of the terminology and procedures used.

The abbreviation NOC is used often in the guide. This stands for "Normal Operating Conditions" and means that the power disconnect should be engaged, the key switch closed, and the range selector (transaxle) in neutral unless directed otherwise.

Indirect or automatic switching is done with relays and contactors. Generally, contactors handle the high-current switching and relays are for much lower currents. Both can be energized or activated by applying voltage to their coil terminals. Contact pairs, found on the relays, are usually combinations of normally-open and normally-closed contacts.

The troubleshooting guide suggests a systematic voltage measurement approach. For example, refer to the troubleshooting section entitled "No drive motor torque in forward. Reverse operation OK." The first step requires the service man to visually determine if the FR relay energizes in forward. If the relay does not energize, a quick voltage measurement at the FR coil (wires 13 and 11) when it should be energized will establish whether there is continuity in the circuit. If 36-volts d-c is present, the coil must be defective so the relay should be replaced. If no voltage is present, systematically move one of the voltmeter probes to new test points closer to the power pack. One such point might be wire 13 on the FR normally open contact while maintaining the negative probe on wire 11 at the FR coil. If 36-volts d-c is available at these points, but not at the FR coil, the fault must be in wire 13 between the FR contact and the FR coil.

5.3 TROUBLESHOOTING GUIDE

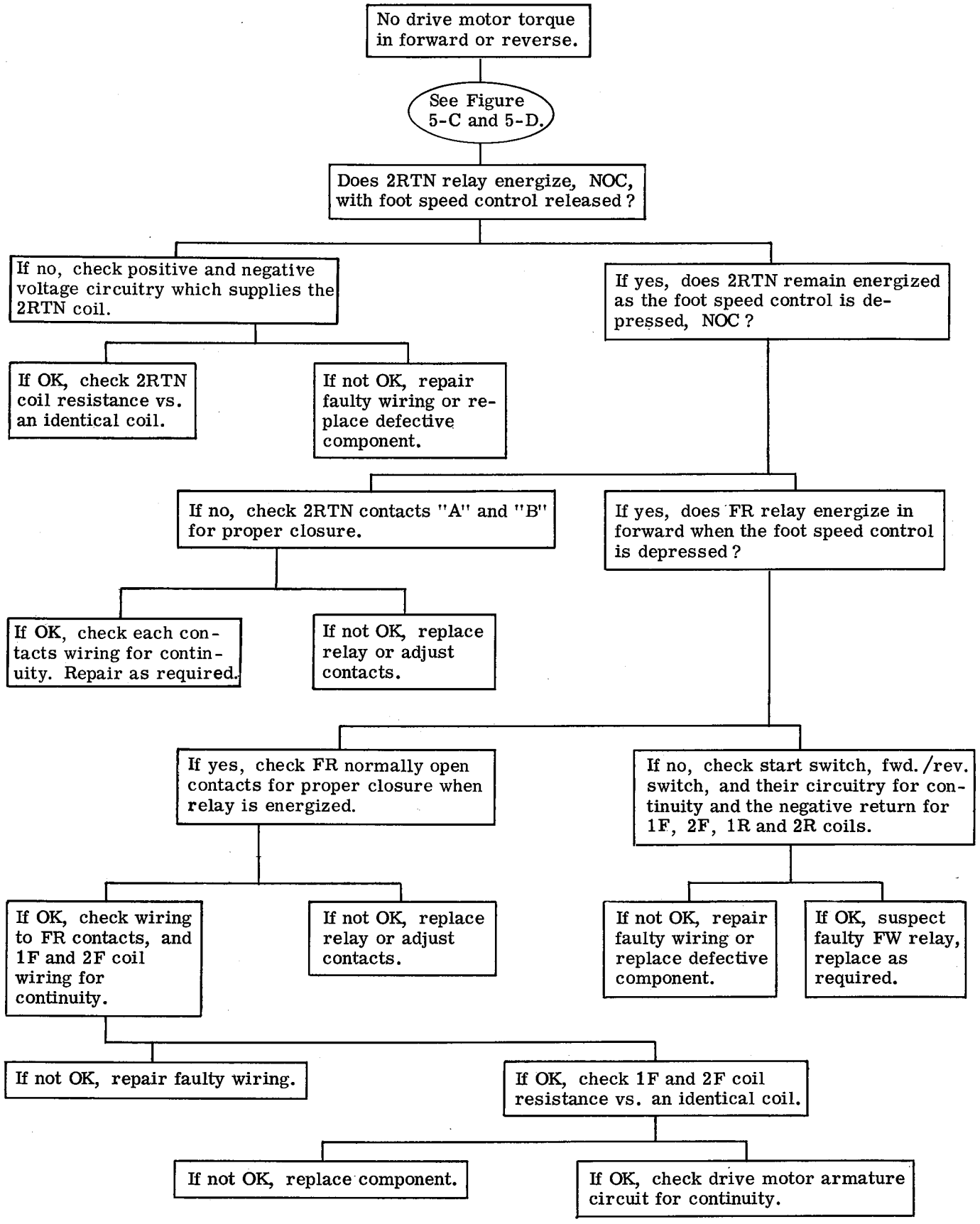
This troubleshooting guide is intended to cover the more common problems that may be encountered with the E20. If a specific problem is not listed, problems listed with similar symptoms may give some insight into possible areas to examine or the procedure to use.

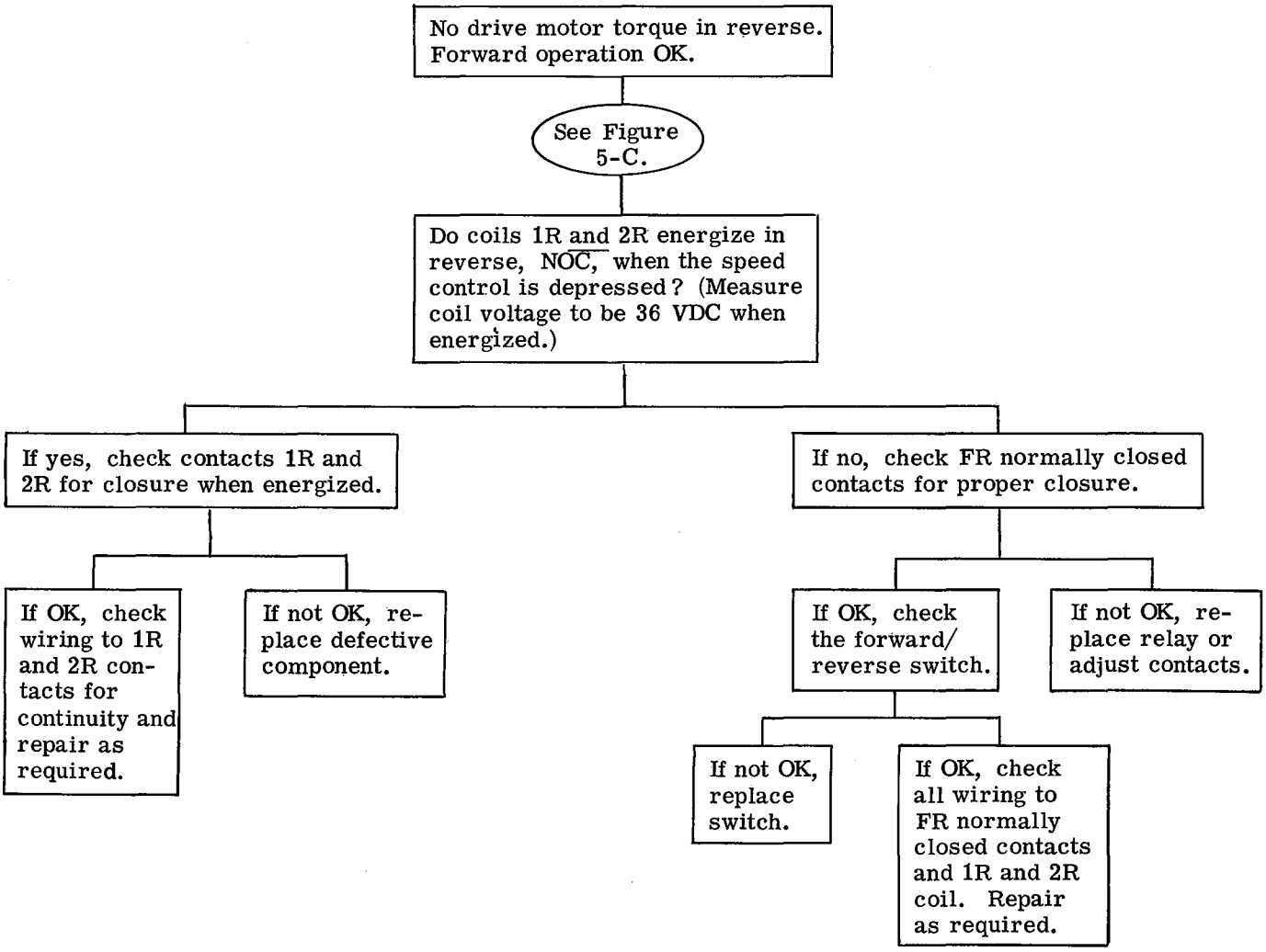
Always charge the power pack and check all fuses before beginning troubleshooting procedures.

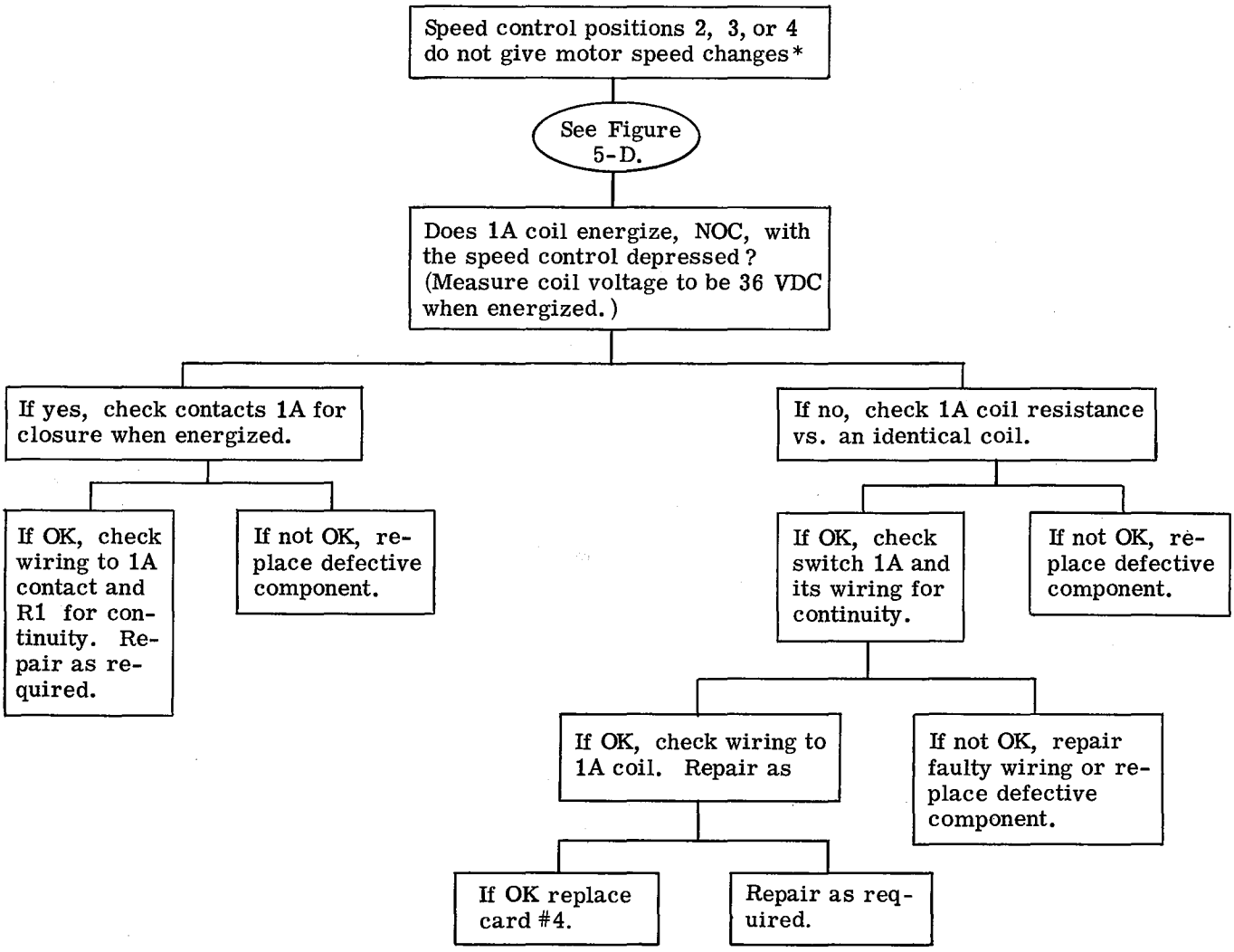
Many of the tests to be performed and the steps to be taken must be taken in the sequence given to produce reliable results. If intermediate steps are omitted, much time can be wasted and results can be very misleading.

If open wiring is suspected, don't ignore the plug and jack connections involved. These connections may become unlatched from the housing and cause an open connection. Whenever a test involves opening any connections, close the connections before proceeding to the next step.

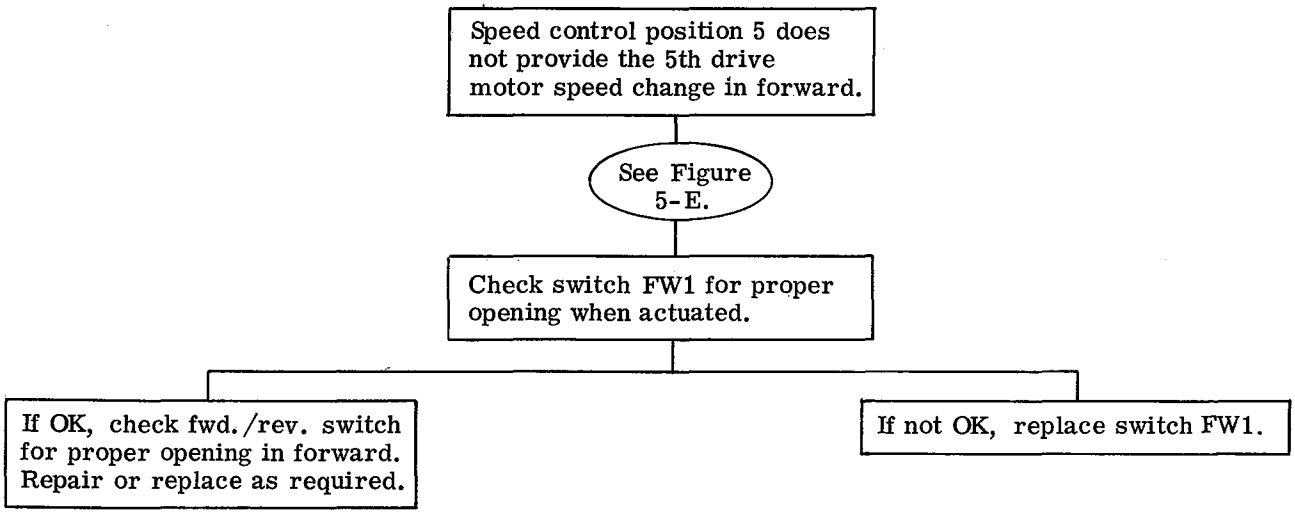
As a final word of caution, if any component is replaced or rewired and failures are experienced, carefully recheck the wire coding for correct location.


No drive motor torque in forward or reverse.
See Figure 5-C and 5-D.
Does 2RTN relay energize, NOC, with foot speed control released?
If no, check positive and negative voltage circuitry which supplies the 2RTN coil.
If yes, does 2RTN remain energized as the foot speed control is depressed, NOC?
If OK, check 2RTN coil resistance vs. an identical coil.
If not OK, repair faulty wiring or replace defective component.
If no, check 2RTN contacts "A" and "B" for proper closure.
If yes, does FR relay energize in forward when the foot speed control is depressed?
If OK, check each contacts wiring for continuity. Repair as required.
If not OK, replace relay or adjust contacts.
If yes, check FR normally open contacts for proper closure when relay is energized.
If no, check start switch, fwd./rev. switch, and their circuitry for continuity and the negative return for 1F, 2F, 1R and 2R coils.
If OK, check wiring to FR contacts, and 1F and 2F coil wiring for continuity.
If not OK, replace relay or adjust contacts.
If not OK, repair faulty wiring or replace defective component.
If OK, suspect faulty FW relay, replace as required.
If not OK, repair faulty wiring.
If OK, check 1F and 2F coil resistance vs. an identical coil.
If not OK, replace component.
If OK, check drive motor armature circuit for continuity.


No drive motor torque in reverse. Forward operation OK.
See Figure 5-C.
Do coils 1R and 2R energize in reverse, NOC, when the speed control is depressed? (Measure coil voltage to be 36 VDC when energized.)
If yes, check contacts 1R and 2R for closure when energized.
If no, check FR normally closed contacts for proper closure.
If OK, check wiring to 1R and 2R contacts for continuity and repair as required.
If not OK, replace defective component.
If OK, check the forward/ reverse switch.
If not OK, replace relay or adjust contacts.
If not OK, replace switch.
If OK, check all wiring to FR normally closed contacts and 1R and 2R coil. Repair as required.



*Contactor 1A is active in position 2, 2A in position 3, and 3A in position 4. This troubleshooting section is written for contactor 1A circuitry, but is similar in technique for 2A and 3A.


Speed control position 5 does not provide the 5th drive motor speed change in forward.
See Figure 5-E.
Check switch FW1 for proper opening when actuated.
If OK, check fwd./rev. switch for proper opening in forward. Repair or replace as required.
If not OK, replace switch FW1.

None of the last three speed control positions give drive motor speed changes, but motor does not overspeed.

See Figure 5-E.

Does FW relay energize, NOC, with the speed control in the first forward position ?

If yes, check switch FW2 for opening when actuated.

If OK, check FW contacts for opening when energized and repair or replace as required.

If not OK, replace defective switches.

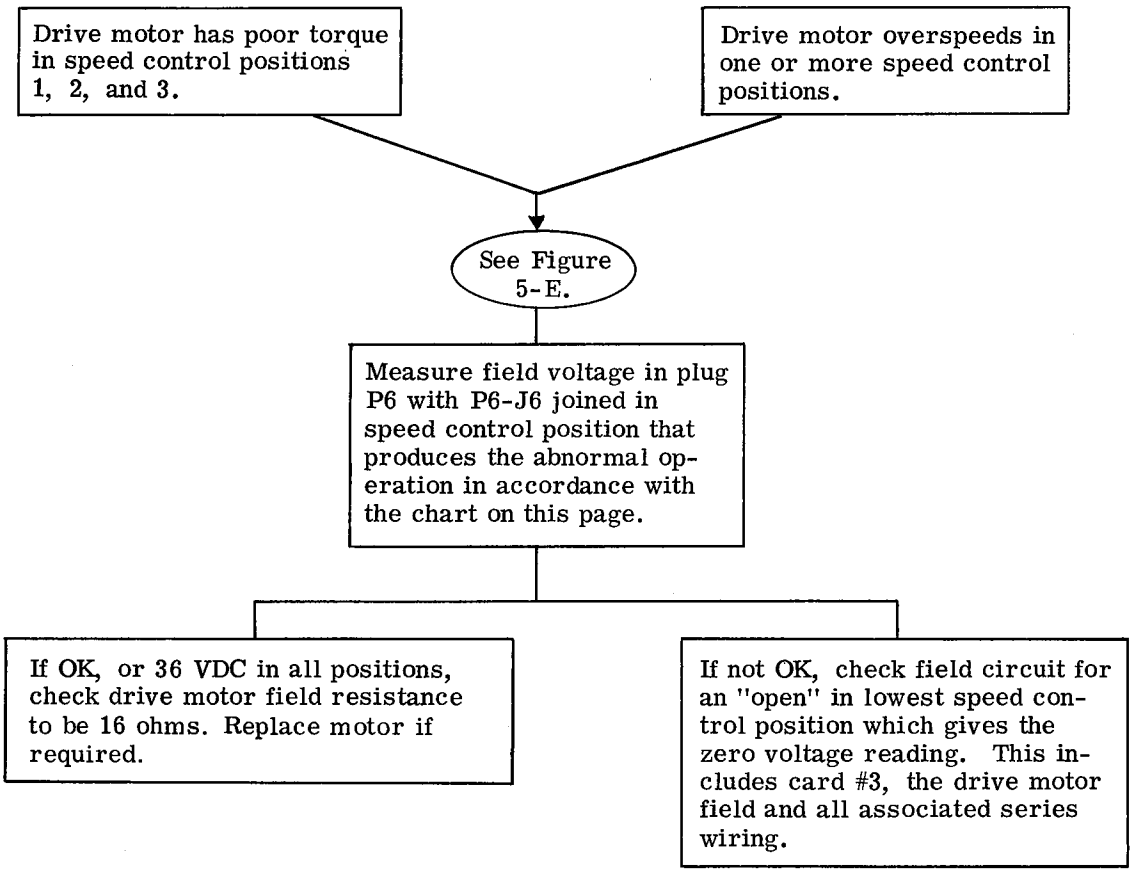
If no, measure 24 VDC or more at FW coil, NOC, with speed control in the first speed forward.

If OK, replace FW relay.

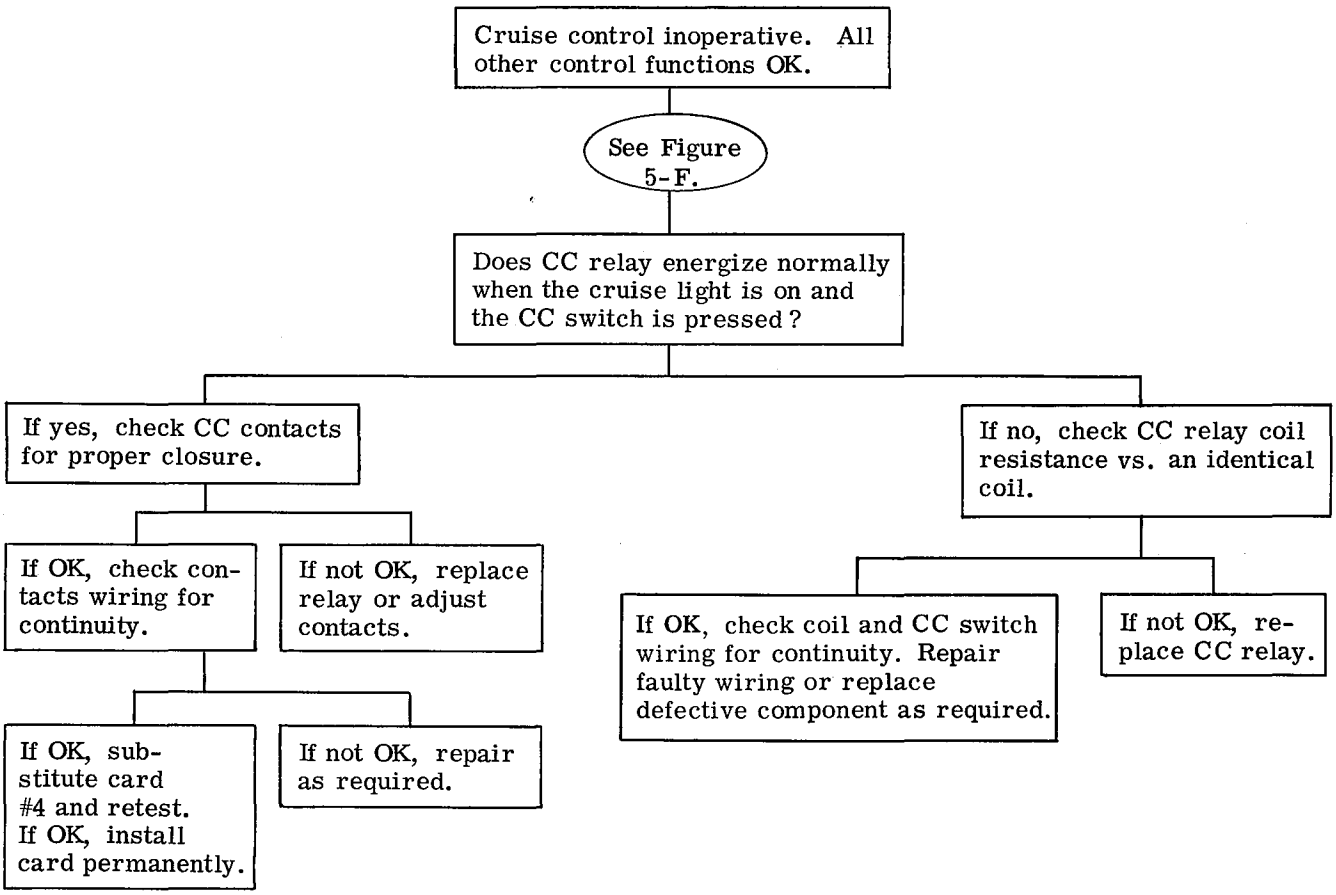
If not OK, substitute card #4 and measure for 24 VDC at FW coil again.

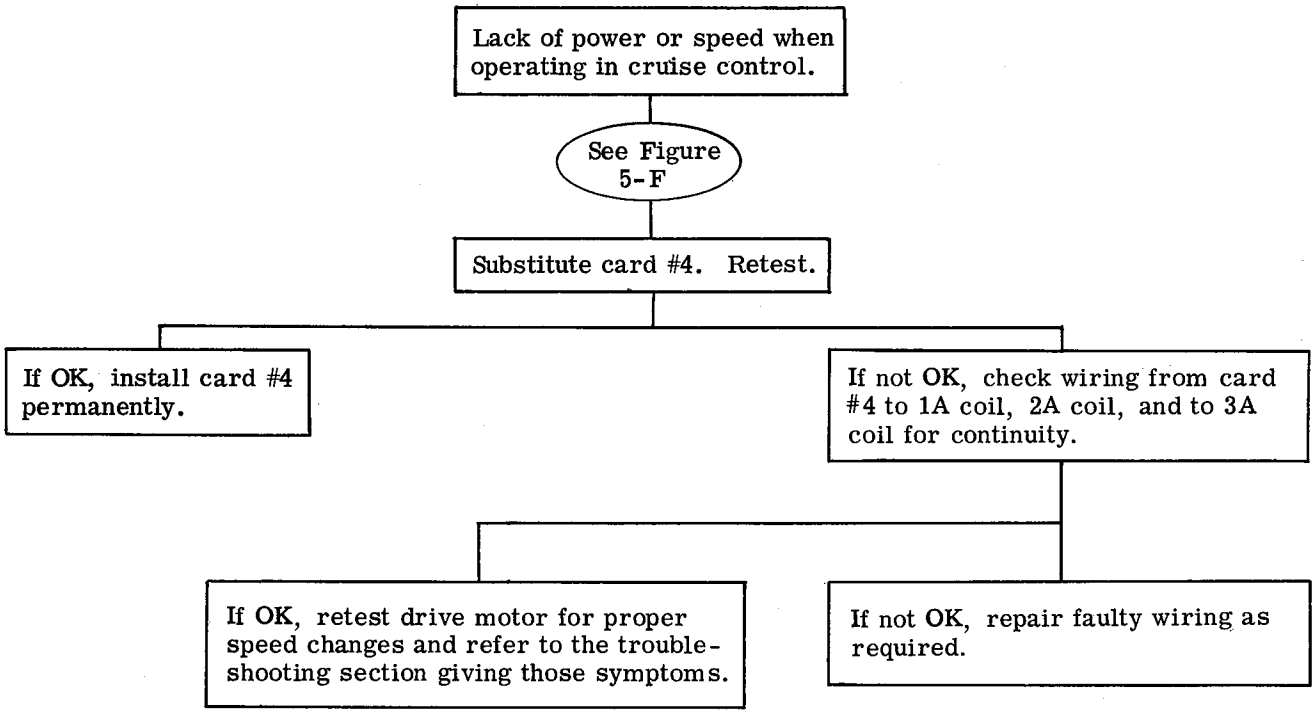
If OK, install new card #4 permanently.

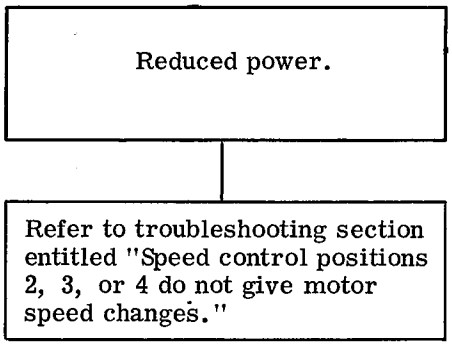
If not OK, check wires 40 and 49 for continuity and repair as required.

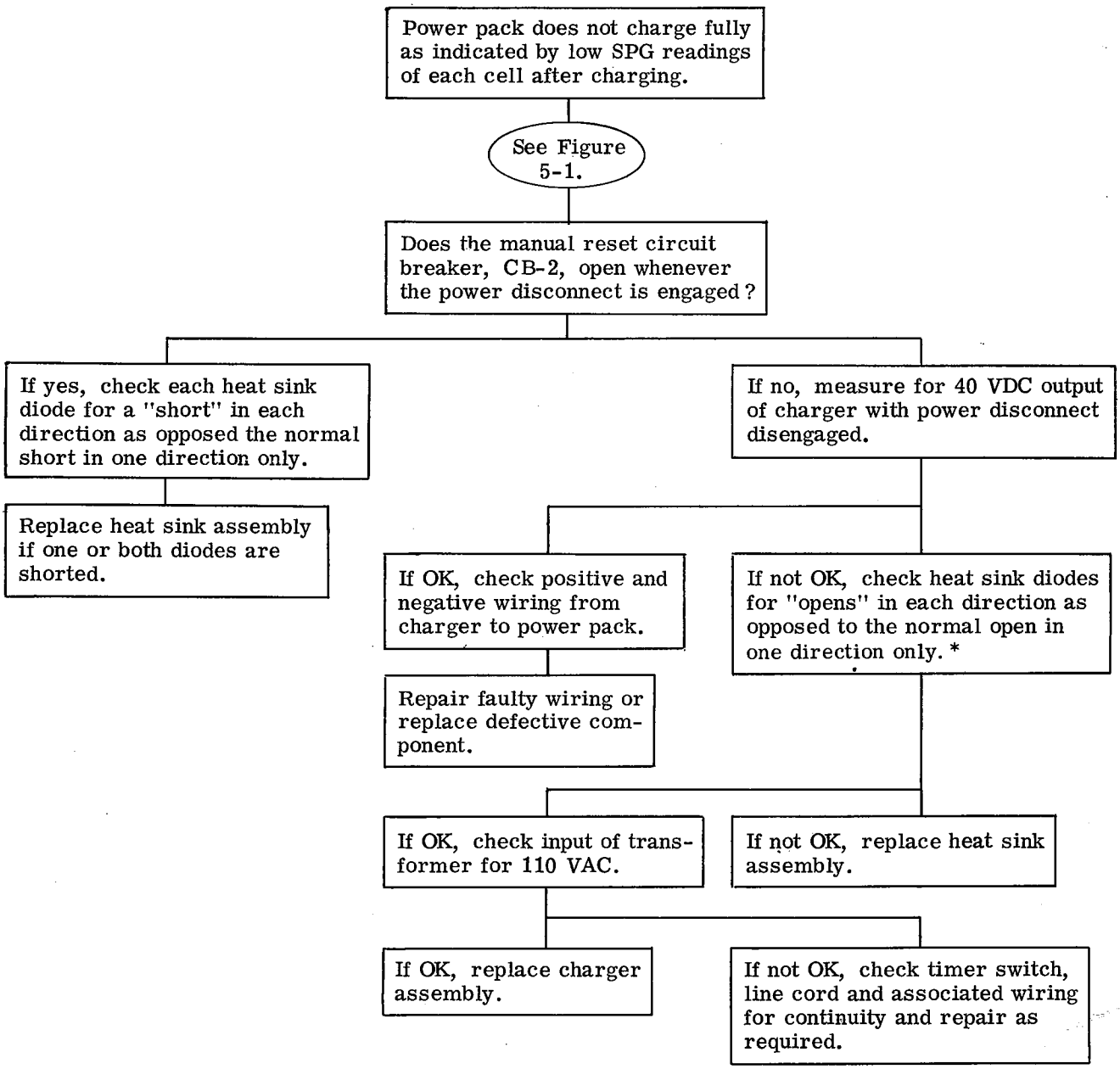


Field Voltage Chart	
Speed Control Position	Approximate DC. Field Voltage Measured at P6. P6-J6 Connected
1	36
2	36
3	36
4	36
5	22
6	15
7	10
8	6

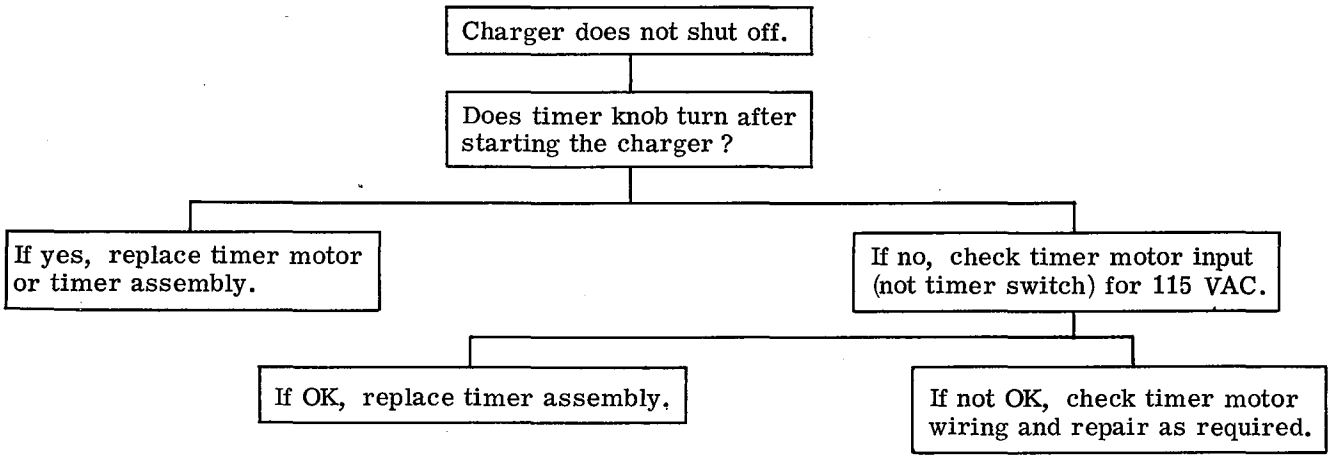

Cruise control inoperative. All other control functions OK.
See Figure 5-F.
Does CC relay energize normally when the cruise light is on and the CC switch is pressed?
If yes, check CC contacts for proper closure.
If no, check CC relay coil resistance vs. an identical coil.
If OK, check contacts wiring for continuity.
If not OK, replace relay or adjust contacts.
If OK, check coil and CC switch wiring for continuity. Repair faulty wiring or replace defective component as required.
If not OK, replace CC relay.
If OK, substitute card #4 and retest. If OK, install card permanently.
If not OK, repair as required.

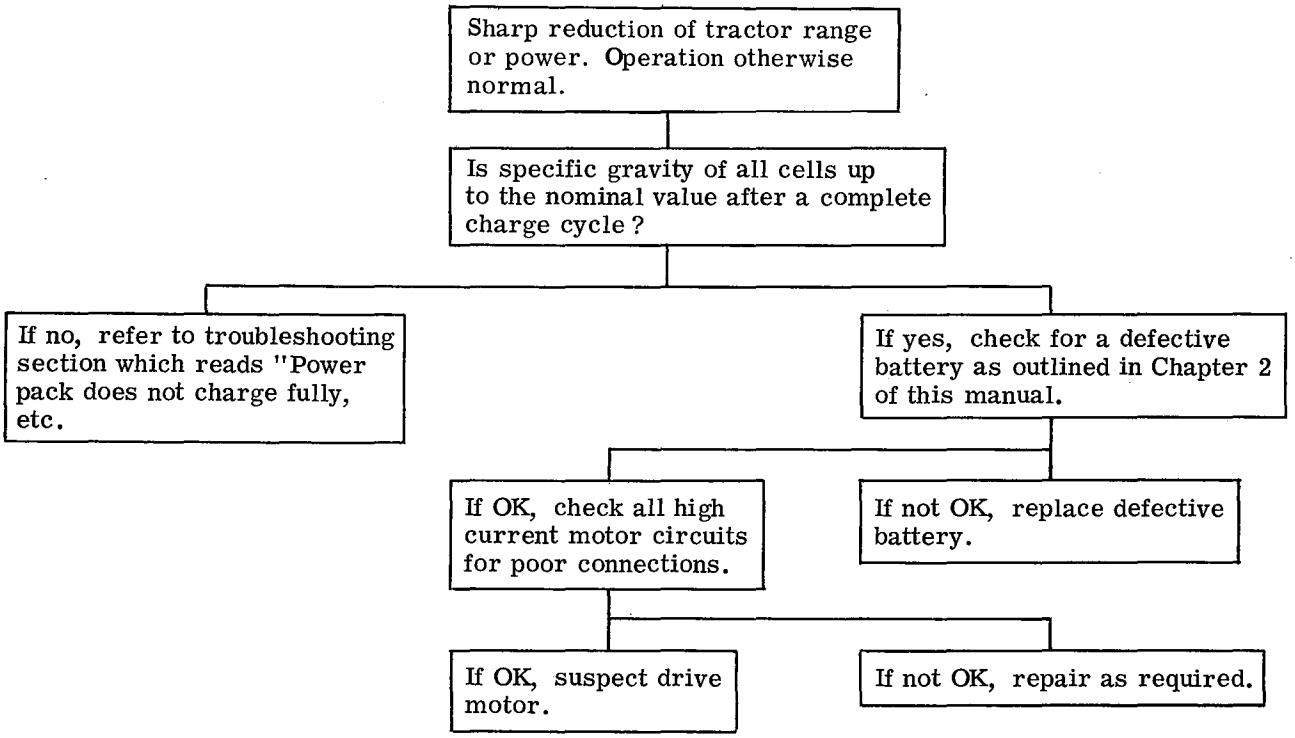

Lack of power or speed when operating in cruise control.
See Figure 5-F
Substitute card #4. Retest.
If OK, install card #4 permanently.
If not OK, check wiring from card #4 to 1A coil, 2A coil, and to 3A coil for continuity.
If OK, retest drive motor for proper speed changes and refer to the trouble-shooting section giving those symptoms.
If not OK, repair faulty wiring as required.

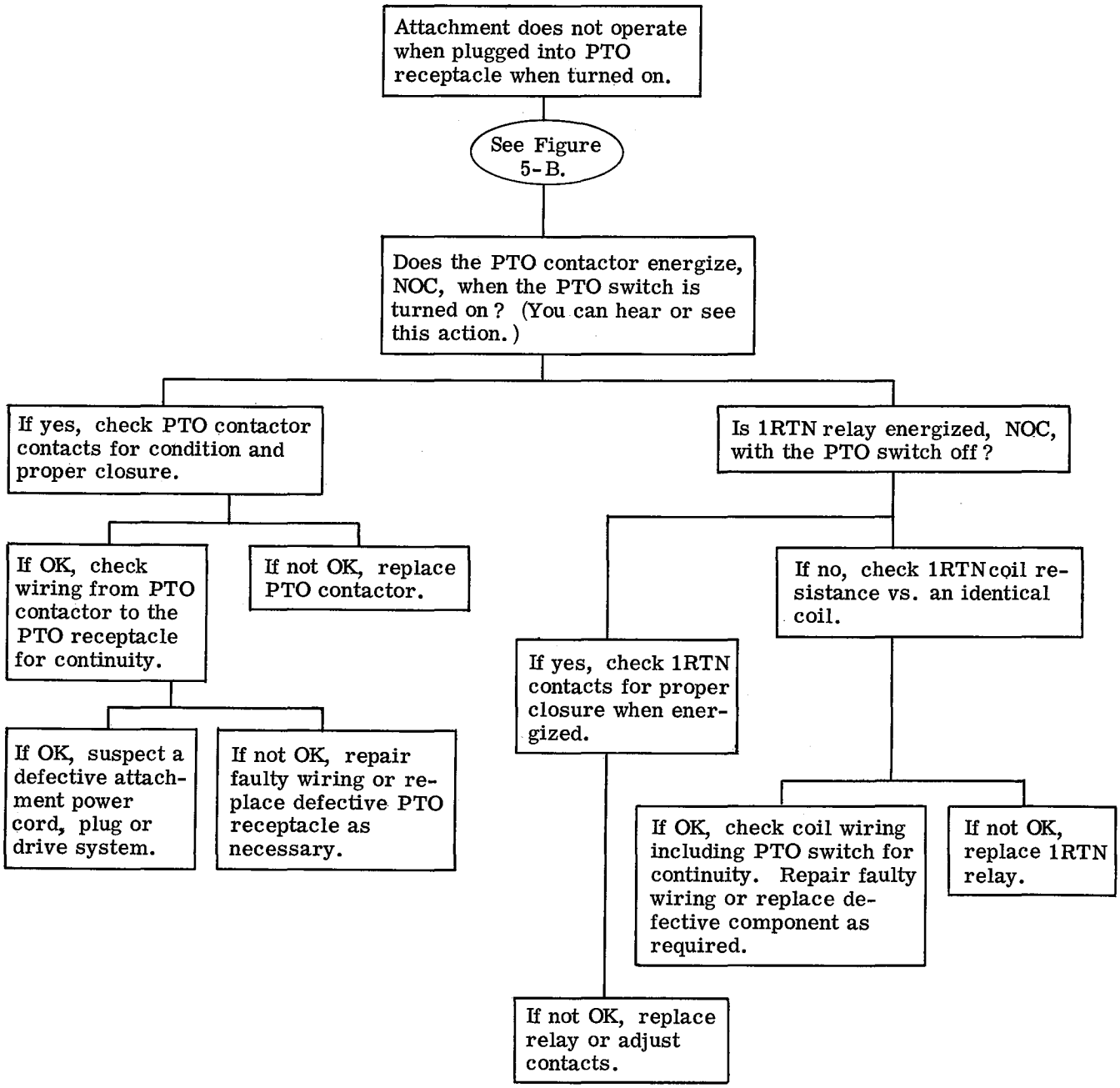

Reduced power.
Refer to troubleshooting section entitled "Speed control positions 2, 3, or 4 do not give motor speed changes."



*Since both diodes are in parallel, one of the diode wires must be removed before either diode can be checked for an "open". Removing a wire is not necessary to check for a short.


Charger does not shut off.
Does timer knob turn after starting the charger ?
If yes, replace timer motor or timer assembly.
If no, check timer motor input (not timer switch) for 115 VAC.
If OK, replace timer assembly.
If not OK, check timer motor wiring and repair as required.


Sharp reduction of tractor range or power. Operation otherwise normal.
Is specific gravity of all cells up to the nominal value after a complete charge cycle ?
If no, refer to troubleshooting section which reads "Power pack does not charge fully, etc.
If yes, check for a defective battery as outlined in Chapter 2 of this manual.
If OK, check all high current motor circuits for poor connections.
If not OK, replace defective battery.
If OK, suspect drive motor.
If not OK, repair as required.


Attachment does not operate when plugged into PTO receptacle when turned on.
See Figure 5-B.
Does the PTO contactor energize, NOC, when the PTO switch is turned on? (You can hear or see this action.)
If yes, check PTO contactor contacts for condition and proper closure.
If not OK, replace PTO contactor.
If OK, check wiring from PTO contactor to the PTO receptacle for continuity.
If OK, suspect a defective attachment power cord, plug or drive system.
If not OK, repair faulty wiring or replace defective PTO receptacle as necessary.
Is 1RTN relay energized, NOC, with the PTO switch off?
If yes, check 1RTN contacts for proper closure when energized.
If not OK, replace relay or adjust contacts.
If no, check 1RTN coil resistance vs. an identical coil.
If OK, check coil wiring including PTO switch for continuity. Repair faulty wiring or replace defective component as required.
If not OK, replace 1RTN relay.

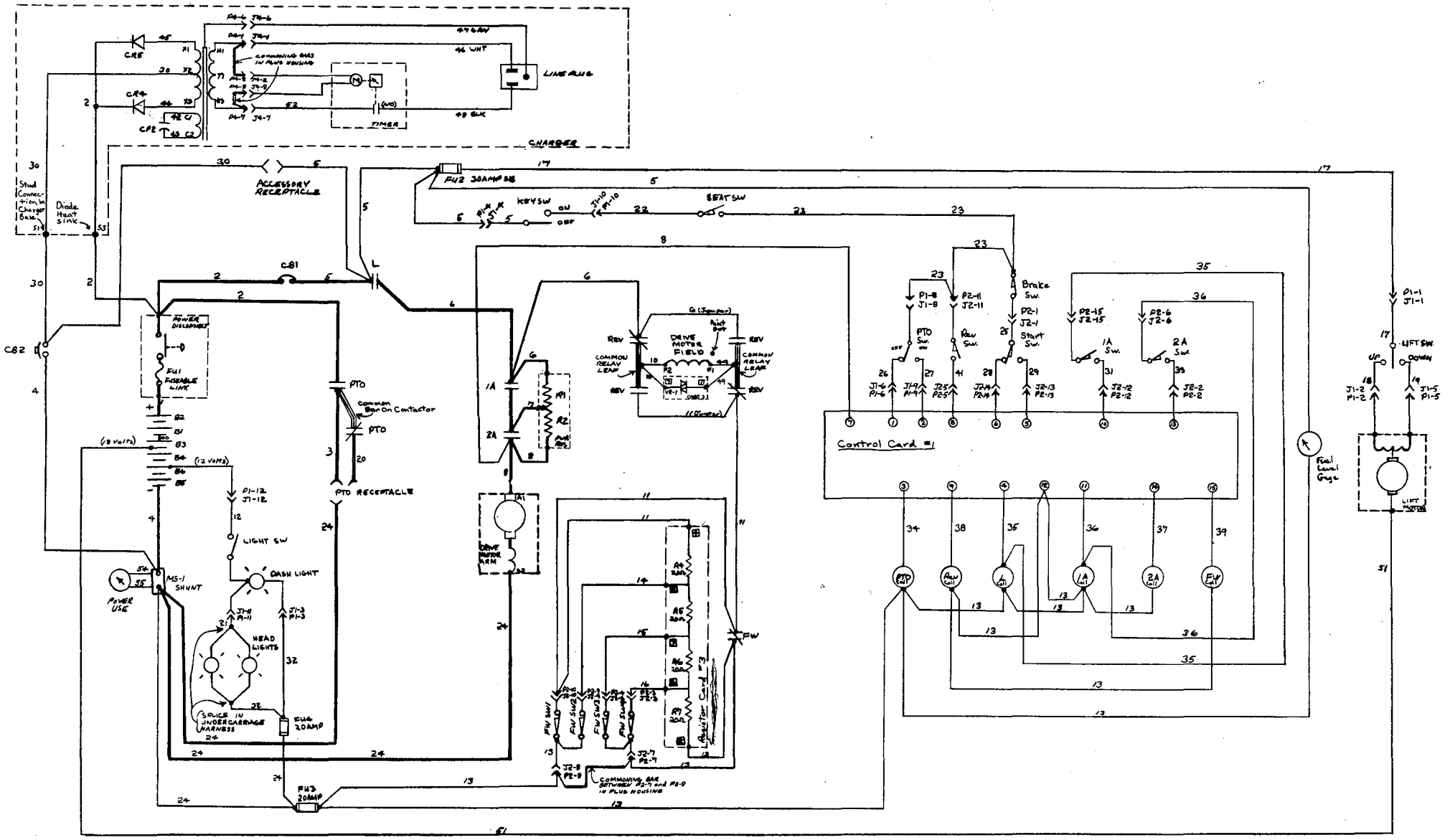
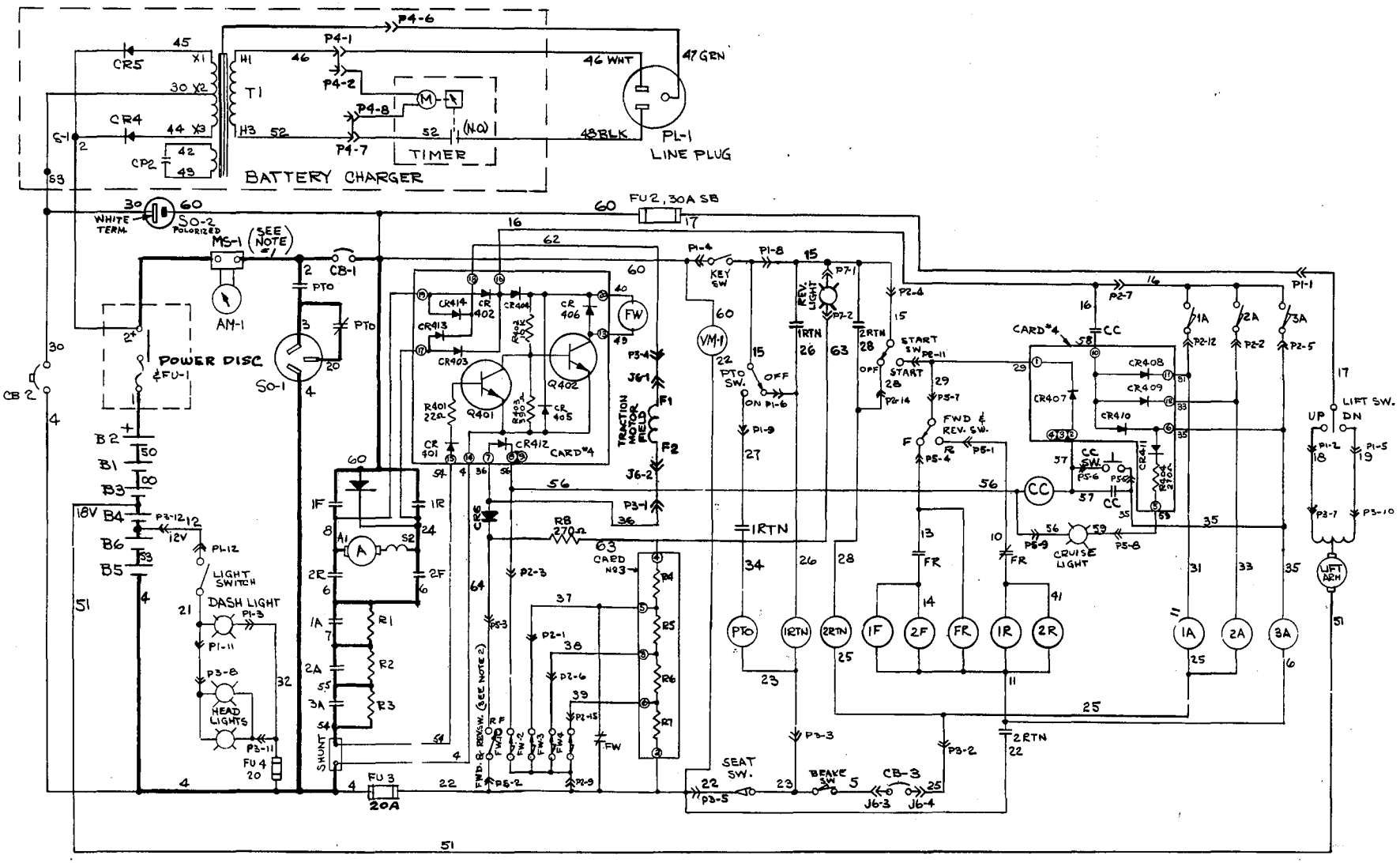


Fig. 4-1 E-15 Troubleshooting Sketch

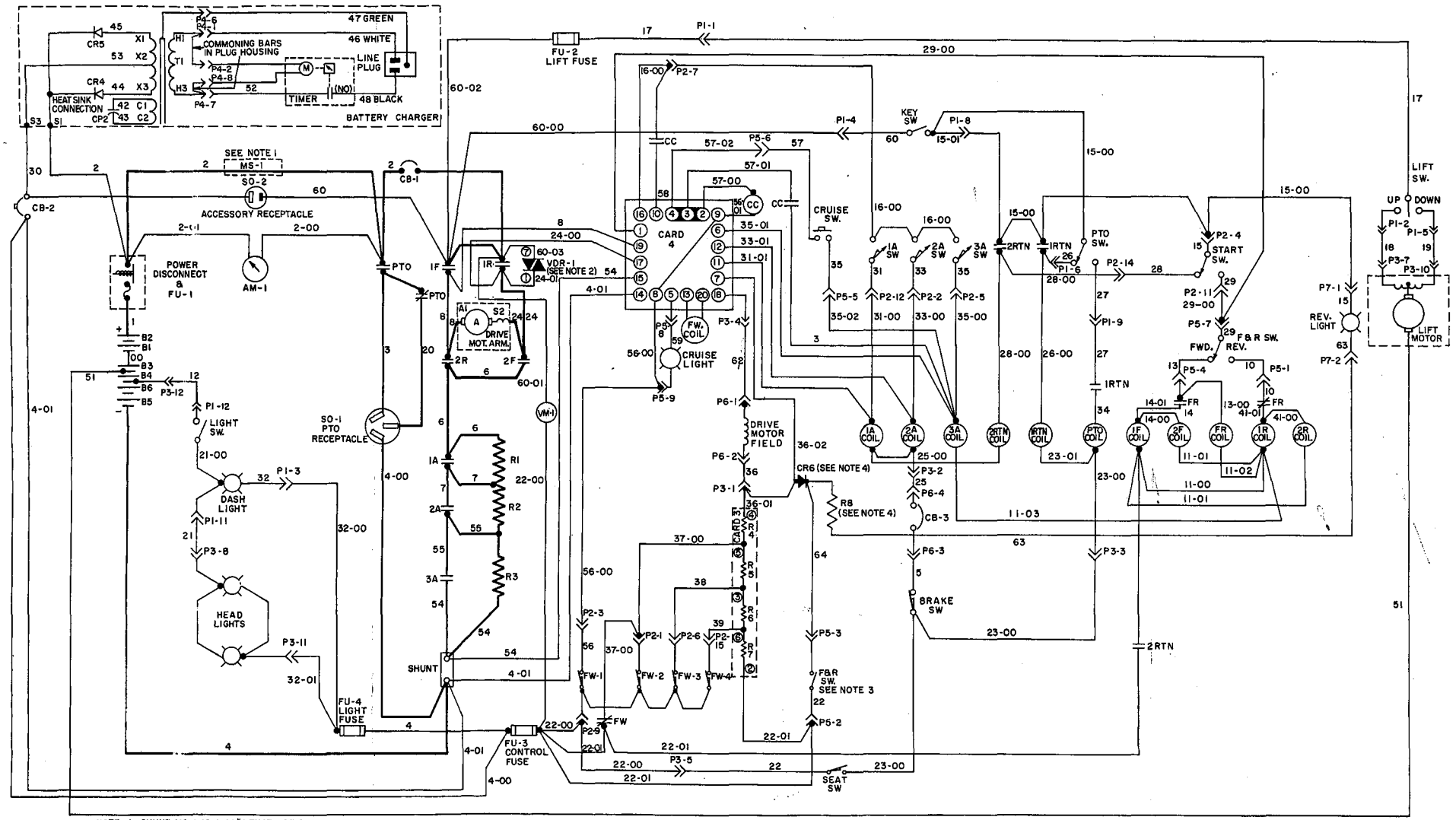


NOTE

1- MS-1 IS 20" LG., #6AWG CABLE BETWEEN THE LINE DISC. & PTO CONTACTOR.

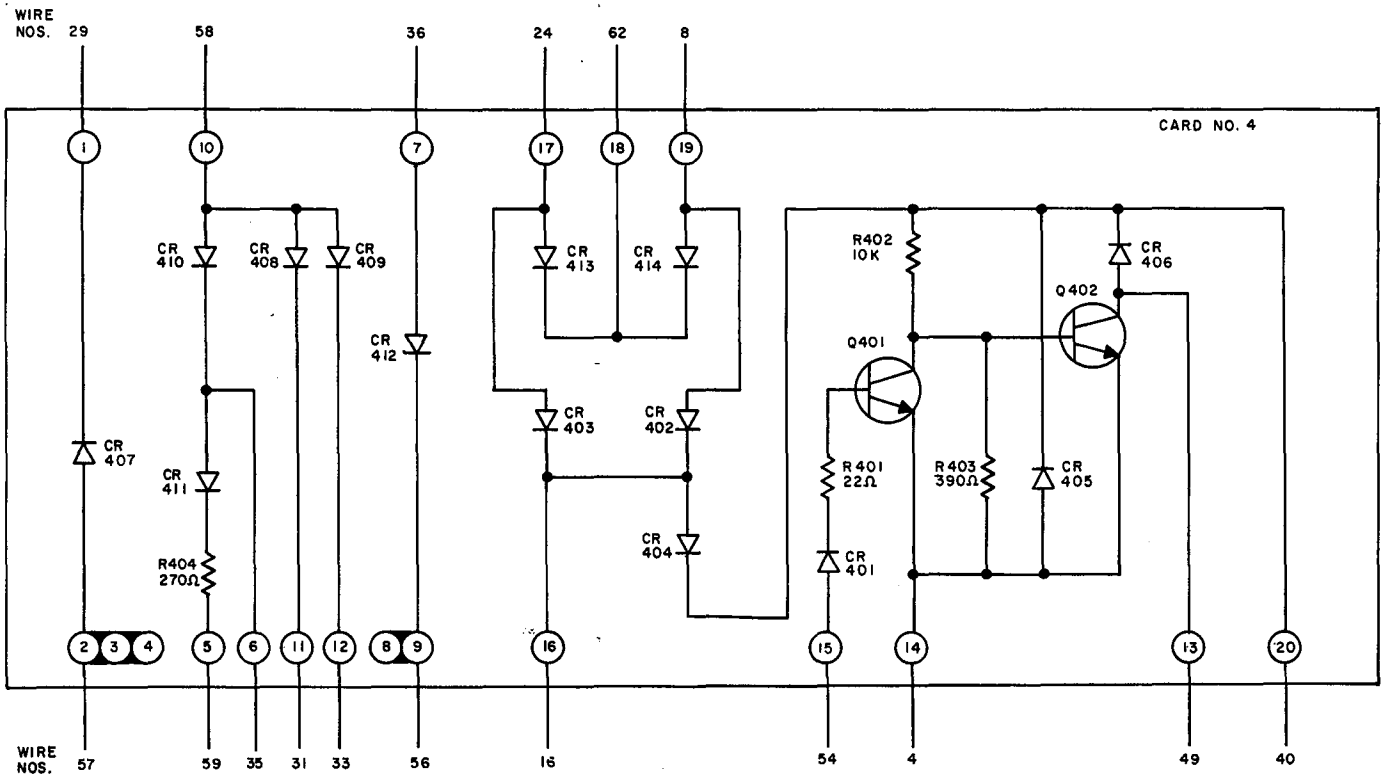
2- F&R SWITCH CLOSED IN REVERSE POSITION ONLY

Fig. 5-1 E20 Troubleshooting Sketch



NOTE: 1. SHUNT MS-1 IS A 20" LENGTH OF 6AWG WIRE
2. VARISTOR VDR-1 IS MOUNTED ON CARD NO. 3
3. THIS PORTION OF F&R SWITCH IS CLOSED IN THE REVERSE POSITION ONLY
4. DIODE CR6 AND RESISTOR R8 ARE MOUNTED ON THE RESISTOR/DIODE ASSEMBLY ON THE UPPER CONTROL PANEL

Fig. 5-1.1 E20 Connection Diagram

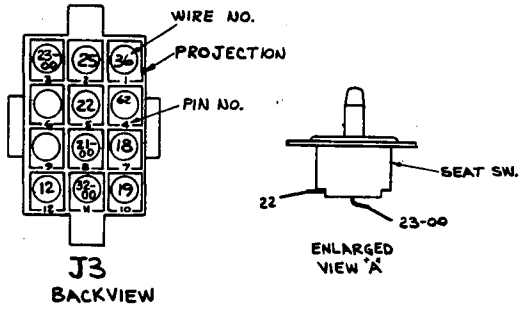


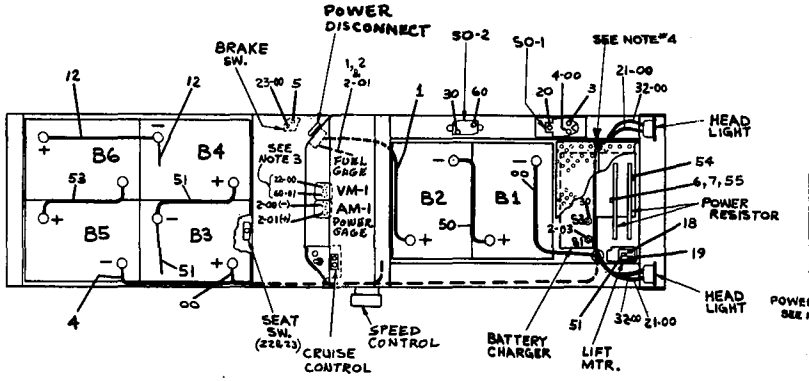
Circled numbers correspond to pad numbers on printed circuit card.

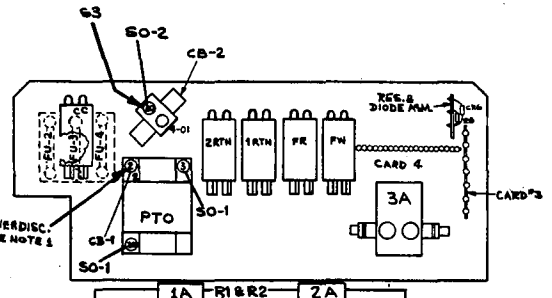
Fig. 5-2 E20 Card #4

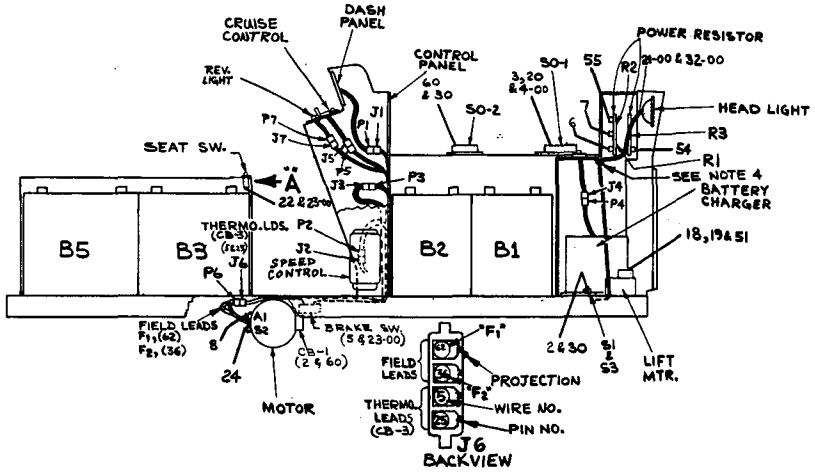
NOTES:

1. CABLE CONNECTION FROM POWER DISCONNECT TO PTO CONTACTOR MUST BE 20 INCHES OF #6AWG.
2. → INDICATES CONNECTIONS TO BE MADE UPON INSTALLATION OF PANEL INTO TRACTOR.
3. WIRES FROM CONTROL PANEL CABLE HARNESS.
4. HEAD LIGHT LEADS 21&32 MUST NOT MAKE CONTACT WITH POWER RESISTOR. USE CABLE TIES TO FASTEN THESE LEADS TO TIMER COVER, 2 PLACES.
5. THIS FIGURE SHOWS MAJOR WIRE CONNECTIONS ONLY.
6. CALL OUTS ARE WIRE CODE NUMBERS OR WIRE TERMINATION POINTS









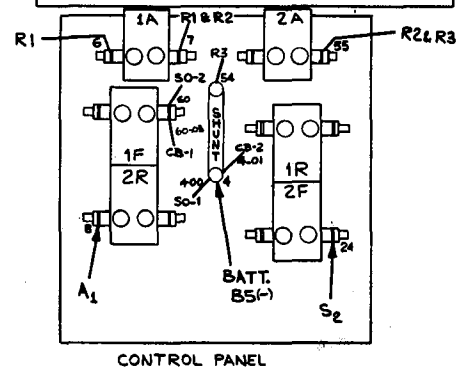
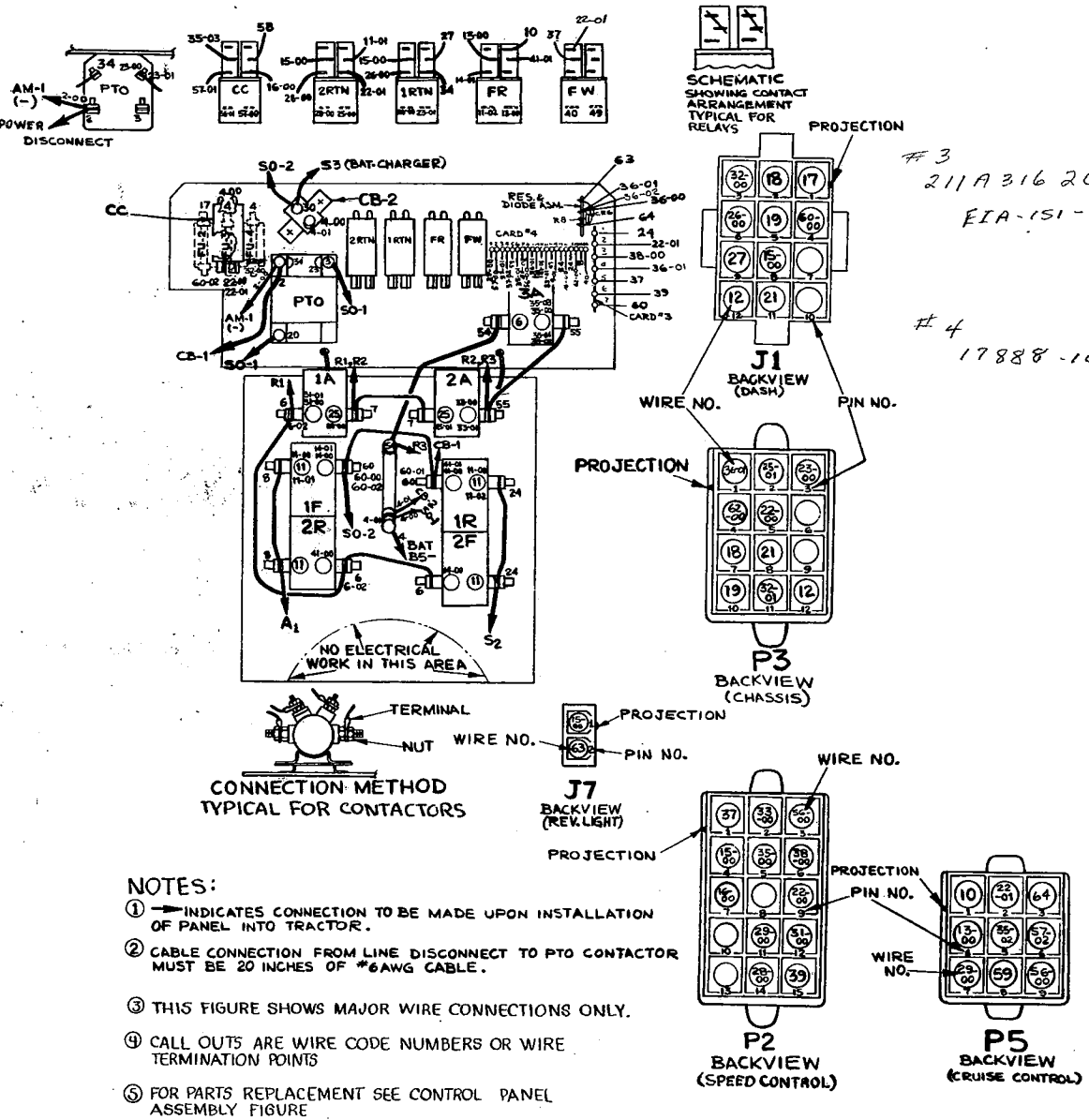


Fig. 5-3 E20 Tractor Wiring



NOTES:

① → INDICATES CONNECTION TO BE MADE UPON INSTALLATION OF PANEL INTO TRACTOR.

② CABLE CONNECTION FROM LINE DISCONNECT TO PTO CONTACTOR MUST BE 20 INCHES OF #6AWG CABLE.

③ THIS FIGURE SHOWS MAJOR WIRE CONNECTIONS ONLY.

④ CALL OUTS ARE WIRE CODE NUMBERS OR WIRE TERMINATION POINTS

⑤ FOR PARTS REPLACEMENT SEE CONTROL PANEL ASSEMBLY FIGURE

Fig. 5-4 E20 Control Panel Wiring

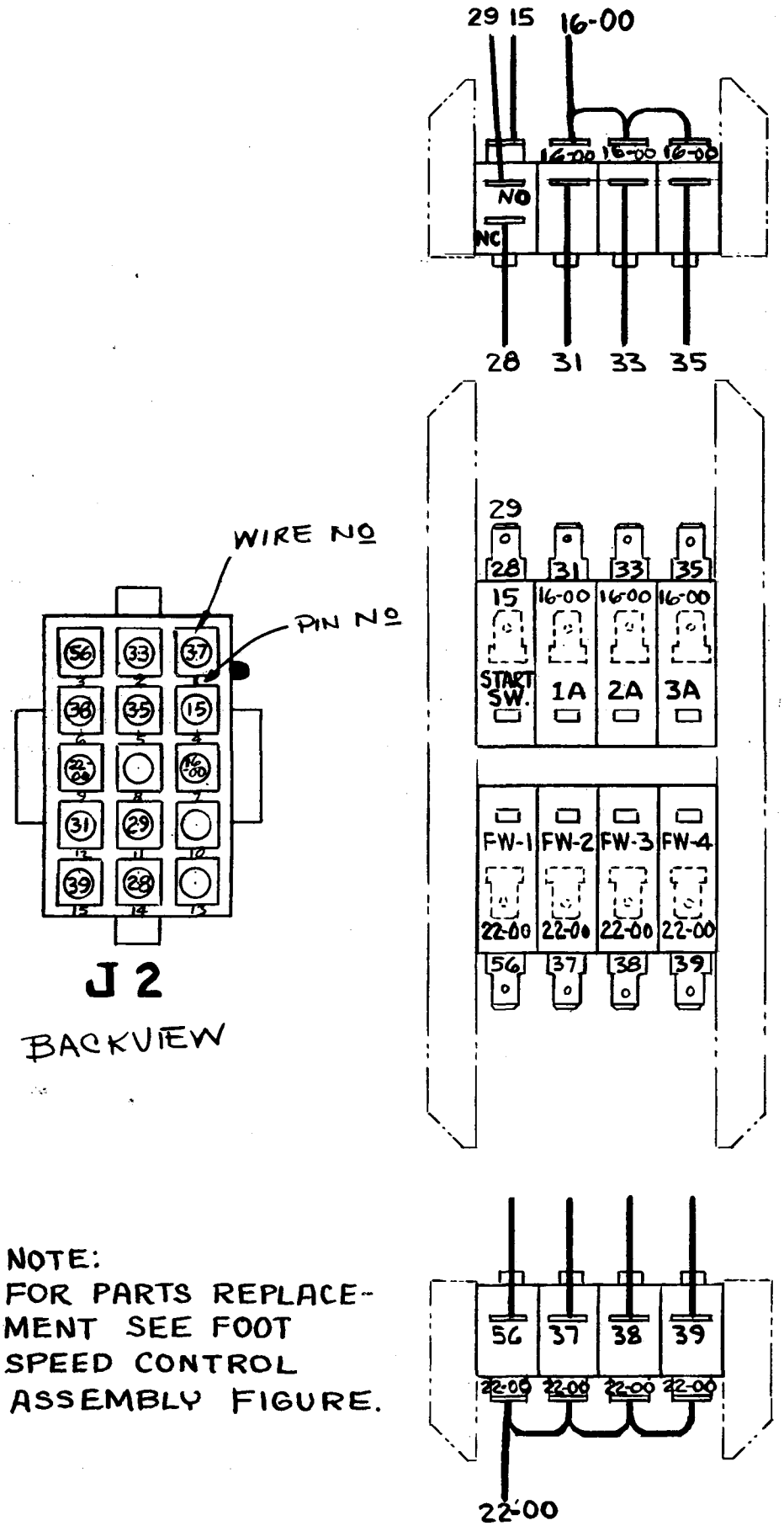


Fig. 5-5 E20 Foot Pedal Speed Control Wiring

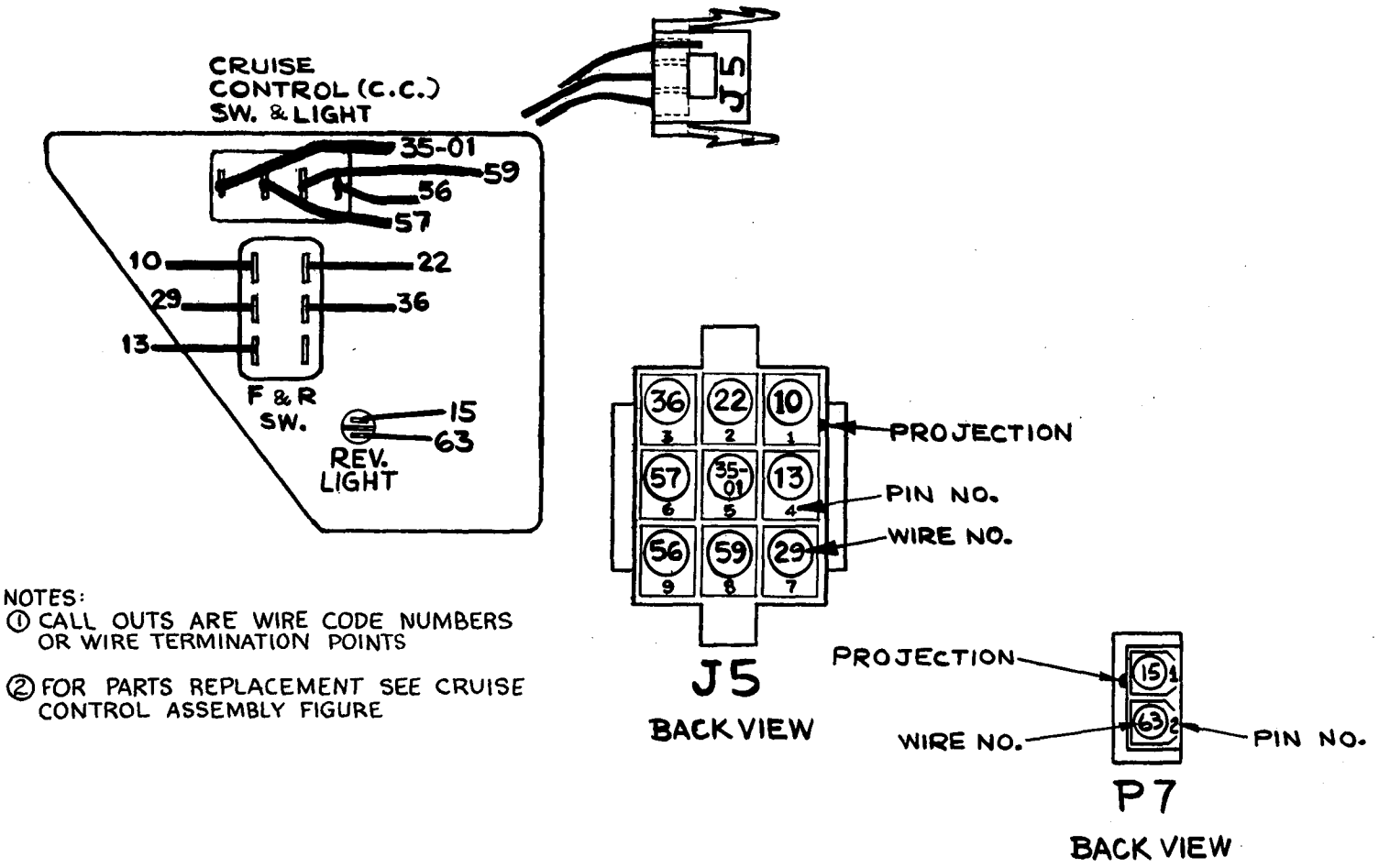


Fig. 5-6 E20 Cruise Control Wiring

CONTROL PANEL ASSEMBLY

Use this list to order replacement parts from Fig. 5-7.

Ref. No.	Description	Part Number	26A						
			E20A	E20B					
4	Panel (Upper)	178B8005P1	X	X					
5	Panel (Lower)	178B8006P1	X	X					
6	Circuit Breaker (Manual)	243A4719P1	X	X					
7	Relay (CC, 1RTN, 2RTN, FR, FW)	243A4562P1	X	X					
8	PTO Contactor	243A4524P1	X	X					
9	Power Contactor	211A3567P1	X	X					
10	Double Solenoid	178B8009P1	X	X					
11	Fuse Block	243A4807P1	X	X					
12	Fuse (30A SB)	243A4597P1	X	X					
13	Fuse (20A)	243A4657P1	X	X					
14	Card #3 (Resistor)	211A3162G2	X	X					211A3162G1 R-C
15	Card #4 (Auxiliary)	163B9977G1	X	X					
16	Cable Tie	243A4540P2	X	X					
18	Control Panel Wire Harness	127D8006G1	X	X					
19	Grill Wire Harness	155C8019G1	X	X					
20	Screw, Hex Hd. (10-32 x 3/8")	(1)	X	X					
21	Screw, Hex Hd. (8-32 x 3/8")	(1)	X	X					
22	Thread Rolling Screw (10-32 x 1/2")	N722AP16008C	X	X					
23	Thread Rolling Screw (10-32 x 3/8")	N722AP16006C	X	X					
25	Thread Rolling Screw (6-32 x 3/8")	N722AP13006C	X	X					
26	Hex Hd. Screw (6-32 x 5/8")	(1)	X	X					
27	Lockwasher (Size 10)	(1)	X	X					
28	Lockwasher (Size 8)	(1)	X	X					
29	Lockwasher (Size 6)	(1)	X	X					
30	Washer (Size 10)	(1)	X	X					
31	Nut, Hex 10-32	(1)	X	X					
32	Screw, Hex Hd.	(1)	X	X					
33	Lockwasher (1/4")	(1)	X	X					
34	Insulator	211A3165P1	X	X					
35	Washer (1/4" x 1" O.D.)	(1)	X	X					
36	Stud	N90P21036	X	X					
37	Shunt Plate	211A3212P3	X	X					
38	Washer (1/4" x 1/2" O.D.)	(1)	X	X					
39	Lockwasher (1/4")	(1)	X	X					
40	Nut, Hex (1/4"-20)	(1)	X	X					
41	Bracket	243A4806P1	X	X					
42	Nut, Hex (6-32)	(1)	X	X					
44	Resistor/Diode Assembly	243A4940G1	X	X					

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

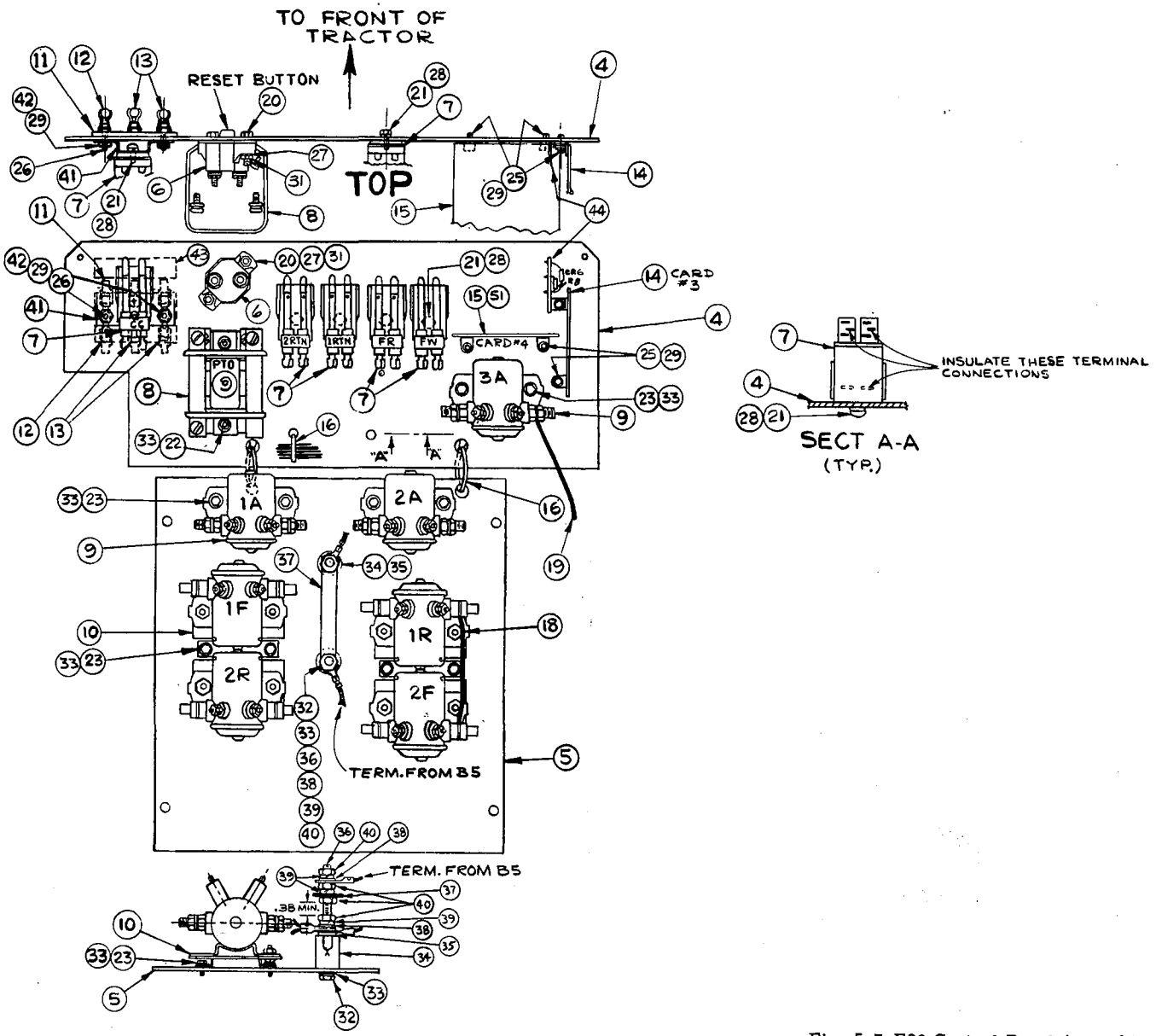


Fig. 5-7 E20 Control Panel Assembly

E20 CRUISE CONTROL ASSEMBLY
Use this list to order replacement parts from Fig. 5-8.

Ref. No.	Description	Part Number	26A					
			E20AA	E20BA				
1	Cruise Control Assembly (All parts as shown)	541C960G1	X	X				
2	Mounting Plate	243A4808P1	X	X				
3	Forward/Reverse Switch	243A4814P1	X	X				
4	Cruise Control Light/Switch	243A4848P1	X	X				
5	Insulation Tubing	211A3551P1	X	X				
6	Cruise Control Harness	178B8095G1	X	X				
8	Cruise Control Decal	243A4815P1	X	X				
9	Fwd./Rev. Decal	243A48151P2	X	X				
11	Reverse Light	243A4979P1	X	X				

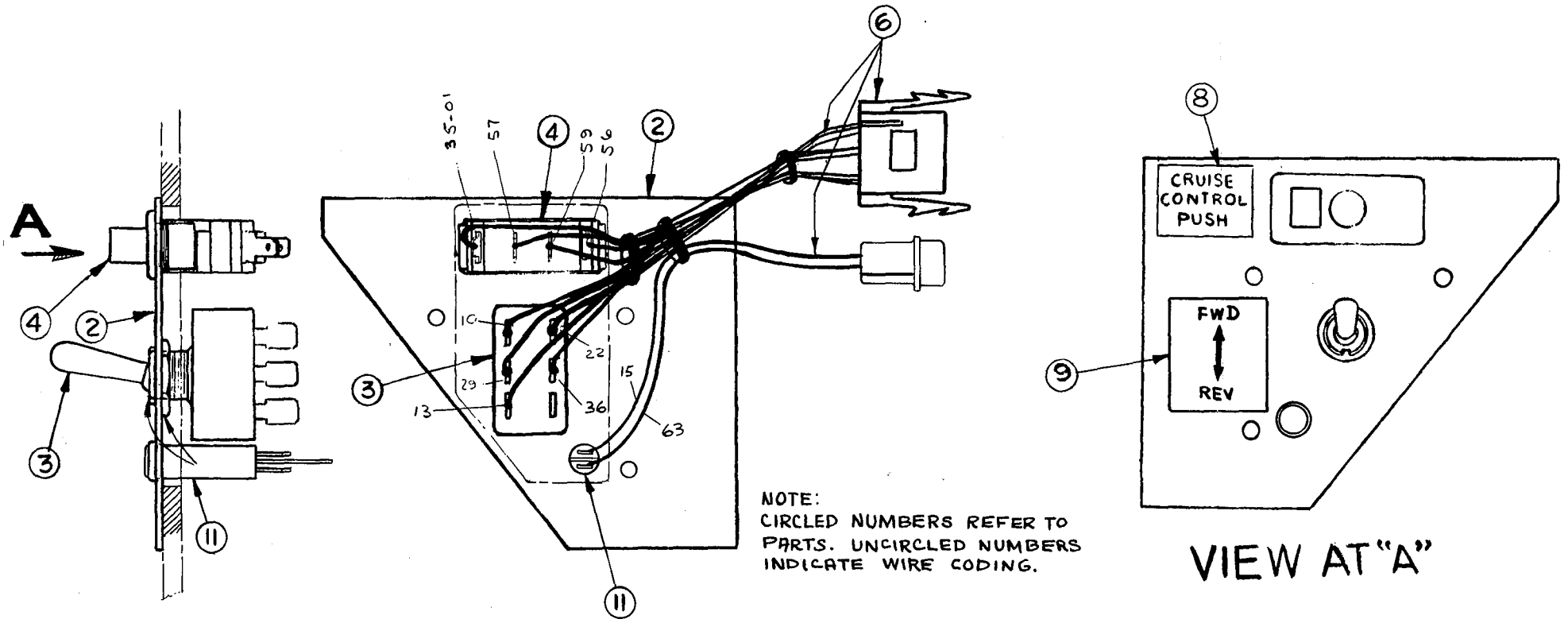


Fig. 5-8 E20 Cruise Control Assembly

E20 CONTROL CABINET ASSEMBLY
Use this list to order replacement parts from Fig. 5-9.

Ref. No.	Description	Part Number	26A					
			E20AA	E20BA				
2	Control Cabinet	587E919P3	X	X				
3	Dash Panel Assembly	See Fig. 4-9	X	X				
4	Control Panel Assembly	See Fig. 5-7	X	X				
5	Cruise Control Assembly	See Fig. 5-8	X	X				
6	Power Disconnect	163B9923G1	X	X				
7	Fuel Level Gage	243A4629G1	X	X				
8	Power Use Gage	243A4630G2	X	X				
9	Bearing	211A3101P2	X	X				
10	Decal	541C68P1	X	X				
11	Thread Rolling Screw (8-32 x 1/2")	N722AP15008	X	X				
12	Thread Rolling Screw (8-32 x 1/2")	N722AP15008C6	X	X				
13	Screw, Hex Hd. (5/16"-18 x 1/2")	(1)	X	X				
14	Lockwasher (5/16")	(1)	X	X				
15	Cover	542C868P2	X	X				
16	Thread Rolling Screw (8-32 x 3/8")	N722AP15006C6	X	X				
A	Knob (Power Disconnect)	243A4502P1	X	X				

Note 1: Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

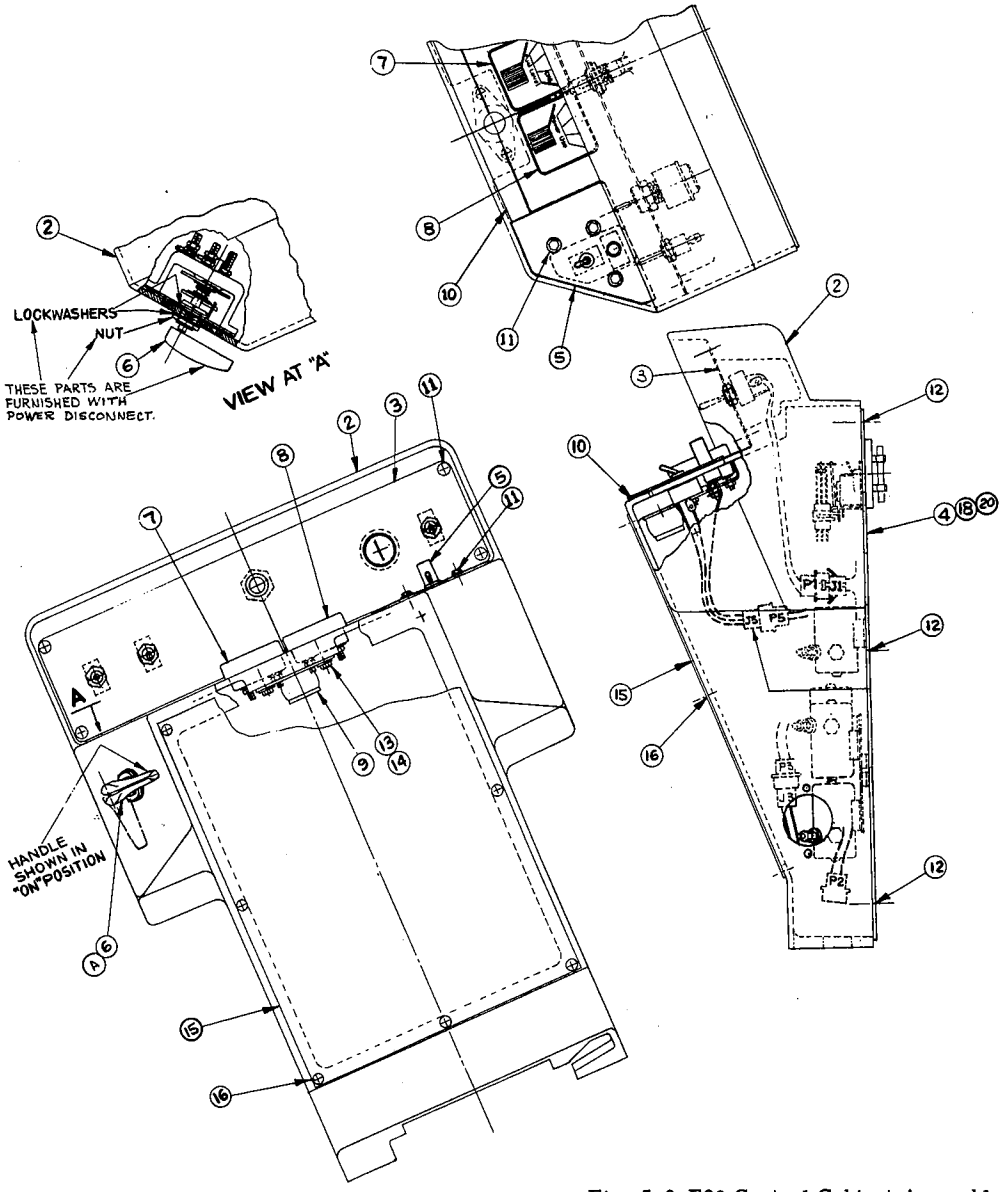


Fig. 5-9 E20 Control Cabinet Assembly

Fig. 5-10, 541C978, Rev 1

P. L. 541C978, Rev 1

E20 FOOT SPEED CONTROL

Use this list to order replacement parts from Fig. 5-10.

Ref. No.	Description	Part Number	26A					
			E20A	E20B				
1	Foot Speed Control Asm. (All parts as shown)	541C978G1	X	X				
2	Box	163B9997P1	X	X				
3	Rail (2 required per assm.)	178B8000P1	X	X				
4	Switch (Start)	211A3198P1	X	X				
5	Switch (1A, 2A, 3A)	211A3198P2	X	X				
6	Switch (FW1 - 4)	211A3198P3	X	X				
7	Screw, Hex Hd. 4-40 x 2"	(1)	X	X				
8	Lockwasher (Size 4)	(1)	X	X				
9	Nut, Hex (4-40)	(1)	X	X				
10	Foot Speed Control Harness	178B8097G1	X	X				
11	Cover	163B9998P1	X	X				
12	Bracket	243A4791P1	X	X				
13	Rivet	N328P14018B6	X	X				
14	Cam	243A4796G1	X	X				
15	Spring	211A3577P3	X	X				
16	Washer (3/8" Brass)	N401P43	X	X				
17	Angle	243A4792P1	X	X				
18	Screw, Hex Hd. (1/4"-20 x 4-1/2")	N22P21072B6	X	X				
19	Spring	211A3577P12	X	X				
20	Push Nut	243A4554P1	X	X				
21	Cover	163B9999P1	X	X				
22	Screw, Hex Hd. (6-32 x 3/8")	(1)	X	X				
23	Pedal Assembly	243A4824G1	X	X				
24	Lock Nut (1/4"-20)	(1)	X	X				
25	Grommet	211A3589P2	X	X				

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

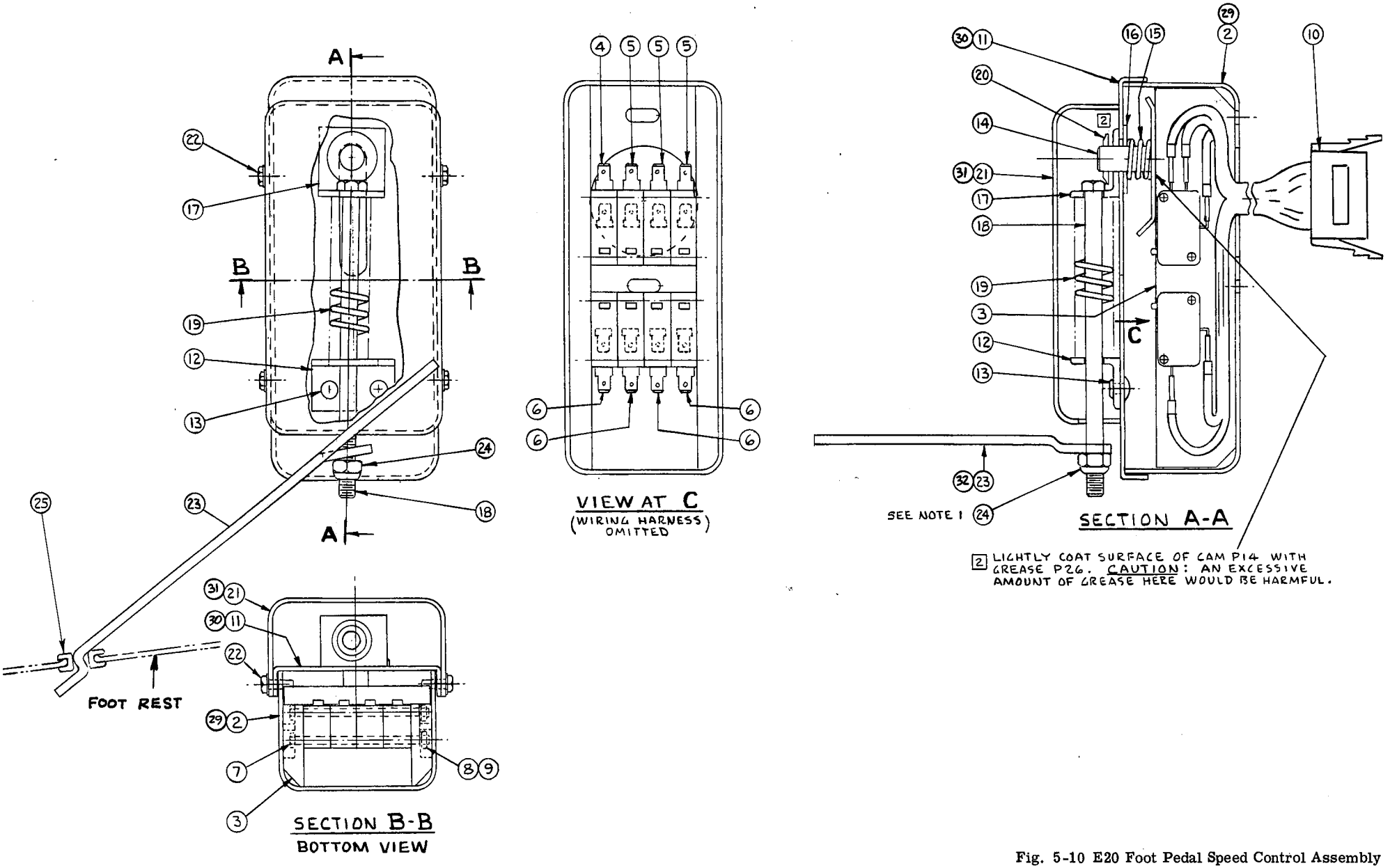


Fig. 5-10 E20 Foot Pedal Speed Control Assembly

E20 CHARGER COVER ASSEMBLY

Use this list to order replacement parts from Fig. 5-11.

Ref. No.	Description	Part Number	26A					
			E20A	E20B				
1	Charger Cover Assembly (All parts as shown)	541C982G1	X	X				
2	Timer Assembly (Plate, motor, cord, knob, etc.)	163B9906G2	X	X				
3	Power Resistor Assembly (R1, R2, and R3)	178B8012G1	X	X				
4	Cover	178B8031G1	X	X				
5	Screw, Pan Hd. Phillips (10-24 x 3/8")	(1)	X	X				
6	Speed Nut	211A3562P1	X	X				
7	Lockwasher (Size 10)	(1)	X	X				
8	Nut, Hex (10-32)	(1)	X	X				
9	Washer, Plain	(1)	X	X				
A	Knob (Timer)	243A4549P1	X	X				
B	Motor (Timer)	211A3507P1	X	X				
C	Charger Cord Assembly	211A3555G1	X	X				

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

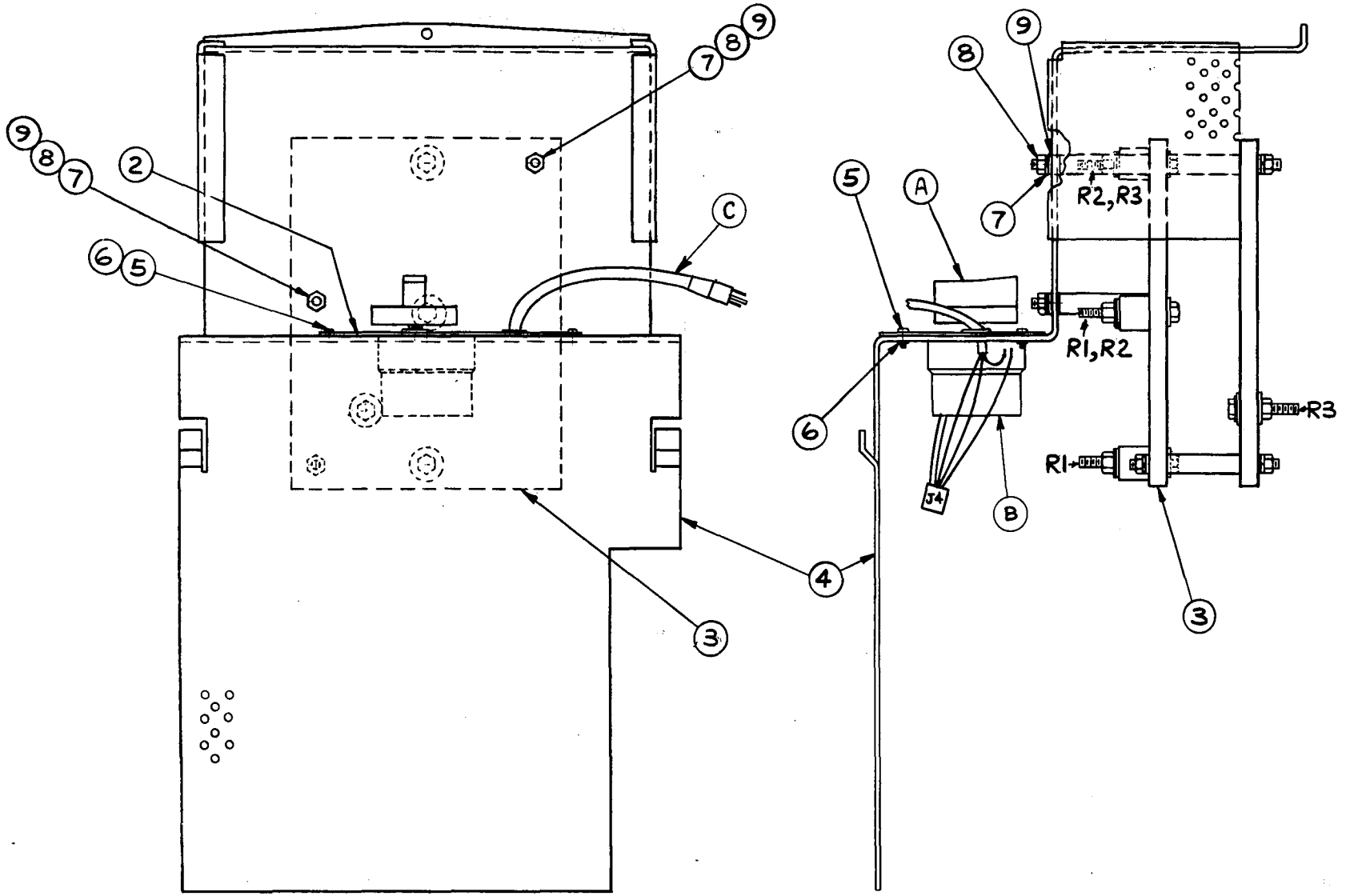


Fig. 5-11 E20 Charger Cover Assembly

FRONT BODY ASSEMBLY

Use this list to order replacement parts from Fig. 5-12.

Ref. No.	Description	Part Number	26A E20A	26A E20B				
2	Grille	423D214P2	X	X				
3	Control Cabinet Assembly	See Fig. 5-9	X	X				
4	Foot Speed Control Assembly	See Fig. 5-10	X	X				
5	Side Plate (Right)	422D837P1	X	X				
6	Side Plate (Left)	422D838P1	X	X				
7	PTO Receptacle	243A4572P1	X	X				
8	Accessory Receptacle	243A4542P1	X	X				
9	Battery Charger Sub-assembly	See Fig. 4-8.1	X	X				
10	Cover Assembly	See Fig. 5-11	X	X				
11	Steering Wheel (Minus Cap)	423D255P1	X	X				
12	Sleeve	243A4809P1	X	X				
14	Hood Assembly	541C940G2	X	X				
15	Cover	542C868P2	X	X				
16	Shim	See Note 1	X	X				
17	Bolt, Hex Hd. (5/16"-18 x 1-1/4")	See Note 1	X	X				
18	Bolt, Hex Hd. (5/16"-18 x 1-3/4")	See Note 1	X	X				
19	Screw, Pan Hd. Phillips (8-32 x 5/16")	See Note 1	X	X				
20	Screw, Pan Hd. Phillips (10-32 x 5/8")	See Note 1	X	X				
21	Screw, Thread Rolling (8-32 x 3/8")	N722AP15006C6	X	X				
22	Screw, Self-locking	243A4588P1	X	X				
23	Rivet	See Note 1	X	X				
24	Rivet	See Note 1	X	X				
25	Bushing	211A3424P1	X	X				
26	Washer	243A4588P1	X	X				
27	Washer, Plain (5/16")	See Note 1	X	X				
28	Lockwasher (5/16")	See Note 1	X	X				
29	Lockwasher (Size 10)	See Note 1	X	X				
30	Lockwasher, External (Size 8)	See Note 1	X	X				
31	Nut, Hex (5/16"-18)	See Note 1	X	X				
32	Nut, Hex (10-32)	See Note 1	X	X				
33	Nut, Hex (8-32)	See Note 1	X	X				
34	Nut, Hex (1/4"-20)	See Note 1	X	X				
35	Lockwasher (1/4")	See Note 1	X	X				
36	Spring Dowel Pin (1/4" x 1")	N533P2516	X	X				
37	Rivet	See Note 1	X	X				
38	Washer (Fiber)	243A4576P3	X	X				
A	Cap Assembly	243A4828G1	X	X				

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

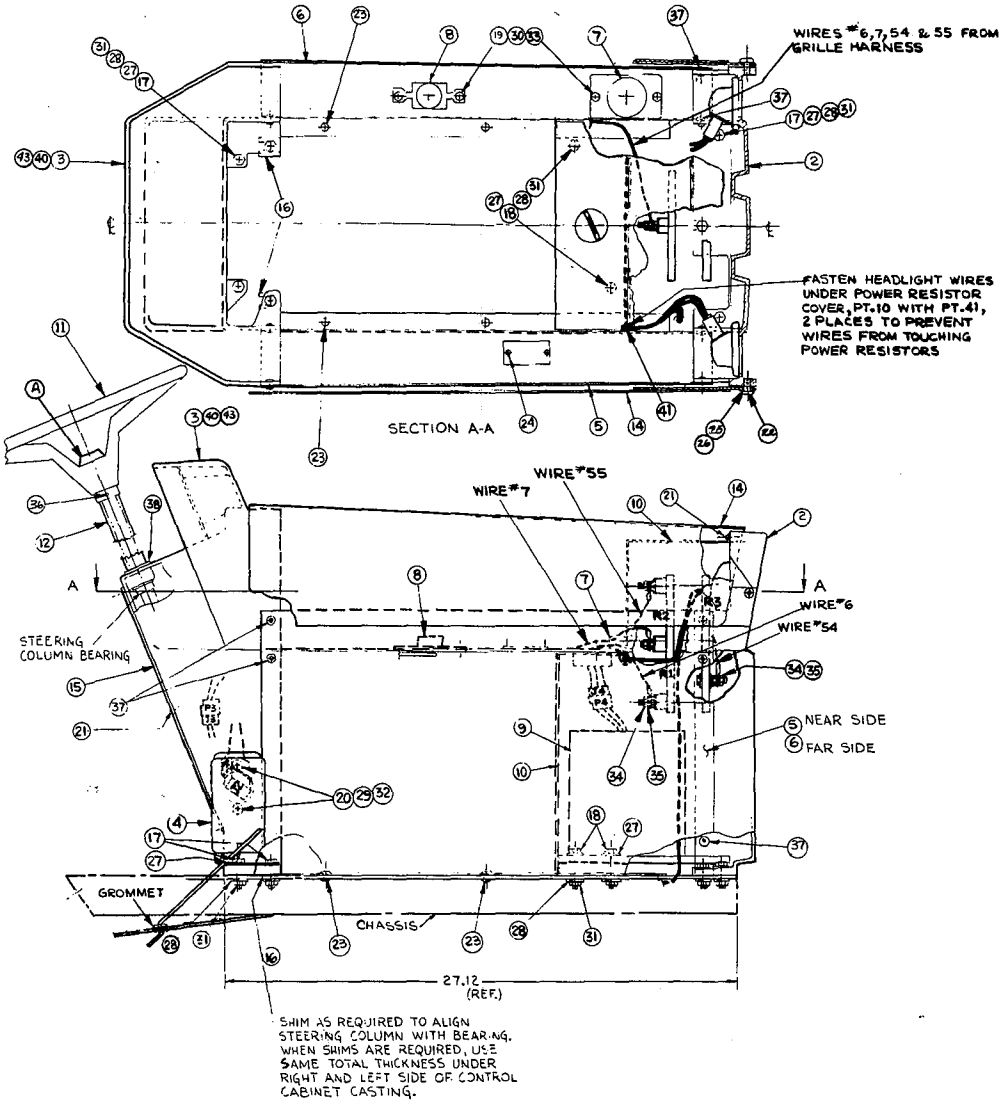


Fig. 5-12 E20 Front Body Assembly

Fig. 5-13, 541C974, Rev 2

P. L. 541C974, Rev 2

E20 BATTERY BOX ASSEMBLY

Use this list to order replacement parts from Fig. 5-13.

Ref. No.	Description	Part Number	26A					
			E20A	E20B				
1	Cover Assembly (All parts as shown)	541C974G1	X	X				
2	Cover	541C938G1	X	X				
3	Stiffener	243A4789P1	X	X				
4	Screw, Pan Hd. Phillips (5/16"-18 x 3/4")	(1)	X	X				
5	"T" Nut	243A4526P1	X	X				
6	Tail Reflector		X	X				
7	Seat Pan	243A4799P1	X	X				
13	Decal ("Elec-Trak")	178B8024P1	X	X				
A	Knob (Seat)	243A4801P1	X	X				
B	Back Cushion	243A4800P1	X	X				
C	Seat Cushion	178B8003P1	X	X				

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

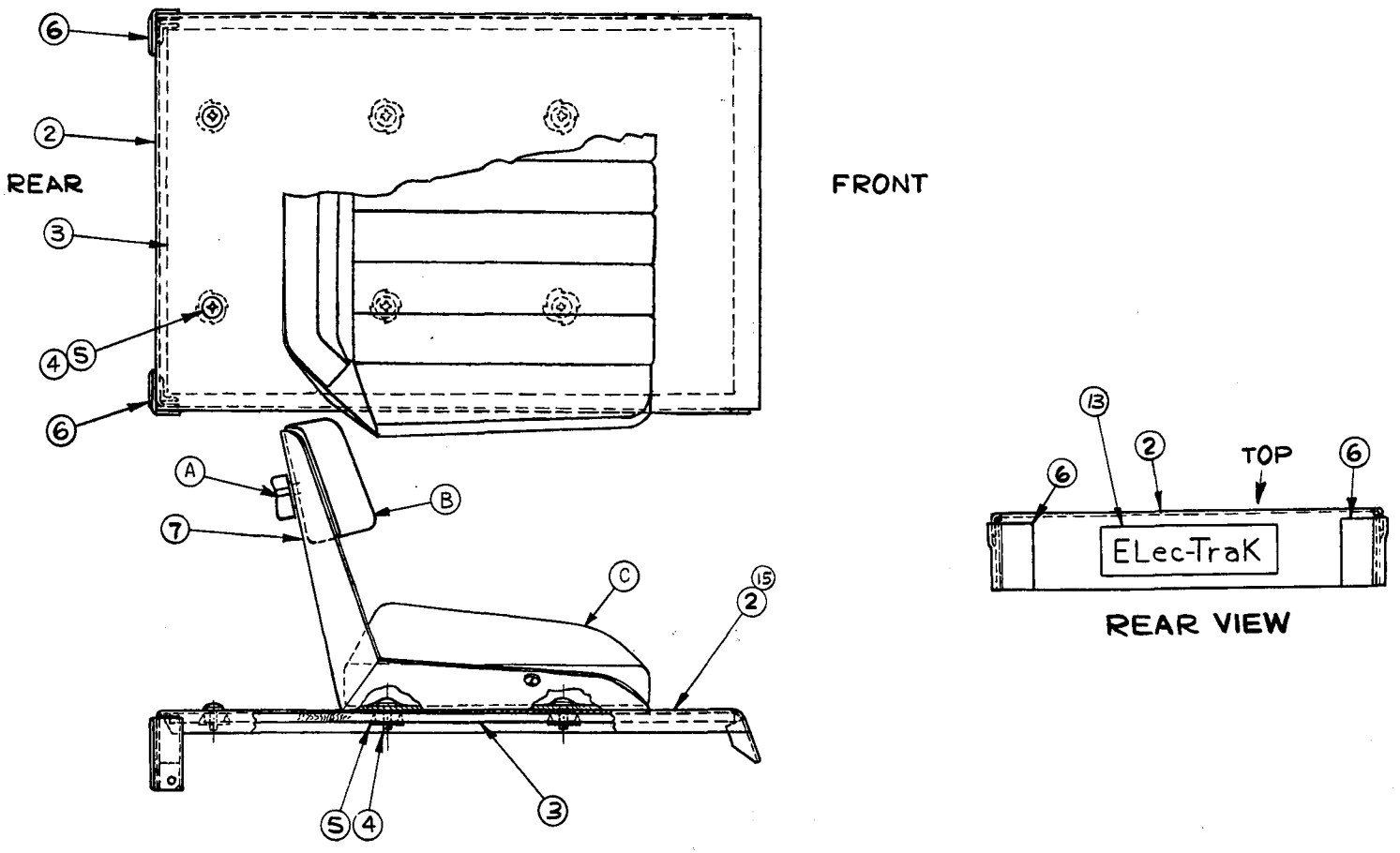


Fig. 5-13 E20 Battery Box Cover Assembly

E20 REAR BODY ASSEMBLY

Use this list to order replacement parts from Fig. 5-14.

Ref. No.	Description	Part Number	26A					
			E20AA	E20BA				
2	Battery Box Assembly (Sheet metal and fenders)	423D221G1	X	X				
3	Cover Assembly	See Fig. 5-13						
4	Clevis Pin (Seat)	211A350P1	X	X				
5	Cotter Pin (1/8" x 3/4")	(1)	X	X				
6	Rivet	(1)	X	X				
7	Seat Switch	243A4790P1	X	X				
8	Screw, Pan Hd. Phillips (1/4"-20 x 1/2")	(1)	X	X				
9	Lockwasher (1/4")	(1)	X	X				
10	Nut, Hex (1/4"-20)	(1)	X	X				
11	Rivet, Seat Spring	211A3191P1	X	X				
12	Washer, Plain (3/8")	See (1)	X	X				
13	Spring, Seat	211A3577P8	X	X				

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

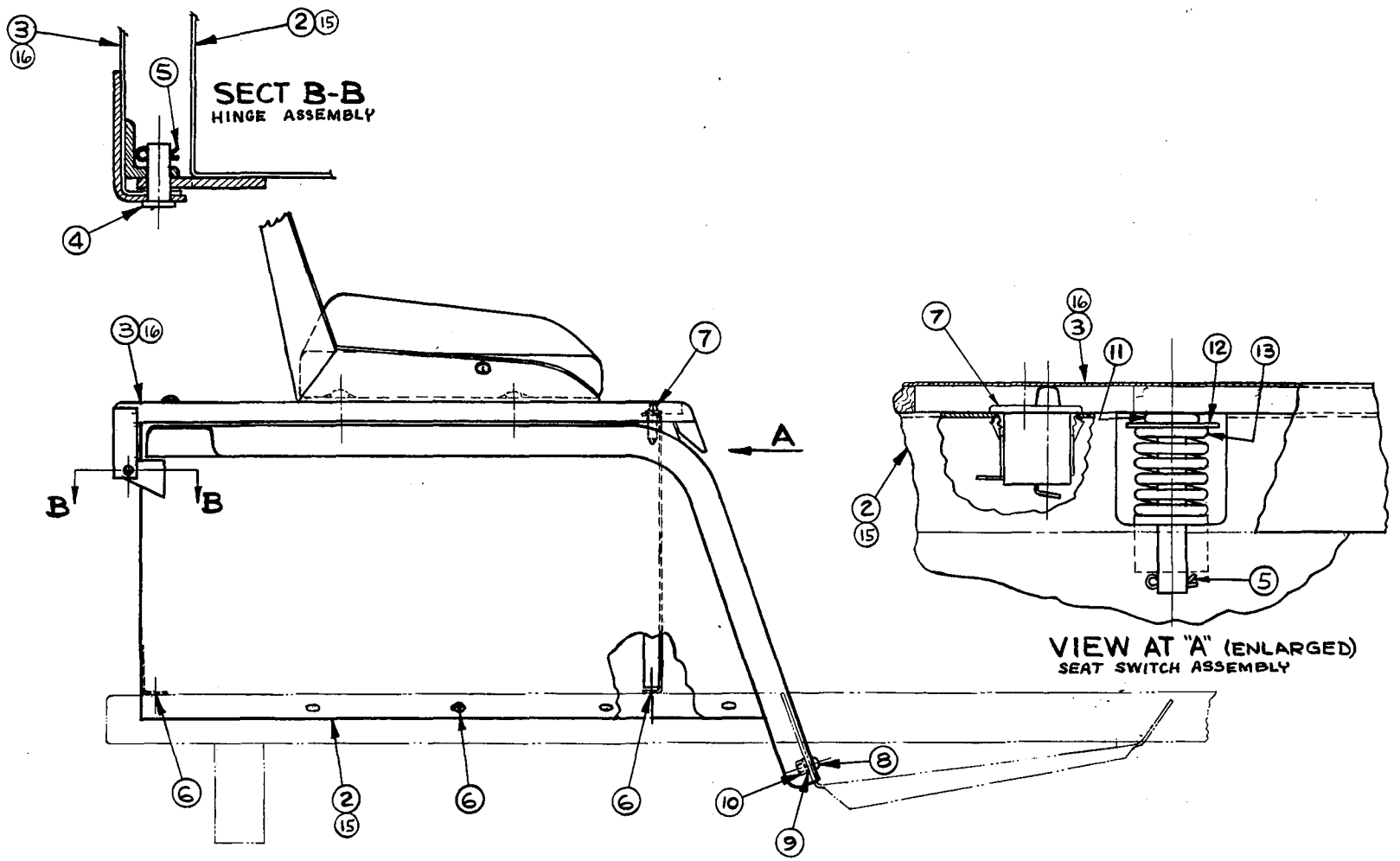


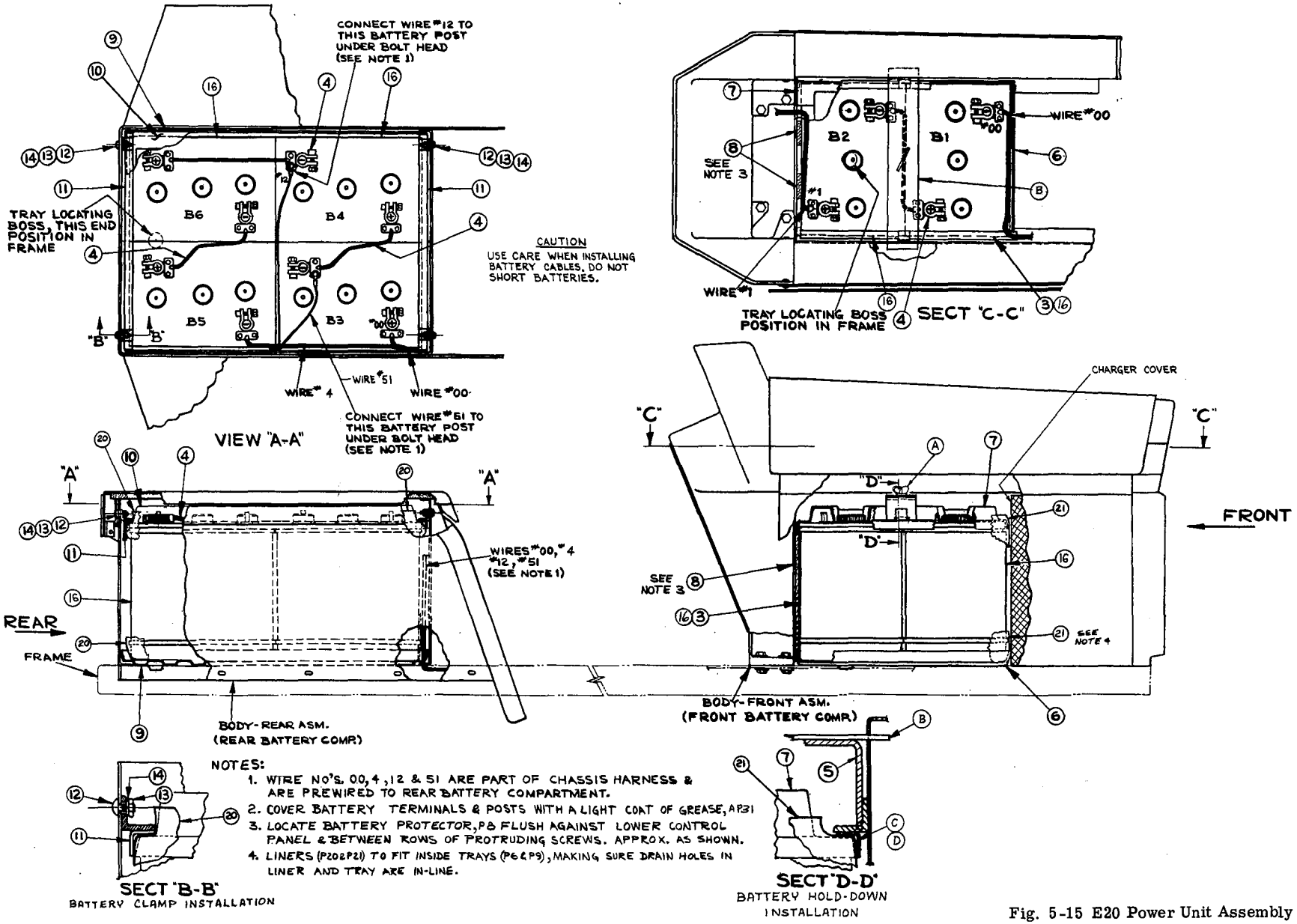
Fig. 5-14 E20 Rear Body Assembly

POWER UNIT ASSEMBLY

Use this list to order replacement parts from Fig. 5-15.

Ref. No.	Description	Part Number	26A E20A	26A E20B				
4	Cable (Battery)	211A3531G1	X	X				
5	"U" Clamp	211A3440G1	X	X				
6	Battery Tray, Front	541C699P1	X	X				
7	Battery Cover, Front	243A4523G1	X	X				
8	Battery Spacer Block	211A3598P2	X	X				
9	Battery Tray, Rear	541C698P1	X	X				
10	Battery Cover, Rear	243A4522G1	X	X				
11	Angle Clamp, Rear	163B9875G1	X	X				
12	Screw, Pan Hd. Phillips (10-32 x 3/8")	(1)	X	X				
13	Nut, Hex (10-32)	(1)	X	X				
14	Lockwasher (Size 10)	(1)	X	X				
16	Battery (Heavy-Duty)	243A4724P1	X	X				
20	Battery Liner - Rear (Poly Bag)	155C8006P1	X	X				
21	Battery Liner - Front (Poly Bag)	155C8005P1	X	X				
A	Screw, Thumb	243A4571P1	X	X				
B	Plate, Retaining	211A3442P1	X	X				
C	Angle Clamp (Front, Right)	211A3439G1	X	X				
D	Angle Clamp (Front, Left)	211A3439G2	X	X				

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.



NOTES:

1. WIRE NO'S. 00, 4, 12 & 51 ARE PART OF CHASSIS HARNESS & ARE PREWIRED TO REAR BATTERY COMPARTMENT.
2. COVER BATTERY TERMINALS & POSTS WITH A LIGHT COAT OF GREASE, AP31
3. LOCATE BATTERY PROTECTOR, P8 FLUSH AGAINST LOWER CONTROL PANEL & BETWEEN ROWS OF PROTRUDING SCREWS. APPROX. AS SHOWN.
4. LINERS (P20 & P21) TO FIT INSIDE TRAYS (P6 & P9), MAKING SURE DRAIN HOLES IN LINER AND TRAY ARE IN-LINE.

Fig. 5-15 E20 Power Unit Assembly

E20 MOTOR AND MOUNTING ASSEMBLY

Use this list to order replacement parts from Fig. 5-16.

Ref. No.	Description	Part Number	26A					
			E20A	E20B				
2	Motor, Drive	163B9996P1	X	X				
3	Pulley, Drive	243A4785P1	X	X				
4	Motor Plate	541C915P2	X	X				
5	Bolt, Hex Hd. (5/16"-18 x 5/8")	(1)	X	X				
6	Circuit Breaker	243A4859P1	X	X				
7	Lockwasher (Size 10)	(1)	X	X				
8	Screw, Pan Hd. Phillips (10-32 x 3/4")	(1)	X	X				

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

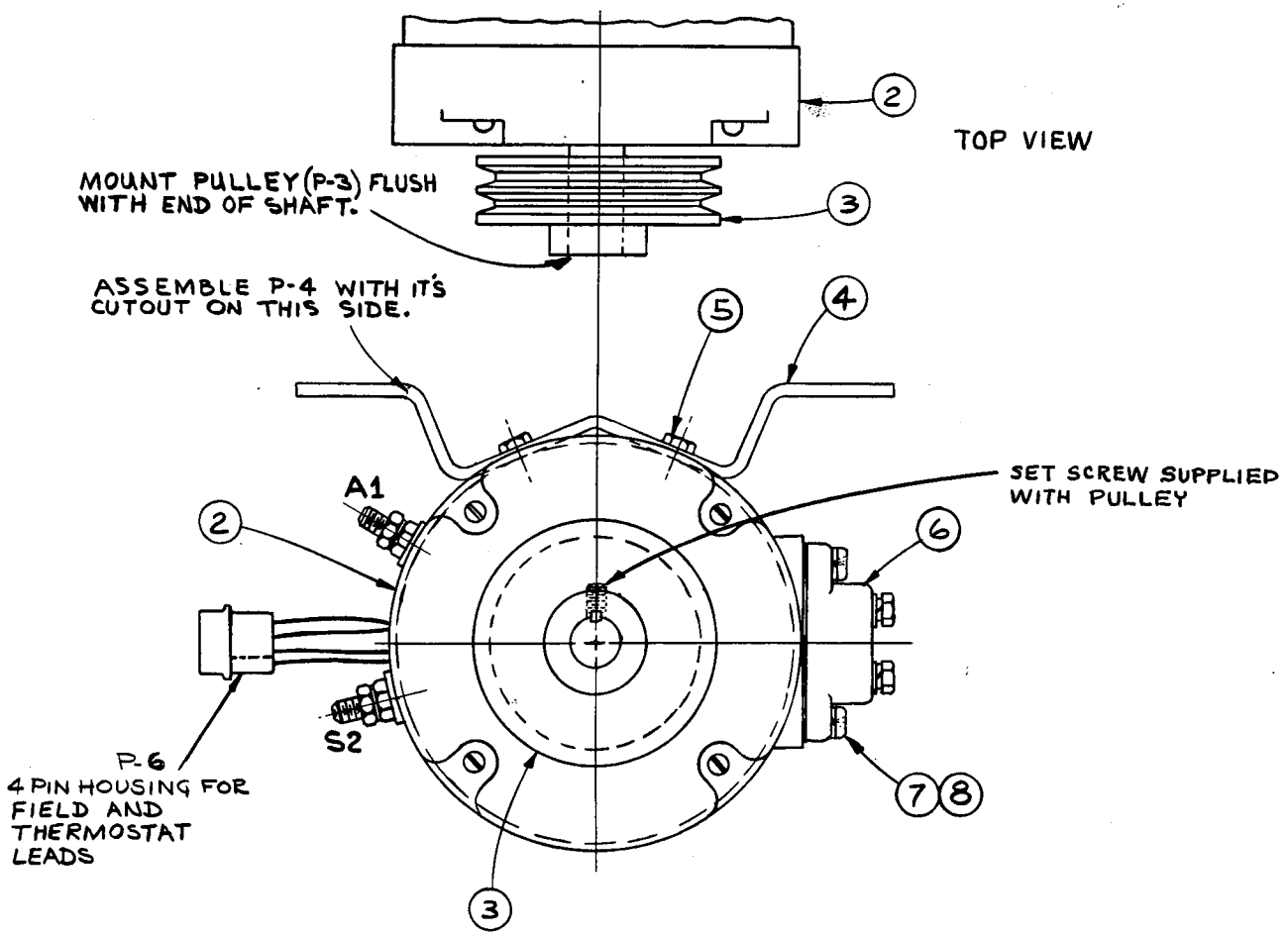


Fig. 5-16 E20 Motor and Mounting Assembly

Fig. 5-17, 423D251, Rev 5

P. L. 423D251, Rev 0, 4

CHASSIS ASSEMBLY

Use this list to order replacement parts from Fig. 5-17.

Ref. No.	Description	Part Number	26A					
			E20A	E20B				
2	Frame Assembly	587E926G1	X	X				
3	Rear Axle Assembly	See Fig. 4-15	X	X				
4	Front Axle Assembly	See Fig. 4-13	X	X				
5	Wheel - Tire (16 x 6.50-8)	163B9707P1	X	X				
6	Wheel - Tire (23 x 9.50-12)	243A4857G1	X	X				
7	Brake Assembly (Front)	See Fig. 4-18	X	X				
8	Steering Assembly	See Fig. 4-14	X	X				
9	Lift Assembly	See Fig. 4-19	X	X				
10	Undercarriage Harness		X	X				
12	Pivot Pin	211A3284P1	X	X				
13	Roll Pin (1/8" dia. x 1")	N533P1316	X	X				
14	Washer, Plain (3/8")	(1)	X	X				
15	Screw, Self-Locking	243A4592P1	X	X				
16	Wheel Lug	243A4589P1	X	X				
17	Motor and Mounting Assembly	See Fig. 5-16	X	X				
18	Screw, Hex Hd. (3/8"-16 x 1-3/4")	(1)	X	X				
19	Nut, Hex (3/8"-16)	(1)	X	X				
20	Lockwasher (3/8")	(1)	X	X				
21	Screw, Hex Hd. (5/16"-18 x 1")	(1)	X	X				
22	Nut, Hex (5/16"-18)	(1)	X	X				
23	Lockwasher (5/16")	(1)	X	X				
24	Boot	211A3532P1	X	X				
25	Carriage Bolt (5/16"-18 x 1")	N62P23016B6	X	X				
26	Cable Tie	243A4540P2	X	X				
27	Screw, Hex Hd. (3/8"-16 x 3/4")	(1)	X	X				
28	Washer, Plain (5/16")	(1)	X	X				
29	Nut, Hex, Jam (1/2"-20)	(1)	X	X				
30	Lockwasher (1/2")	(1)	X	X				
31	Clamp, Battery Post	243A4521P1	X	X				
32	Clevis Pin	211A3505P2	X	X				
33	Hair Pin Cotter	243A4543P3	X	X				
35	Bolt, Drive (Order multiples of 2 only)	211A3226P4	X	X				
36	Boot	211A3532P2	X	X				
37	Knob, Transaxle	211A3249P3	X	X				
38	Extension Bar	163B9919P1	X	X				
39	Bolt, Hex Hd. (1/2"-13 x 1-1/4")	(1)	X	X				
40	Lockwasher (1/2")	(1)	X	X				
41	Nut, Hex (1/2")	(1)	X	X				
42	Decal - "Parking Brake"	211A3247P1	X	X				
43	Decal - "Transaxle"	243A4797P1	X	X				
44	Decal - "Downshifting"	243A4794P1	X	X				
45	Decal - "Shifting"	243A4869P1	X	X				

(1) Not stocked, order locally. For bolt and screw replacement use Grade 5 or better.

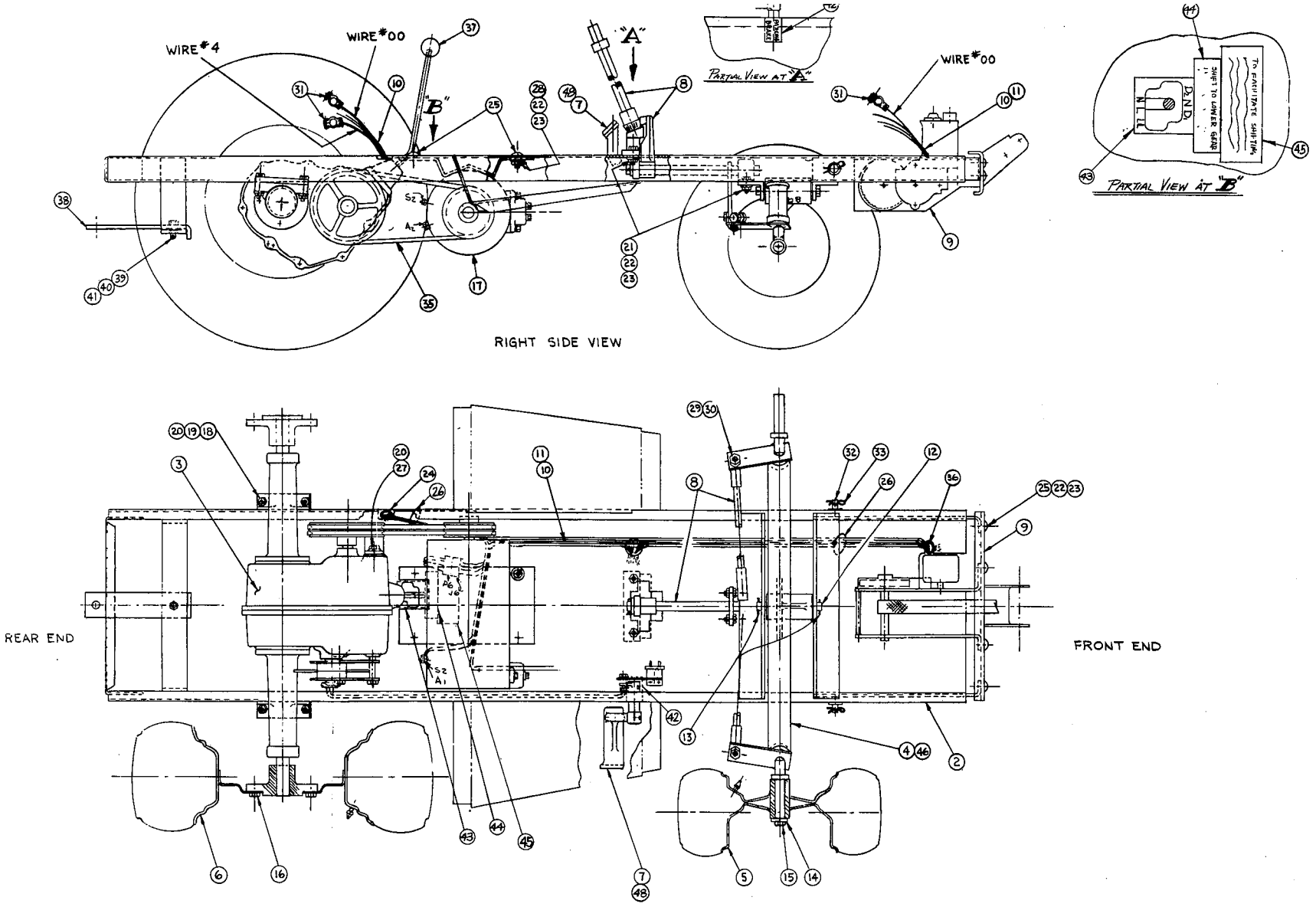


Fig. 5-17 E20 Chassis Assembly

ELEC-TRAK MOWER MOTOR REPAIR

7.1 MOTOR INSPECTION

1. Examine the motor for external damage. Rotate the motor shaft to check for tightness. The shaft will normally cog, but it should turn if it is okay. If tight, start disassembly and look for bad bearings or the armature striking the field magnets.

2. If there is no external damage and the shaft turns freely, remove the terminal cover for further checking of the motor.

3. Check the motor for grounds by checking the continuity between one terminal and the case or using a ground checking instrument or multimeter. The resistance to ground should be infinity, or if a continuity checker is used, there should be zero current flow. If a ground condition is noted, look for a brush pigtail or spring touching the end shield, or for worn or broken insulators around the terminals. If no ground is found at these points, check the armature for grounds between the commutator and the shaft when it is removed from the motor.

4. If the above checks disclose no faults, connect the motor to a 36-volt d-c power source (observe proper polarity) and run it checking for unusual noise or rough operation. If the motor does not run and there is no current flow, examine for an open circuit in the brush rigging or armature assembly. To detect whether there is an open in the armature, rotate the shaft 90 degrees and recheck. If the motor runs, suspect an open coil in the armature.

WARNING: Make all electrical connections before turning power on.

If there is any unusual noise, look for the armature striking some internal part of the motor or for broken parts when disassembling motor. Check the shaft to see that runout is 0.004 inch T.I.R. or less as this could be causing vibration or striking. It is possible that a rough bearing is causing the noise. If the motor hums, but does not run, check for tight bearings or a partially burned armature.

7.2 DISASSEMBLY

CAUTION: When disassembling for maintenance, use a clean bench free of steel parts or chips. The permanent magnet field will attract loose parts, chips or debris.

5. Remove the clamp screw nuts.

6. Remove the brush assembly. Examine the brushes and the rigging for tightness, excessive wear or other visible defects. Each brush should have free movement in its holder, and if it does not, any obstruction causing the binding should be removed. If a brush is broken, cracked, severely chipped or if the length is very short the brush should be replaced.

7. Remove the armature from the shell and magnet assembly. Check the condition of the armature winding for burns or damage. If one or more of the conductors are abnormally black or appear burned compared to the other armature conductors, it is an indication that power had been applied to the motor when the motor could not rotate. If there are deep burned sections on the commutator bars, it is an indication of an open winding. If any of the above conditions are in evidence, the armature should be replaced.

8. If the armature appears normal and the bearings show evidence of rust, tightness or roughness, the bearings should be replaced.

9. Check the field for loose or broken magnets. The shell contains permanent magnet field poles. Inspect and clean the motor prior to any re-assembly to make sure no foreign material adheres to the magnets. If the magnets are loose or any large pieces are broken out, the stator should be replaced.

10. On 3-3/8 inch diameter motors, check the shell's end flange assembly(ies) for looseness or incomplete sealing around the flange. If the flange is loose or the openings are not sealed, an epoxy sealing material should be poured into the openings to give the assembly rigidity and prevent water entering.

7.3 ASSEMBLY

11. If the field has been checked and is normal or if it has been replaced, be sure all surfaces and the bearing housing are clean. Put a quantity of SRI-2 grease in the cavity below the bearing opening. This grease is necessary to help prevent water entry into the cavity.

12. If the armature is normal, clean it and make sure that the commutator is in good condition. The commutator bars should not be pitted, burned or grooved. Slight roughness of a commutator can be polished away with a grade 4/0 or finer sandpaper. Never use emery cloth as the particles of emery are conductors and may short circuit the commutator bars. Also, do not use oil or other lubricants on the commutator or the brushes. If the commutator bars cannot be cleaned up in this manner, the armature should be replaced.

13. If a new armature is not used and the bearings of the old armature have been removed because of roughness or corrosion, assemble new bearings to the armature. These bearings need not be lubricated since they are supplied from the manufacturer with the correct amount and grade of grease.

14. If the clamp screws have been removed from the shell end flange, they should be reassembled into that flange so they are snug.

15. Insert the armature into the shell and magnet assembly being careful that the magnetic pull does not pull it sideways and damage the windings. Make sure that the lower bearing or flange is seated in the flange cavity.

16. Prepare the brush assembly for installation to the armature by inserting the shim washers (if used) and bearing spring washer into the housing and holding in place with a small amount of grease. Push each brush into the brush holder until its end will permit the commutator to pass without hitting and adjust the spring so that it is against the side of the brush and will hold the brush in the cocked position. Install the assembly to the upper bearing and while it is still about 1/4-inch from its final seating on the housing, release each brush by pushing on the outside end until the spring falls into its proper position and holds the brush against the commutator. Seat the flange in its

proper location on the housing and assemble the nuts to the clamp bolts to hold the assembly together. Rotate shaft by hand prior to power connection to assure proper assembly.

17. Connect the motor to a 36-volt d-c power source and run it listening for any unusual noises or roughness. The motor should now be ready for use. Install the motor and make wire connections to give the proper rotation. Replace the motor terminal cover.

7.4 GENERAL INFORMATION

Brushes

Brushes should be inspected periodically to assure uninterrupted service. The mower motors are equipped with two brushes accessible by removing the terminal cover and end flange. To remove a brush, pull the brush spring away from the brush and slightly loosen the terminal stud. Replace with a new brush and tighten the terminal stud.

Commutator

When replacing brushes, check the commutator for wear. If the commutator is worn down more than 1/32-inch on the diameter (1/64-inch surface), turning and undercutting is recommended. Usually three sets of brushes can be used for each commutator turning.

Bearings

Ball bearings are lubricated for life. Under good conditions, bearings will give over 20,000 hours of service. A wheel puller and hydraulic press should be used for removal and installation exercising care to prevent distortion to surrounding parts or damage to the bearing.

Magnets

The magnets are made from an oriented ceramic material. Avoid dropping or sharp blows. There is no deterioration in magnetic properties with age, however, demagnetizing will occur with severe overvoltage (about 150 percent

normal). If demagnetizing occurs the speed will increase slightly. Magnets can be purchased only as part of the shell and magnet assembly.

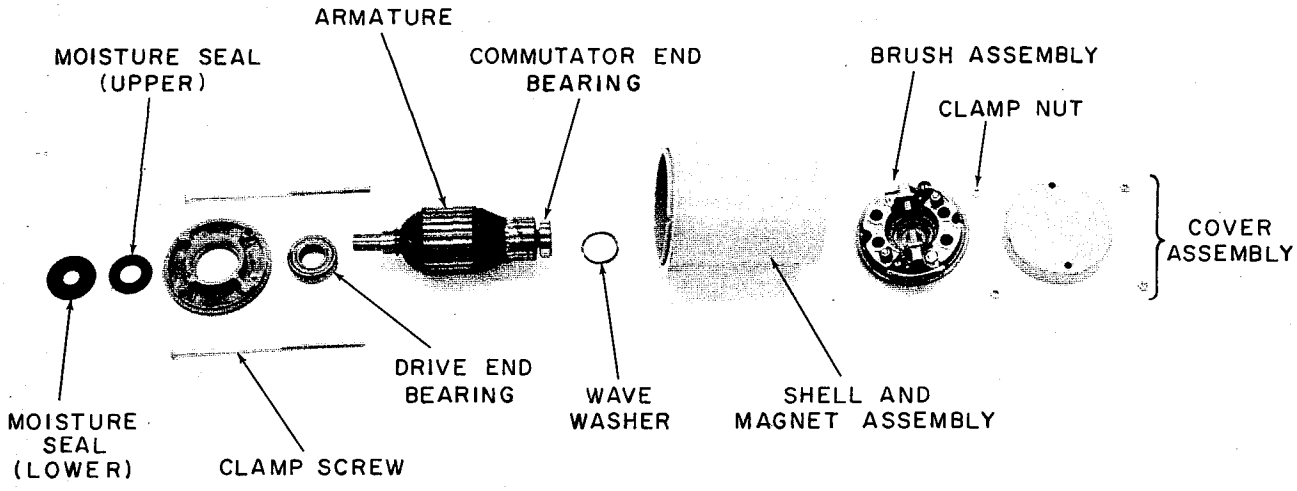


Fig. 7-A. 4 1/2 Inch Diameter Mower Motor (Typical)

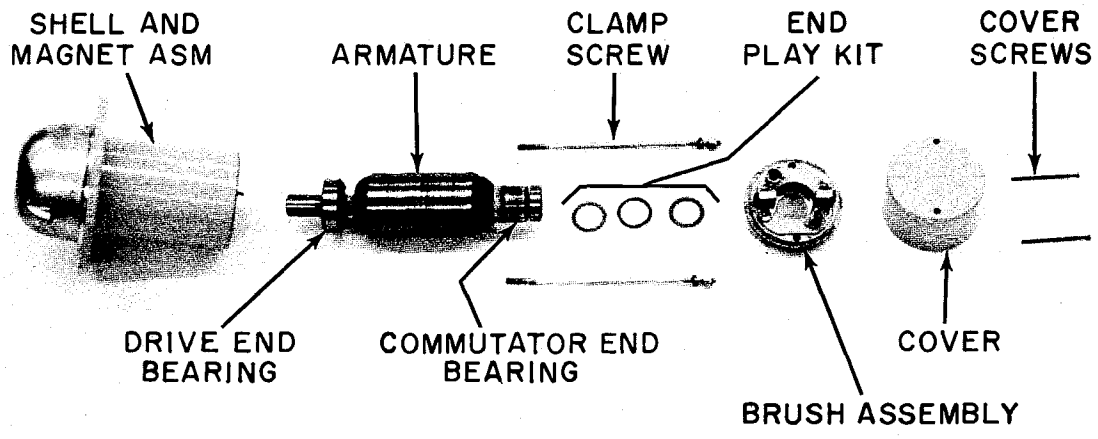


Fig. 7-B. 3 3/8 Inch Diameter Mower Motor