ORS-74-4035

home owner's
SERVICE MANUAL

Elec-Trak®
Tractor

This manual is intended to assist homeowners in servicing their ELEC-TRAK equipment after the warranty period has expired. ELEC-TRAK equipment while covered by warranty should <u>ONLY</u> be serviced by an authorized ELEC-TRAK <u>servicing</u> dealer because all other unauthorized service will void the warranty.

This manual does not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to your authorized ELEC-TRAK dealer.

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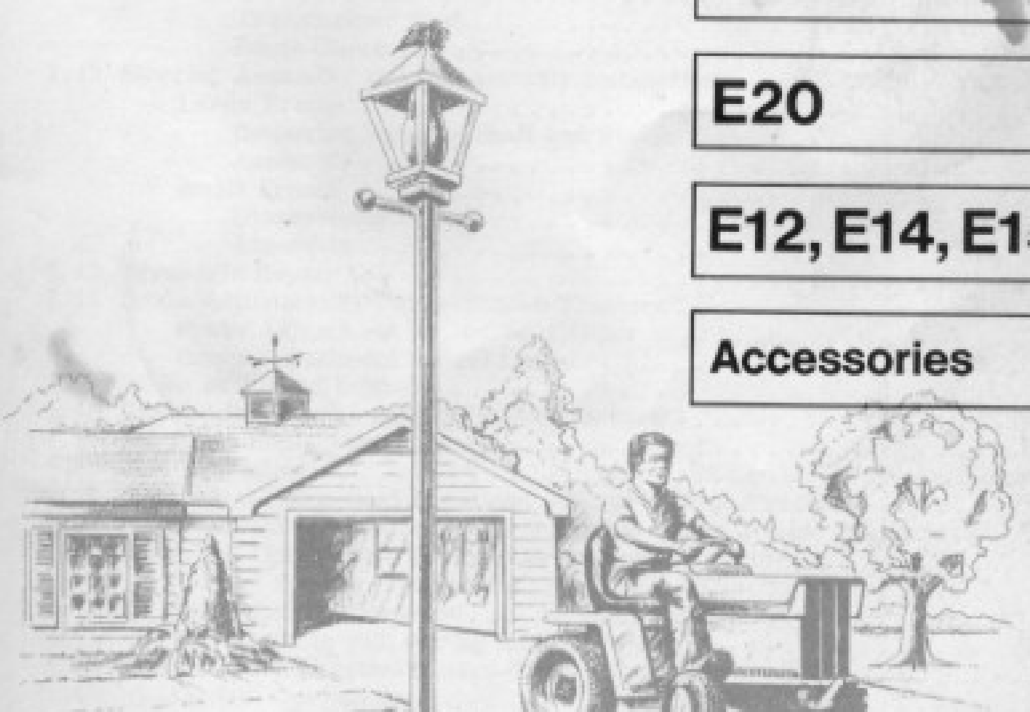


Index

INDEX (CONT'D)

GENERAL INFORMATION

1.1 INTRODUCTION

So you want to service your ELEC-TRAK(T) tractor yourself! Follow the instructions given in this manual. Basic requirements are listed below.

To service your tractor, you will need:

- Some mechanical aptitude, so that you can see how the parts fit together mechanically.
- Some electrical understanding. You should know a little circuit theory, and how to measure electrical values. Theory of operation for the specific circuits used in the tractors is discussed in the particular section for each tractor model.
- Some tools and instruments. (These will be discussed as they are needed.)
- A good understanding of how the equipment should work when it is functioning properly. (Read the appropriate theory of operation section for the model tractor being repaired.)
- A systematic troubleshooting method. This will be explained later in this section.

You should establish safe work procedures and follow them. General precautions are listed below, while others are flagged throughout the book with Warnings and Cautions.

1.2 SAFETY DURING SERVICE

- Wear safety glasses.
- Remove all watches, rings, tie clasps, and metal objects from shirt pockets to avoid unwanted short-circuits.
- Open the Power Disconnect switch.
- Stay alert and think about what you are doing.
- Unplug the charger line cord from the house wall outlet.

1.3 PRIMARY HAZARDS TO GUARD AGAINST

- Electric shock is possible from the charger primary circuit (120 volts).
- Use the same care as you would with any other household appliance.
- Battery short-circuits generate high currents which can cause burning and arcing. Always be careful to avoid touching points of opposite polarity with metal instruments.
- Battery explosion – Immediately after charging, some amount of hydrogen gas may be present. Use the same care as around gasoline engines and allow the tractor to ventilate before starting to work on it.
- Burns – Service implies a fault, and some electric faults can generate heating of parts. Be alert for hot spots and signs of overheating.
- Rotating Energy – Be sure all motion has stopped before working on components.

> CAUTION: WHEN MAKING MEASUREMENTS WITH THE POWER ON AND SYSTEMS RUNNING, USE CARE IN PLACING METER PROBES AND LOCATION OF YOUR BODY, HANDS AND ARMS.
>
> ALWAYS UNDERSTAND WHAT YOU ARE DOING!

- Be sure you get all your tools out before closing up the enclosures.
- Don't pull belts with your hand close to a pulley – you can lose a finger.
- Work in a dry place on dry equipment.
- Replace all guards and do not bypass any safety interlocks.
- Keep bystanders out of the way.
- Know how to handle battery electrolyte spillage.

1.4 TERMS AND SYMBOLS

The following terms and symbols will be encountered throughout this manual in using ELEC-TRAK

(T) Trademark of General Electric Co., U.S.A.

Tractor schematics and Troubleshooting Guides. You should become familiar with each term and symbol and the function performed by the device it represents before attempting to service your tractor.

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

Coil – An electromagnet, used in the tractor primarily as the actuating means for relays and contactors when power is applied from a control switch.

Contactor – A contactor is a device operated other than by hand, for repeatedly establishing and interrupting an electric power circuit.

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.

FW – Field Weakening

J1-12, P2-3 – 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 the wire number remains the same after passing through plug and jack connections, P1 mates J1, P2 mates J2, etc.

NC – Normally closed (switch, relay, contactor).

NO – Normally open (switch, relay, contactor).

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

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.

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

Relay – Used to control the opening and closing of the operating circuit of a device so that the main operating current does not pass through the control switch or other initiating device.

RTN – "Return to Neutral" relay and circuit.

SC-1 thru 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.

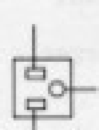
SC0 thru SC7 – Normal forward speeds corresponding to Speed Control positions beginning with neutral. Note: If the tractor is defective, one or more speeds may be inoperable, but the speed control position called for in the test should be used.

Short – A short-circuit is an abnormal connection of relatively low resistance made accidentally between two points of different potential in a circuit.

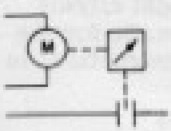
SPG – Specific gravity – The ratio of the weight of any volume of a substance to the weight of an equal volume of water taken as the standard unit. Thus, battery electrolyte, with a specific gravity of 1.260, weighs 1.26 times as much as an equal volume of water.

VAC – Volts alternating current.

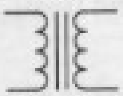
VDC – Volts direct current.



Grounded ac Line Plug.

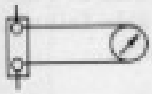


Timer - A motor-driven device that shuts off a power source as well as itself after a preset time.

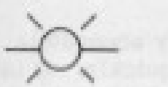


Transformer - Changes ac voltage from one voltage to another. May step up or step down voltage level.

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



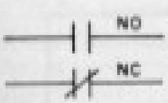
Shunt and Meter - A method of reading high current values. The current is passed through the shunt. The meter reads the voltage drop.



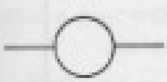
Light or Lamp

Manual Switch or Disconnect. (Shown in open position)

Cam-operated Switch. (Shown in closed position)

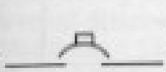


Relay or solenoid-operated contacts. NO – normally open; NC – normally closed.



Actuating coil of relay or solenoid.

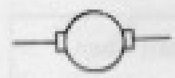
Thermal Overload Protector (Circuit Breaker) - Automatic reset protective device, senses current and/or temperature combinations. Provides a closed circuit until overloaded.



Thermal Overload Protector - Manual reset.

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

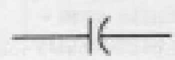
Plug-in Disconnect - Eases removal of electrical assemblies.



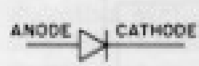
Motor Armature - The rotating center member of an electric motor.

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

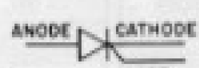
Resistor - Device to resist the flow of current; measured in ohms (Ω).



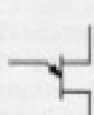
Capacitor - Two electrodes separated by an insulator or dielectric. This device can be charged and discharged at a controlled rate; also can store energy for short periods of time. Sizes considered in μf. (Microfarads)



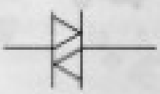
Diode - Allows current to flow only in one direction, from anode to cathode.



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.

1.5 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 or 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 Fig. 1-1.

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 tractor light circuit requires service. A simplified schematic for the light, with the lift circuit added for instruction, is shown in Fig. 1-2.

Since the trouble is in the headlight circuit, only that closed path need be considered. That path is shown in Fig. 1-3, but should be visualized from the complete schematic, not redrawn.

The tractor power pack maximum output is approximately 36 volts, but Fig. 1-2 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 the headlights nor the dash light illuminate. From the schematic of Fig. 1-3, 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 usually be inspected quickly. It is good practice to check the fuses as the first step in any troubleshooting procedure.

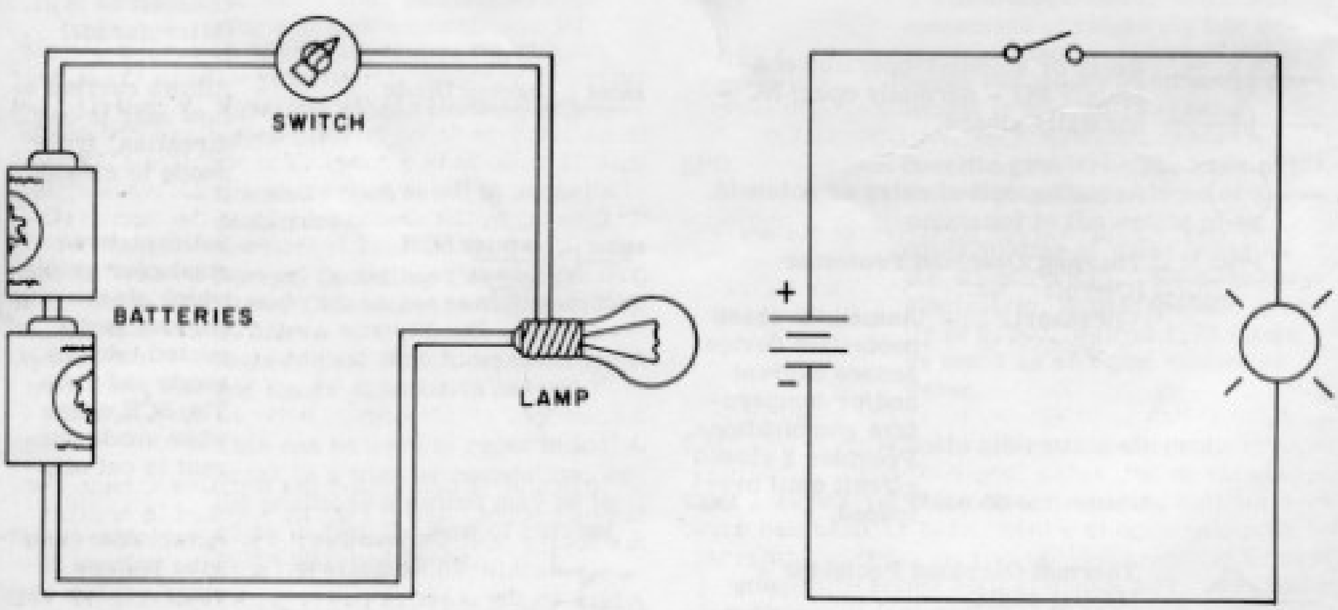


Fig. 1-1

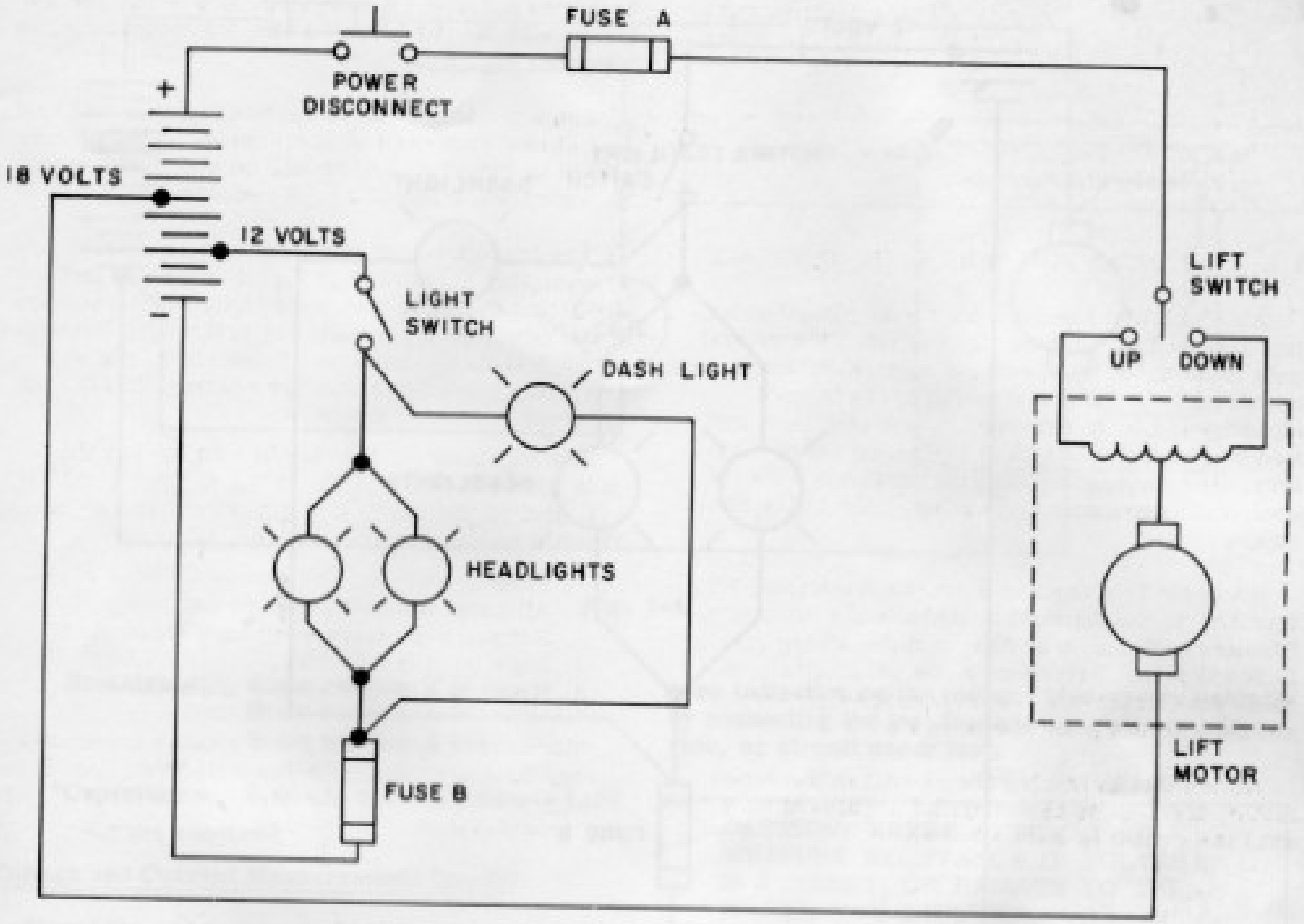


Fig. 1-2

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 accessible 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 to the lamps is open, 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 Fig. 1-2 taps the top 18 volts from the power pack and uses a fuse in the positive

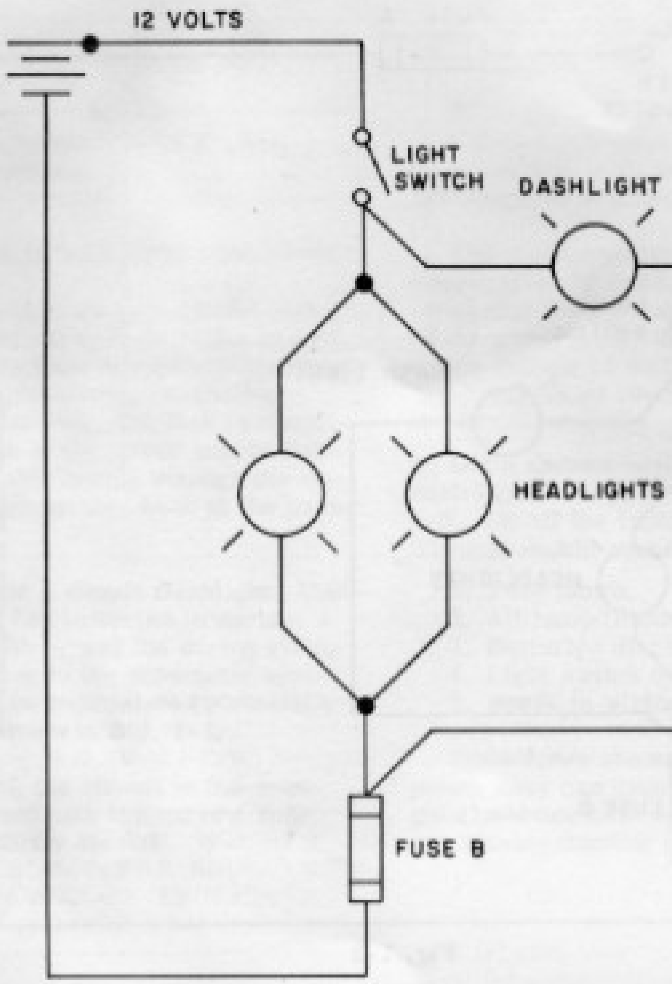


Fig. 1-3

tive 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 you become familiar with logical troubleshooting procedures, experience develops, and familiarity with the circuits increases, and you will find less need to refer to procedure guides, but will work solely from the wiring drawings and schematics.

The schematic shown in Fig. 1-4 can be used to gain symbol familiarity, trace closed paths, establish a systematic troubleshooting procedure, or just figure out how it works.

1.6 USE OF THE VOLT-OHM-MILLIAMMETER – (VOM)

Your basic tool for troubleshooting electrical malfunctions is the Volt-Ohm-Milliammeter (VOM or multitester). You will need a VOM rated at 20 ohms/volt, with ranges as follows:

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

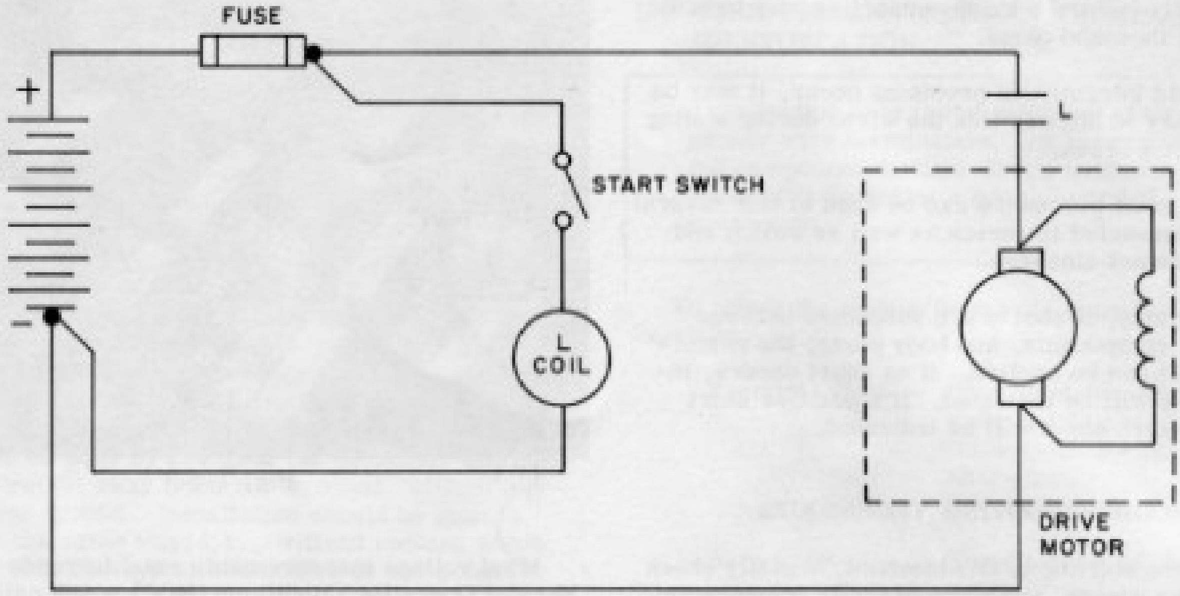


Fig. 1-4

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)

*Not required

Voltage and Current Measurements (ac/dc)

Insert the red test lead plug into the 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 THE MAXIMUM RANGE ON THE VOM AND THEN LOWER THE RANGE A STEP AT A TIME UNTIL YOU REACH A RANGE WHERE YOU CAN OBTAIN A READING.

Resistance

To measure resistance, turn the selector switch to the range desired. Short the test leads together and turn the "zero ohm adjust" until you obtain a zero indication on the meter. Measure resistance by connecting the test leads to the resistor, device, or circuit under test.

> CAUTION: NEVER ATTEMPT TO MEASURE RESISTANCE IF VOLTAGE IS PRESENT, OR DAMAGE TO THE METER MAY RESULT.

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.

1.7 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 TRACTOR, DISCONNECT THE CHARGER FROM THE LINE VOLTAGE SOURCE AND DISENGAGE THE POWER DISCONNECT. SINCE THE E8M AND E10M TRACTORS ARE NOT EQUIPPED WITH A POWER DISCONNECT, THE BATTERY CLAMP TERMINATING WIRE NUMBER 2-01 MUST BE LIFTED FROM THE POSITIVE POST OF BATTERY B2 BEFORE PROCEEDING WITH SERVICING OF THE TRACTOR UNLESS VOLTAGE MEASUREMENTS MUST BE MADE. SEE FIG. 1-5.

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.

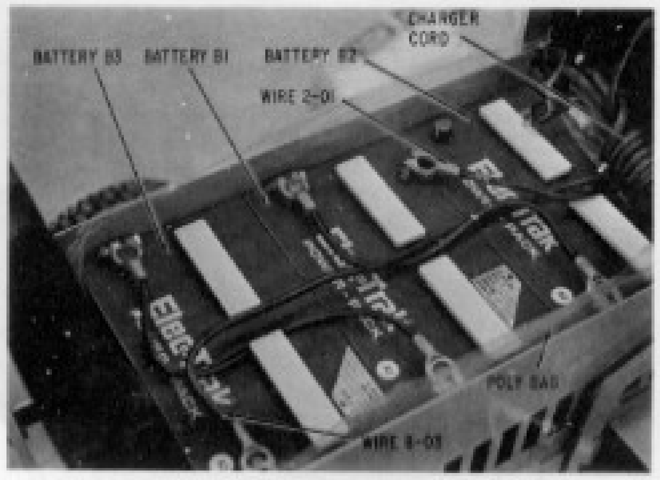


Fig. 1-5

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 TRACTOR.

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.

1.8 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, <u>without</u> 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 (on tractors so equipped) 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.

Wire 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.

1.9 WIRE TERMINATION AND TERMINAL IDENTIFICATION

> This Section aids in the selection of the proper wire termination, and in preventing component damage during soldering while still providing a good electrical connection.

To select the proper terminal, consider the following:

Terminal Style	-	Ring, fast-on, edge, mate-n-lok pin, mate-n-lok socket, shur-plug, bifurcated, etc.
Wire Gage	-	The diameter of the wire
Stud Size	-	The size of the stud to which the ring terminal is fastened

Use Fig. 1-6 and Table I to determine which terminal is required.

<u>Terminal Crimping</u>

Terminals which cannot be accommodated by available crimping tools should be partially closed on the wire with another tool, such as pliers, and then soldered. (See soldering instructions.)

Wire and terminals should be free of dust, dirt, and grease. Before soldering, a good mechanical

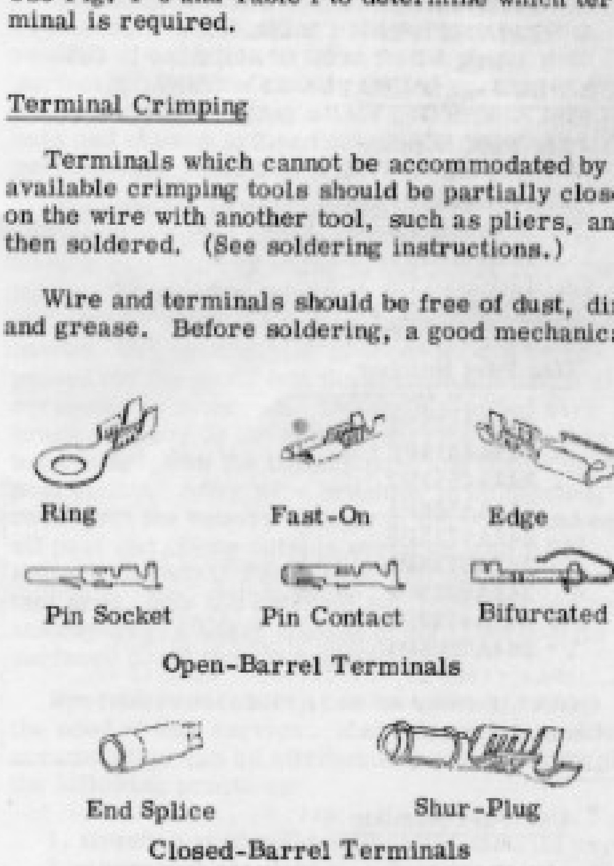


Fig. 1-6

TABLE I

RING TERMINALS

Use Part Number	Replaces
243A4541P5	243A4538P1, 211A3594P3, 321598
243A4541P4	33461, 243A4538P1, 211A3594P2
243A4541P7	31808, 243A4538P2, 211A3594P5
243A4541P1	31805, 243A4538P7, 211A3594P10
243A4541P3	31772, 243A4538P1, 211A3594P1
243A4541P6	31827, 243A4538P8, 211A3594P4
243A4541P8	34123, 243A4538P3, 211A3594P6
243A4541P9	31256, 243A4538P4, 211A3594P7
243A4541P10	31257, 243A4538P6, 211A3594P8
243A4538P3	---
243A4541P11	31252, 243A4538P5
243A4541P12	33466

FASTON TERMINALS

Use Part Number	Replaces
243A4553P1	60972-2, 243A4570P1, 211A3594P13
243A4570P7	60631-1, 243A4570P1, 60628-1, 211A3594P11
243A4822P2	42844-1, 243A4570P6, 211A3594P12
247A7567P1	---
247A7467P6	---

SHUR PLUG TERMINALS

Use Part Number	Replaces
243A4660P1	---
243A4660P4	42473-2, 211A3594P18
243A7362P1	---

PIN, SOCKET CONTACTS

Use Part Number	Replaces
243A4539P3	60620-1, 243A4539P1, 211A3594P14
243A4539P2	---
243A4552P2	60619-1, 243A4552P1, 211A3594P15
243A4566P1	60843-1
247A7735P2	350391-1, 247A7735P1
247A7736P2	350390-1, 247A7736P1
243A4823P2	350011-3, 243A4823P1
243A4569P1	*60826-1, *60156-2, *211A3594P16
244A7093P1	---

* Do not use (brass)

SPLICES

Use Part Number	Replaces
247A7655P1	31818
243A4595P1	---
243A4841P1	---
243A4567P1	34865, 211A3594P19

TABLE I (CONT'D)

PIN AND SOCKET HOUSINGS

Use Part Number	For Pin and Socket Part Number
243A4564P3	243A4539P3, 243A4539P2
243A4564P4	243A4539P3, 243A4539P2
243A4564P5	243A4539P3, 243A4539P2
243A4568P3	243A4552P2
243A4568P4	243A4552P2
243A4568P5	243A4552P2
243A4596P1	243A4552P2
243A4600P1	243A4539P3, 243A4539P2
243A4596P3	243A4552P2
247A7737P1	247A7735P2
247A7738P1	247A7736P2
244A7094P1	244A7093P1
244A7094P2	244A7093P1
244A7094P3	244A7093P1
178B8013P3	243A4823P2

connection should be made by twisting the wires together or closing the terminal on the wire. Only rosin-core solder should be used, since acid-core solder may cause corrosion.

Soldering

Use the proper soldering gun or iron for the job. An iron of 150 watts is sufficient to solder any terminal in the tractor. For small terminals or connections such as small diodes, varistors, etc., a lower-wattage iron (40 watts) should be used, while soldering on printed-circuit cards requires an iron with a 25-watt rating.

When soldering or desoldering any component (diode, resistor, etc.), a heat-sink should be used to prevent excessive heat from reaching the component (see Fig. 1-8). By grasping the component wire between the component body and the joint to be soldered, heat traveling towards the component is blocked. When the soldering iron tip is held against the joint, feed solder between the tip and joint to provide high localized temperature for quick soldering.

1.10 POWER-PACK TECHNICAL INFORMATION

ELEC-TRAK power packs, being the heart of the ELEC-TRAK tractor operation, require care and maintenance to give maximum life and serviceability. This section presents information for initial inspection, charging, storage, watering, cleaning and testing. Recommended procedures should be thoroughly understood and followed completely.

Cleaning and Protecting

Gases and overflowing electrolyte which may result from the charging process may cause a residue of 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 a few minutes, wipe all surfaces dry and clean. After the post clamps have been removed, this neutralizing process should be repeated for the posts and the clamps to ensure all corrosion is removed. The double-ended wire brush supplied in the battery service kit is then used to brighten the battery post and inside of the post clamp. After wire brushing is completed, reconnect the battery clamps to the posts and coat all post and clamp outside surfaces with AP31 Battery Terminal Protection. Do not coat the contact area, only the external surfaces exposed to atmosphere; a heavy coating of AP31 on contact surfaces could impair conductivity.

Preventive 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

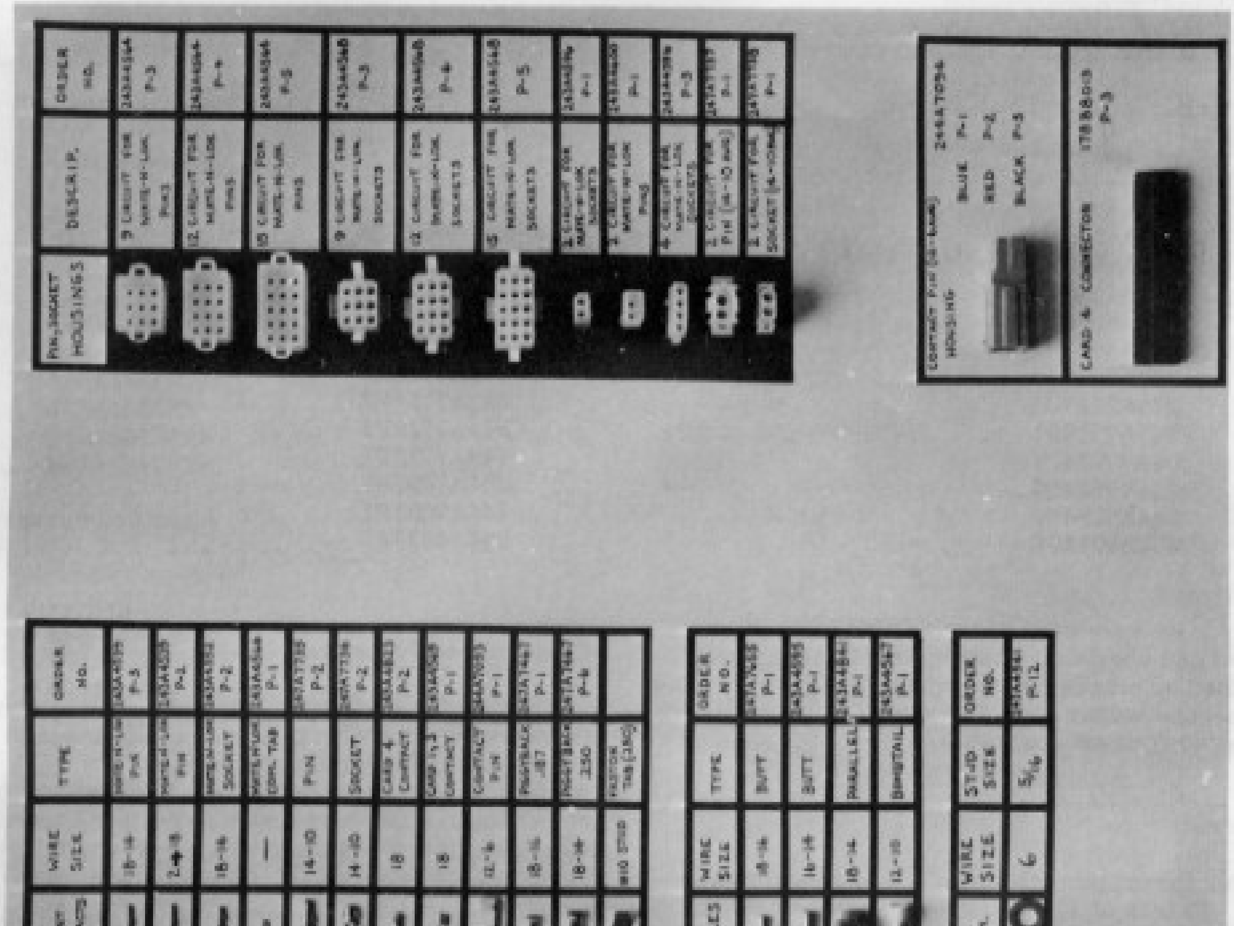
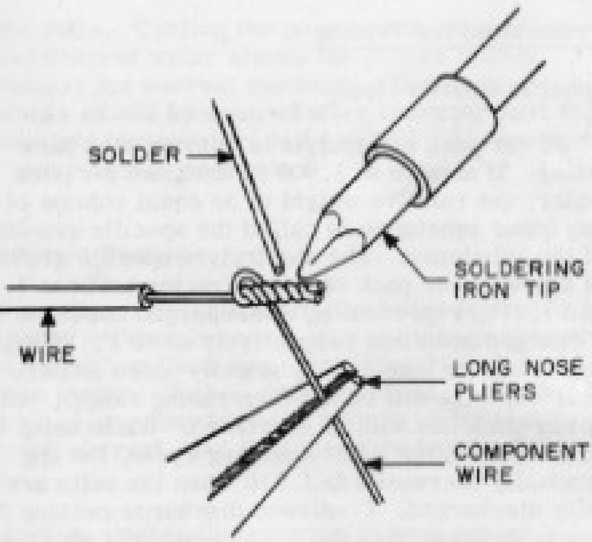


Fig. 1-7



USING PLIERS AS A HEAT SINK TO PREVENT HEAT DAMAGE TO COMPONENTS

Fig. 1-8

All those concerned should be made aware of proper care to eliminate recurrence of these problems, but even then the gases produced during normal charging may slowly cause clamps and posts to oxidize and should be cleaned.

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 put through a full charging cycle and should be allowed to reach room temperature. A voltage reading of each battery during discharging can reveal a bad cell. See Appendix B for test procedures.

Acknowledgement is given to the Association of American Battery Manufacturers for much of this technical information.

Charging Information

Fully charge the batteries by setting the charger knob to the appropriate indicator mark, letting the charger operate until it shuts off. See the tractor Use and Care Manual for instructions for your particular tractor.

NOTE: Always be sure that the disconnect is in (engaged) when charging batteries installed in tractor.

Add water to each cell of the battery to the specified level as described in the tractor Use and Care Manual. It is important, for best battery care, to be sure (a) that the perforated plates which may be seen through the filling holes are covered by the water level to a depth of 1/4-3/4 inch before charging, and (b) that the water level is brought to the bottom level of the indicator ring after charging. In this way, overfilling is prevented but sufficient water is assured. The water filler jug (AP12) does (b) automatically and quickly.

The tractor or batteries may be stored in the cold, provided the batteries are charged. Discharged batteries can freeze in cold temperatures unless recharged at once. The following table illustrates the relationship between amount of charge and freezing temperature of the electrolyte.

Amount of Charge	Freezing Temperature of Electrolyte
100%	-80 F
75%	-42 F
50%	-16 F
25%	- 2 F
10%	+ 7 F

Self-discharge of batteries is practically nonexistent below +40 degrees Fahrenheit, and they can be stored for several months without attention when not used and in any temperature less than +40 F.

If stored in a warm area above 40 F, specific gravity and the water level in the batteries should be checked about once a month. If the spg falls to 1.220 the batteries should be recharged.

After storage of more than a few weeks, it is advisable to give batteries an overnight charge before using. There is little danger of overcharging batteries when they are cold, so extra charging in the winter is advisable when use is expected within the next 24 to 36 hours.

WARNING: THE CHARGING PROCESS EVOLVES SMALL AMOUNTS OF HYDROGEN GAS; THEREFORE, NORMAL PRECAUTIONS LIKE THOSE FOR GASOLINE REFUELING SHOULD BE USED WHENEVER BATTERIES ARE BEING CHARGED. (NO SPARKS OR OPEN FLAMES NEAR THE BATTERIES.) THIS GAS CONCENTRATION WILL NOT OCCUR IF THERE IS

FREE AIR CIRCULATION IN THE IMMEDIATE AREA OR IF THE STORAGE AREA IS FAIRLY LARGE SO CONCENTRATION IS REDUCED.

Watering

During the late stages of the charging cycle, there is a bubbling action or gassing process which allows some water in the electrolyte solution to evaporate, but only water is lost; so it is only necessary to add water to bring up the electrolyte level to the proper point. Distilled water or tap water that is low to average in mineral content is satisfactory for use in the batteries.

Water is to be added only after the batteries are charged. The only exception to this rule is if the electrolyte level should fall below the top of the plates. Sufficient water should be added to bring the electrolyte level just above the plates. The batteries should then be charged, and if necessary, additional water added after charging. (This is because the electrolyte expands during charging.)

Under normal conditions, it will only be necessary to check the electrolyte approximately once per month, or just before charging if the batteries are in storage. Use of the tractor in higher temperature locations or under very heavy use may require more frequent checks of the level.

Any electrolyte running out of the top of the cells is an obvious sign of overfilling. It is important that the electrolyte level be maintained above the plates but never above the indicator ring. Overfilling can result in dilution of electrolyte, which reduces capacity and life of the power pack. Overfilling can also cause corrosion where spillage of electrolyte occurs. This should be cleaned immediately to keep self-discharging to a minimum.

Battery Electrolyte Spillage

Any spilled battery electrolyte should immediately be neutralized with a solution of 5 tablespoons of baking soda to a quart of water, and then cleaned up with a sponge.

WARNING: BATTERY ELECTROLYTE (SULPHURIC ACID SOLUTION) IS EXTREMELY CORROSIVE. DO NOT GET UN-NEUTRALIZED ELECTROLYTE ON YOURSELF OR YOUR CLOTHES, SINCE SEVERE ACID BURNS COULD RESULT. KEEP ALL BYSTANDERS AND ANIMALS AWAY UNTIL THE ACID HAS BEEN NEUTRALIZED AND CLEANED UP.

Procedures for Testing

Specific Gravity (spg)

Power pack electrolyte is heavier than pure water. If a value of 1.000 is assigned 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 1.275, representing a discharged condition and a charged condition respectively at 80 F. If the spg is higher than 1.275, 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 when the cells are fully discharged. Continued discharge causing the spg to go lower than the 1.110 point will shorten the power pack life, therefore, deep discharging as well as overcharging 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 a sample of electrolyte from a cell, jiggle the hydrometer to be sure the indicator is floating free, and record the indicated spg. Do not maintain liquid level in the hydrometer by squeezing the bulb as this gives inaccurate readings. The spg readings of the cells of any power pack unit should not vary from each other by more than 0.050. If variations do not exceed this figure and the spg in each cell is above 1.250, the unit is in good condition. Considerable variation in specific gravity readings (0.050 points or more) usually indicates sources of trouble internal to the battery. Specific gravity varies with temperature, so for correct readings the electrolyte temperature should be at 80 F.

Hydrometer Care and Correction

Hydrometers become inaccurate if not cleaned regularly. It is a 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. For every 10 degrees above 80 F, 0.004 specific gravity must be added, and 0.004 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. Hydrometer readings should be delayed after charging until the electrolyte temperature falls to 80 F, and no reading correction is necessary.

Discharge Testing

Two approved methods of discharge testing are available – the automotive-type post-to-post hand-held tester and the timer-controlled 36-volt discharge tester. Both testers operate in a similar fashion, i.e., they load the battery under test by drawing current, and then measure terminal voltage.

Post-to-post testers normally have scales to indicate the condition of both 6-volt and 12-volt batteries. They are designed to be applied rapidly by holding the polarized probes securely against the posts of the battery under test. Leave battery cables connected for this test. The indication on the appropriate scale gives the battery condition after 3 to 5 seconds as to whether it is good, fair, or poor.

> CAUTION: DO NOT HOLD THE TESTER IN PLACE FOR OVER 5 SECONDS. BE CAREFUL HANDLING IT AFTER THE TEST, SINCE ITS RESISTIVE ELEMENT CAN BECOME EXTREMELY HOT IN A SHORT LENGTH OF TIME.

This quick application ability lends itself well to field-checking batteries for shorted or dead cells, but gives no control or indication of long discharging periods. In other words, the post-to-post tester may show all batteries to be "good", but the complaint of reduced range may still go unresolved. More elaborate battery testing may show that a battery cell shorts after 45 minutes of use and is the source of the trouble. The 36-volt discharge tester allows testing 6-volt batteries by attaching the polarized leads on the ends of the set of batteries connected in series and starting the tester. The timer of the tester starts immediately and the unit draws a controlled current of 75 amperes until the series terminal voltage reaches 31.5 volts. At that voltage, the timer stops and shuts off the current. For a good power pack, this test takes in excess of 60 minutes. During the test, the voltmeter is used on the 10-VDC scale to measure the terminal voltage of each battery at 15-minute intervals. This is a comparison check and any terminal voltage that differs from the others significantly (0.5 volt or more) indicates a battery that may need replacement.

Either test must be performed only after the batteries have been fully charged, as indicated by a specific gravity measurement of all cells as previously outlined.

The other function that the 36-volt discharge tester performs is that of determining if the entire power pack is capable of supplying a specified number of amperes for a minimum time. The discharge tester supplied for ELEC-TRAK power pack testing is to be used for testing one set of standard or heavy-duty 6-volt batteries only; 6 batteries connected in series.

The tester consists of a 75-ampere load, a voltage sensing system, and a means of electrically timing the discharge. This unit will give the ampere-hour capability of a battery pack when discharged at a constant 75-ampere rate, which has been standardized as a test condition for batteries used in systems such as electric vehicles. The ampere-hour rating assigned to a battery is based on a discharge current that would require 20 hours for full discharge.

The output of a battery when discharged from full charge to a discharge measured at 1.75 volts per cell will depend on the previous history of the battery. As a battery is used, its capacity will increase at first and then will begin to decrease. The time of this decrease is also affected by the kind of use experienced over the battery life, by the temperature, and by the care and maintenance of the battery. The accepted test for end of life is when a battery discharges from full charge to 1.75 volts per cell in less than 60 minutes, being discharged at a 75-ampere rate.

This tester is used to indicate when the power pack has reached the minimum performance level, below which one or more batteries in the power pack must be replaced. This level requires a 75-ampere rate of discharge to a series terminal voltage of 31.5 volts (18 x 1.75) in less than 60 minutes. Testing for improper charging and/or dead cells should be performed before applying the discharge test.

Your ELEC-TRAK tractor dealer has the equipment and knowledge required to test batteries and determine their condition.

1.11 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 creates more charging energy per cycle of ac power input.

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 once 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-Hertz 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 higher rate of charge for each cycle of ac power input.

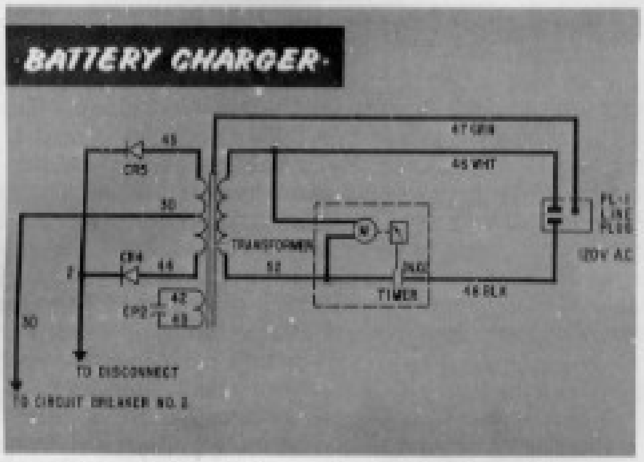


Fig. 1-9. Battery charger (schematic)

- CR4 and CR5 are diodes
- CP2 is the capacitor
- Wires #30 to 44 or 30 to 45 will measure about 45 volts ac when charger is on
- Wires #44 to 45 will measure about 90 volts ac when charger is on
- Wires #2 to 30 will measure about 45 volts dc when charger is on

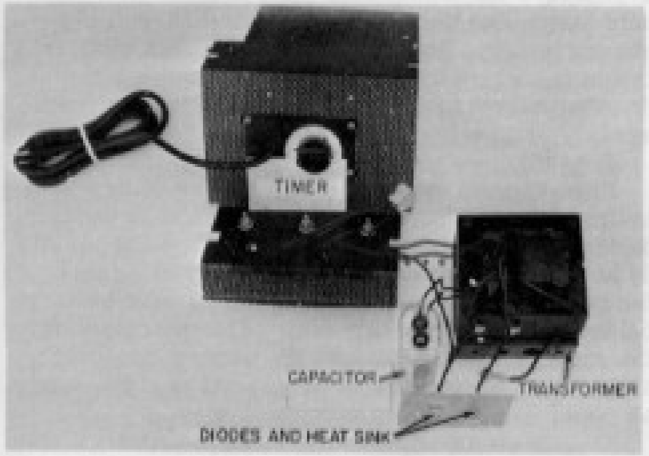


Fig. 1-10. Charger description

- 120 volt, 15 amp ac input for charger
- Transformer reduces 120 volts ac to 90/45 volts ac
- Capacitor regulates charging rate
- Maximum draw on 120 volts ac is approximately 14 amps
- Timer when set to 1-2 years runs about 18 hours before it shuts off
- Power disconnect must be engaged

PROBLEM	PROBABLE CAUSE	WHAT TO DO
1. Line fuses are blown with timer off.	1. Short in ac cable.	1. Replace line cord.
2. Line fuses blow when charger is turned on with the timer.	2. Improper wiring of ac socket, miswired timer to charger connector, short in transformer winding.	2a. Check wiring of cord, timer assembly and connector.
		2b. Change the ac cord.
		2c. Look for a short in the transformer leads or timer motor terminals at the charger connector.
		2d. Change the timer.
		2e. Check for shorted diodes on the heat sink.
		2f. Check for burned primary (input) winding on transformer.
3. Charger hums but no output, or hums with low output.	3a. Power disconnect or fusible link open.	3a. Close power disconnect switch (where applicable) check fusible link for burnout. This would happen only if there is a direct short across the battery pack. Be sure the short is removed before replacing the fusible link.
	3b. CB 2 needs to be reset.	3b. Reset CB 2 by firmly pushing on red button with thumb, until distinct "click" is heard. Arcing when closing or immediate retrip indicates shorted diode on heat sink.
	3c. Defective CB 2.	3c. With charger off and power disconnect open, measure resistance of CB 2 terminals. When reset, the resistance should be zero ohms. If not, replace CB 2.
	3d. Loose wires at CB 2.	3d. Sometimes CB 2 will trip if charging current is normal. A loose connection at the circuit breaker will cause excessive heat which warms up the breaker and causes it to trip below its current rating. The breaker may be okay, but most likely it will have to be replaced because of excessive contact erosion.
	3e. Loose wire at heat sink.	3e. A loose wire at the heat sink will act as resistance in series with the charger and thereby reduce the charger voltage available at the batteries.

PROBLEM	PROBABLE CAUSE	WHAT TO DO
3. (Cont'd)	3f. Open diode.	3f. An open diode on the heat sink will reduce dc voltage of the charger to 15-20 volts output with charger disconnected from the battery pack. Replace the heat sink assembly. DO NOT REUSE heat sink plates.
	3g. One or both diodes are shorted on heat sink.	3g. If one or both diodes are shorted the output of the charger will be 0 to 2 volts and CB 2 will not reset. In this case, replace the heat sink assembly and install a new CB 2.
	3h. Defective capacitor.	3h. A defective charger capacitor will have same symptoms as shorted diodes, except CB 2 will not trip.
	3i. Defective transformer.	3i. A defective transformer can be checked by ac voltage measurement on the output windings. See Transformer Test.
4. The timer knob can turn the charger "ON" and "OFF," but does not run itself back from "START" charge point.	4a. Timer motor not receiving line voltage.	4a. Check connector and terminals locked in connector.
	4b. Timer motor could be defective.	4b. Replace timer.
5. CB 2 tripping out with no ac power on.	5. This is an indication that a diode is shorted on the heat sink and drawing power from the battery pack.	5. Check both diodes with an ohmmeter for forward and reverse resistance - see "Diode Checks." Change the heat sink and CB 2. WARNING: Be sure line cord is unplugged and power disconnect open (or battery cable removed) when attempting repairs.
6. Charger operates okay but will not turn "OFF."	6. The timer contacts are probably welded shut or shorted.	6. Replace with a new timer.

Charger Troubleshooting

If the charger is found to be faulty, use the following procedure.

(1) Remove and insulate the battery cable that goes to the fusible link from the battery positive terminal, thus removing battery pack voltage from the charger and the tractor, or open the power disconnect (where applicable).

(2) Remove the charger cover, wire #2 and #30 from the charger base, and place the charger near the tractor such that the timer can plug into transformer for operational tests.

(3) Turn the ac power on and move the timer to the "start" position. Measure the dc voltage across test points indicated.

Transformer Test

To test transformer ac output for proper values, proceed with the following:

a. Remove one or both diodes from transformer lead test point* 44, 45.

* Test Point will be called T.P.

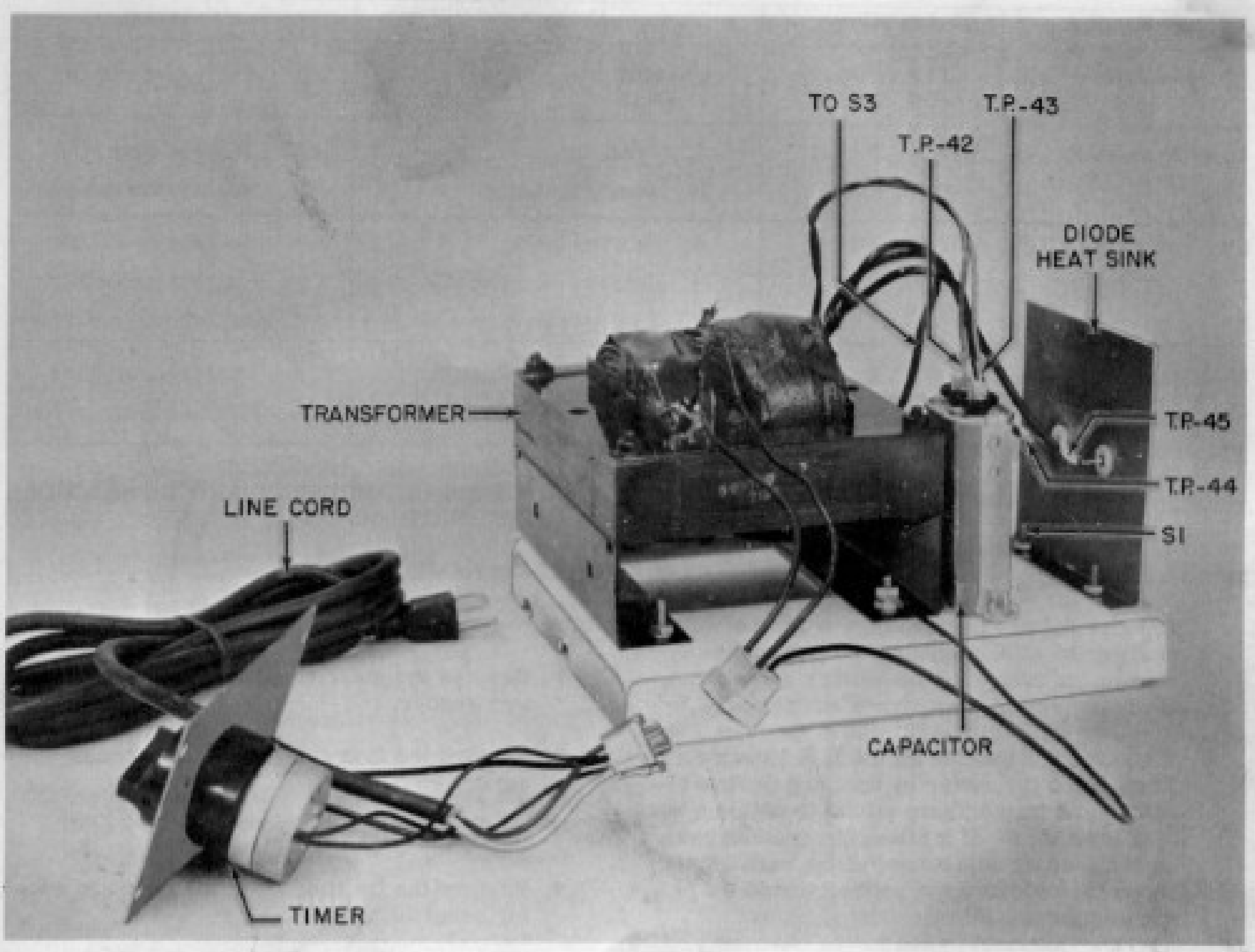


Fig. 1-11

b. Remove one transformer lead from the capacitor T. P. 42 or 43.

CAUTION: DO NOT ALLOW THE LEAD TO TOUCH ANYTHING ELSE.

c. Apply power to the transformer and measure ac voltage of approximately 70 volts ac across leads removed from the diodes, T. P. 45 and 44. Also measure 35 volts ac from each T. P. (45 and 44) to T. P. S3 (the secondary winding center tap).

WARNING: DO NOT ATTEMPT TO MEASURE CAPACITOR VOLTAGE. DO NOT TOUCH CAPACITOR OR LEADS.

d. Turn off power and reconnect the capacitor leads to the capacitor, T. P. 42 and 43.

e. Turn the power back on, and measure ac voltage of approximately 90 volts ac and 45 volts ac where 70 volts and 35 volts were measured in C.

These values are correct for a normally operating transformer, assuming the input voltage is within specifications and capacitor used is not faulty.

Voltage Reading	Location	Cause	Correction
10 to 44 volts dc	T.P. S 1 (+) T.P. S 3 (-)	Charger Okay	----------------
15 to 20 volts dc	T.P. S 1 (+) T.P. S 3 (-)	A. Open diode B. Faulty transformer	A. Replace heat sink B. Replace transformer
0 to 2 volts dc	T.P. S 1 (+) T.P. S 3 (-)	A. Shorted diode B. Shorted capacitor C. Faulty transformer	A. Replace heat sink B. Replace capacitor C. Replace transformer
30 to 34 volts dc	T.P. S 1 (+) T.P. S 3 (-)	A. Faulty capacitor B. Faulty transformer	A. Replace capacitor B. Replace transformer

Diode Check - See Fig. 1-12 and 1-13

To check for defective diodes, use the following procedure:

1. Remove battery pack voltage from the charger by either opening the power disconnect or removing the battery cable from the battery pack.

2. Place the multimeter on the R X 10 scale. Then, zero the meter by touching probes together and turning zero adjust to obtain a zero ohm indication. If a full scale reading cannot be obtained by adjustment of the zero adjust knob, then replace the battery inside the multimeter.

3. Low resistance (ohms) should be measured between each diode lead and the heat sink. With the meter leads reversed, no reading should be seen. Be sure to measure both diode leads to the heat sink.

4. If zero ohms (full scale) is observed, then one or both diodes are shorted and the heat sink must be replaced.

5. If low resistance is obtained in one direction and (infinity) in the opposite direction, then the diodes are not shorted, but one may or may not be open.

6. If Transformer Test indicates an open diode (15-20 volts output), then clip one diode lead near the insulated transformer wire and retest each diode as in (3) above. A lack of reading in both directions of either diode indicates an open diode. Replace the heat sink.

1.12 STEERING ASSEMBLY AND DISASSEMBLY INSTRUCTIONS

LARGE FRAME

Removing the steering shaft and pinion:

1. Remove the steering wheel, plastic spacer, and washer.

2. Remove the lower control panel access cover.

3. Loosen the set collar.

4. Remove the tie rods from the gear and sector assembly.

5. Remove the cotter pin and shims from the end of the gear-and-sector assembly shaft.

6. Remove the bearing from the front axle support.

7. Remove the bolts attaching the mounting bracket to the frame.

8. By sliding the sector shaft forward and the bracket rearward, disconnect the shaft from the bracket. Remove the mounting bracket from the top.

9. Rotate the shaft and sector assembly 45 degrees and remove from the frame.

10. The steering shaft can be lowered through the frame.

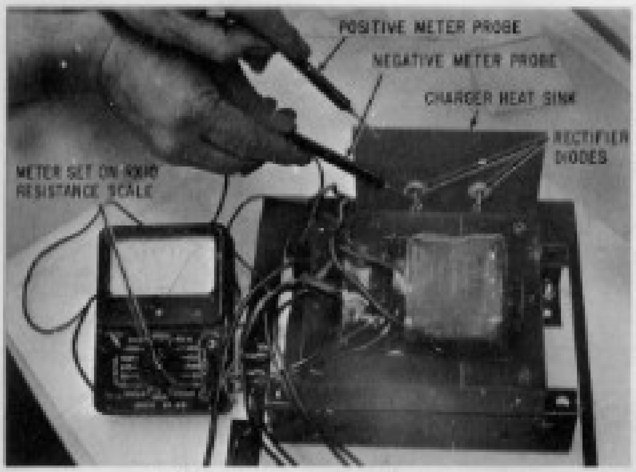


Fig. 1-12 Charger heat-sink diode-resistance measurement

Assembly of large-frame steering

1. Install the set collar and bearing on the steering shaft and install it through the hole in the control cabinet.

2. Install the shaft and sector assembly through the hole in the frame.

3. Install the mounting bracket through the frame (from top) and mate the bracket with the shaft and segment assembly.

4. Place the shaft and pinion in the mounting bracket.

5. Attach the bearing to the front axle support.

6. Slide the mounting bracket as far forward as possible and tighten the bolts.

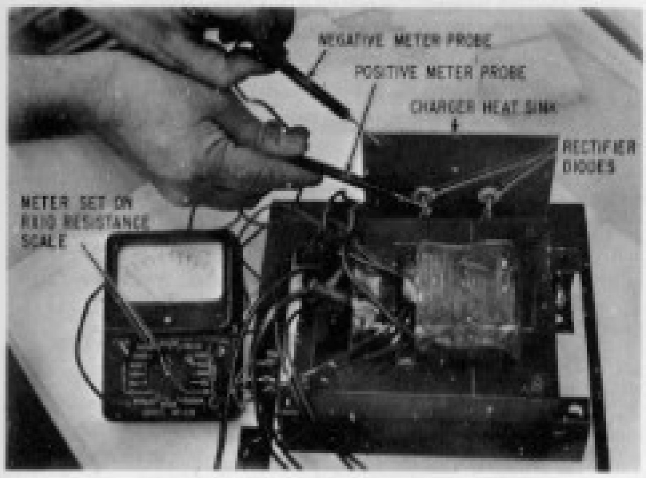


Fig. 1-13 Charger heat-sink diode-resistance measurement

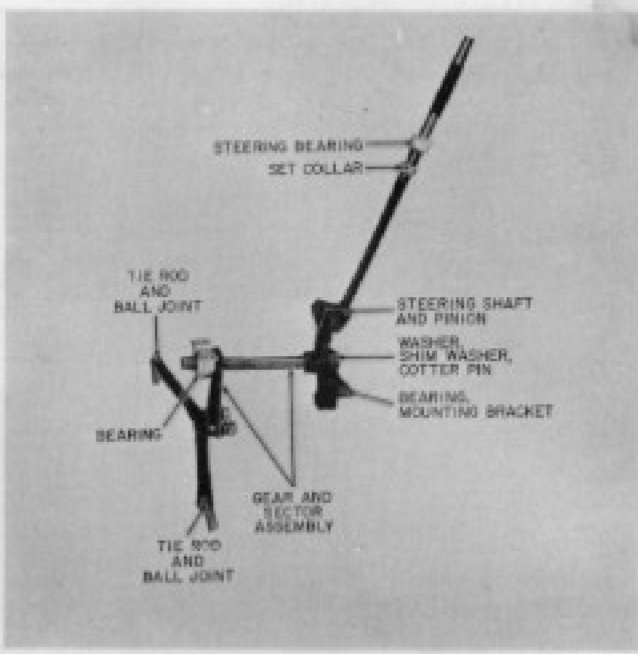


Fig. 1-14

7. Tighten the bearing and set collar on the steering shaft. The set collar prevents loss of steering, since it holds the pinion into the segment.

8. Install the tie rods.

9. Before installing the cotter pin to the rear of the shaft and segment assembly, add shims to adjust for proper gear sector and pinion mesh. Gears should not ratchet under load.

10. Replace the lower control panel access cover.

11. Install the washer, plastic spacer, and steering wheel.

SMALL FRAME

Disassembly:

> CAUTION: BEFORE STARTING DISASSEMBLY, DISCONNECT AND INSULATE BATTERY CABLE #2-01 FROM POSITIVE POST OF BATTERY B2 AND REPLACE BATTERY COVER.

1. Remove the steering wheel and plastic spacer.

2. Remove the gear shift knob and motor compartment cover (four bolts).

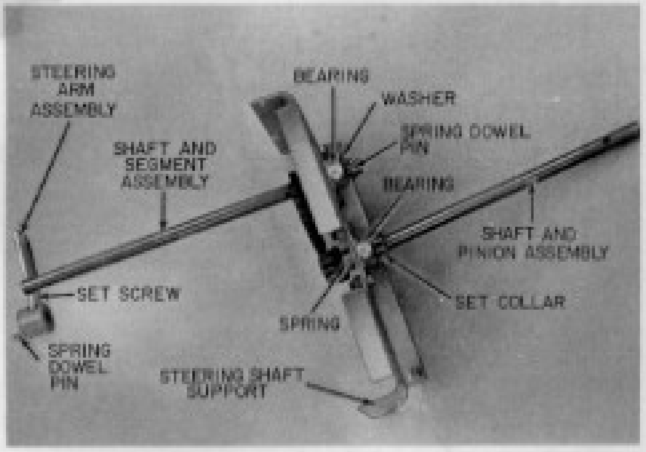


Fig. 1-15

3. Remove the two screws and the lower control panel. Disconnect plugs J-3 and J-4.

4. Unbolt the dash compartment and lift off over the shaft and pinion assembly.

5. Remove the steering arm from the bottom of the shaft and sector assembly.

> NOTE: Only if shaft and sector need to be replaced.

6. Lift the steering shaft support plate and both steering shafts out of the tractor.

> NOTE: If shaft and segment assembly are not to be changed, remove the dowel pin before lifting out the steering shaft support plate, and the shaft and segment assembly will stay in the tractor.

7. Remove the shaft and pinion assembly by loosening the set collar.

8. Remove the shaft and sector assembly by removing the dowel pin.

<u>Assembly:</u>

1. Tighten the bearings on the support plate.

2. Install the shaft and pinion assembly, compress the spring fully, and tighten the set collar so that the spring stays compressed.

3. If the shaft and segment has been removed, replace the spacer on the segment shaft and install the shaft into the bearing. Place the washer and dowel pin in place.

4. Install the steering assembly into the tractor by putting the shaft of the shaft and segment assembly into the bearing in the bottom of the tractor. If the shaft and segment was not removed, install the washer and dowel pin at this time.

5. Replace the bottom steering arm.

6. Position the dash compartment over the steering shaft and replace the four bolts.

7. Replace the plastic spacer and the steering wheel.

8. Loosen the set collar, allowing the shaft and pinion to engage with the gear sector. The spring will keep the gears properly meshed. Relocate the set collar on the shaft (1 inch above the bearing) and retighten.

9. Connect J-3 and J-4 and install the control panel.

10. Install the motor compartment cover and gear-shift knob.

11. Connect the battery cable # 2-01 to the positive post of battery B-2. Install the battery covers and hold-downs.

1.13 TRANSAXLE REPAIR

In-warranty transaxle repairs on all ELEC-TRAK tractor models are to be performed by Tecumseh-Peerless factory authorized outlets. The following procedures should be followed on repairs:

a. Locate the nearest Tecumseh-Peerless representative from the telephone yellow pages, listed under "Engines - Gasoline". (Some ELEC-TRAK tractor dealers may also be Tecumseh-Peerless representatives.)

b. Make arrangements with the factory repair outlet to have the unit repaired. The complete tractor, if possible, should be delivered to the repair outlet. Evidence of tractor date of sale should be presented to assure the warranty is in effect.

c. If the unit is in warranty, the factory outlet representative will repair or replace the transaxle at no charge.

d. Claims for in-warranty labor and parts will not be paid by General Electric. All repairs performed by non-factory authorized outlets will void the transaxle warranty and are not reimbursable.

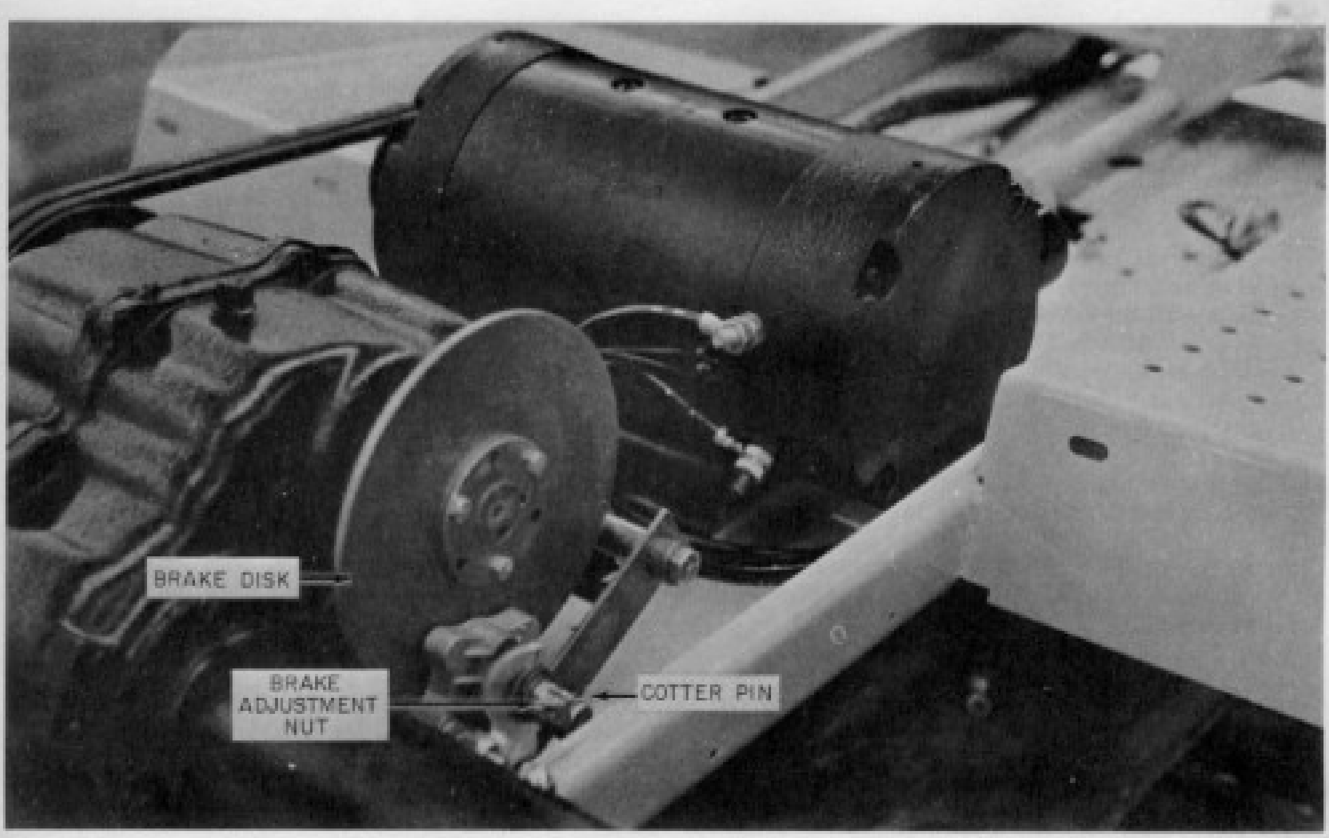


Fig. 1-16 Die-Cast Caliper Brake

1.14 BRAKE ADJUSTMENT (Large-frame Tractors)

Two types of brake calipers are used on large frame tractors.

Brake Adjustment - Die-Cast Caliper

1. Block the front wheels and move the range selector to neutral.
2. Lift the rear tractor wheels clear of the ground with a proper capacity jack (1000 lb rating) and add a safety block to back up the jack.
3. Remove the rear wheel on the brake side of the transaxle.
4. Remove the cotter pin that locks on the brake adjustment nut (castle nut). Refer to Fig. 1-16.
5. Turn the adjustment nut until it is finger tight.
6. Back off the adjustment nut counterclockwise until a very slight drag is felt when rotating the brake disk by hand.
7. Replace the cotter pin.
8. Check to be sure the brake disk is free with very little drag by rotating it manually.
9. Replace the wheel and lower the tractor.
10. Test the brake function for more effective stopping and firmer pedal pressure.
11. Proceed to BRAKE SWITCH ADJUSTMENT.

Brake Adjustment - Steel Caliper

1. Block the front wheels and move the range selector to neutral.
2. Lift the rear tractor wheels clear of the ground with a proper capacity jack (1000 lb) and add a safety block to back up the jack.

3. Remove the rear wheel on the brake side of the transaxle.

4. Remove the cotter pin from the brake clevis pin. See Fig. 1-17.

5. Remove the brake clevis pin.

6. Rotate the brake clevis to shorten the brake linkage. Shorten until the brake drags (test by manually rotating the brake disk), then back off one-half turn at a time until brake drag is minimal, but not eliminated. The clevis and clevis pin must be reinstalled temporarily to check brake drag.

7. Reinstall the clevis, clevis pin, and cotter pin on the brake actuating lever.

8. Reinstall the wheel and test brake function for more effective stopping and firmer pedal pressure.

1.15 BRAKE SWITCH ADJUSTMENT

As part of any brake service procedure, the brake switch adjustment should also be checked and corrected if necessary. Proper brake switch adjustment should be determined as follows. Apply full speed selection of the throttle in the highest speed range (D2) on level ground.

CAUTION: BE SURE THE AREA OF TRAVEL IS CLEAR OF OBSTRUCTIONS AND ENOUGH DISTANCE IS PROVIDED FOR STOPPING.

Once top speed is achieved, slowly depress the brake pedal and observe the Power Use gage. When the needle of the Power Use gage increases to the Green-Yellow border of the upper range, or one-third of full-scale, the drive motor should turn off.

If adjustment is necessary, locate the brake switch mounted on the underside of the frame immediately to the right of the brake pedal. Notice that the switch is actuated when its lever arm is deflected as the brake pedal is depressed. During this actuation, the lever arm rides on a shoulder bolt mounted on a slotted pawl. (See Fig. 1-18.) It is this bolt that must be repositioned in the slot to adjust the drive-motor/brake cut-off point.

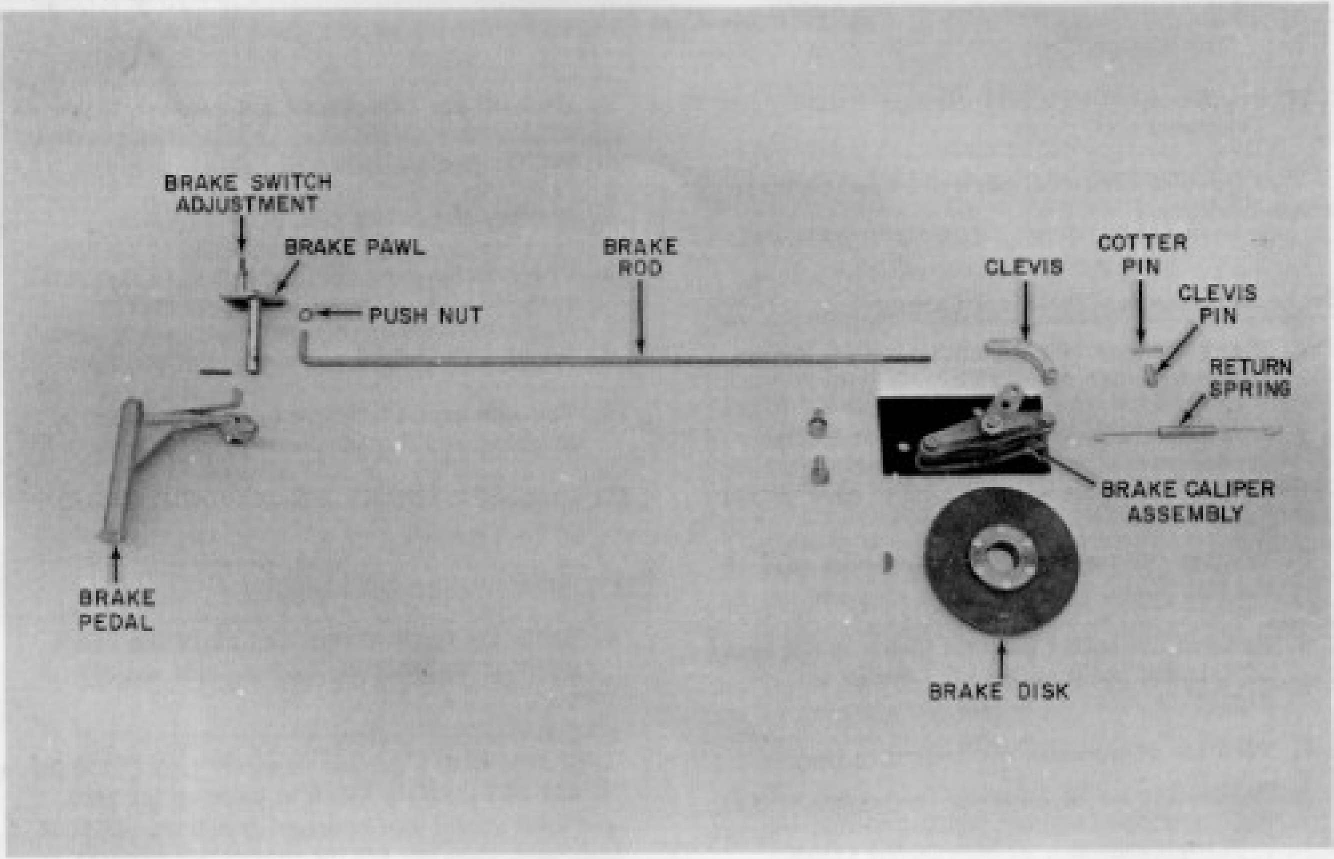


Fig. 1-17 Steel Caliper Brake

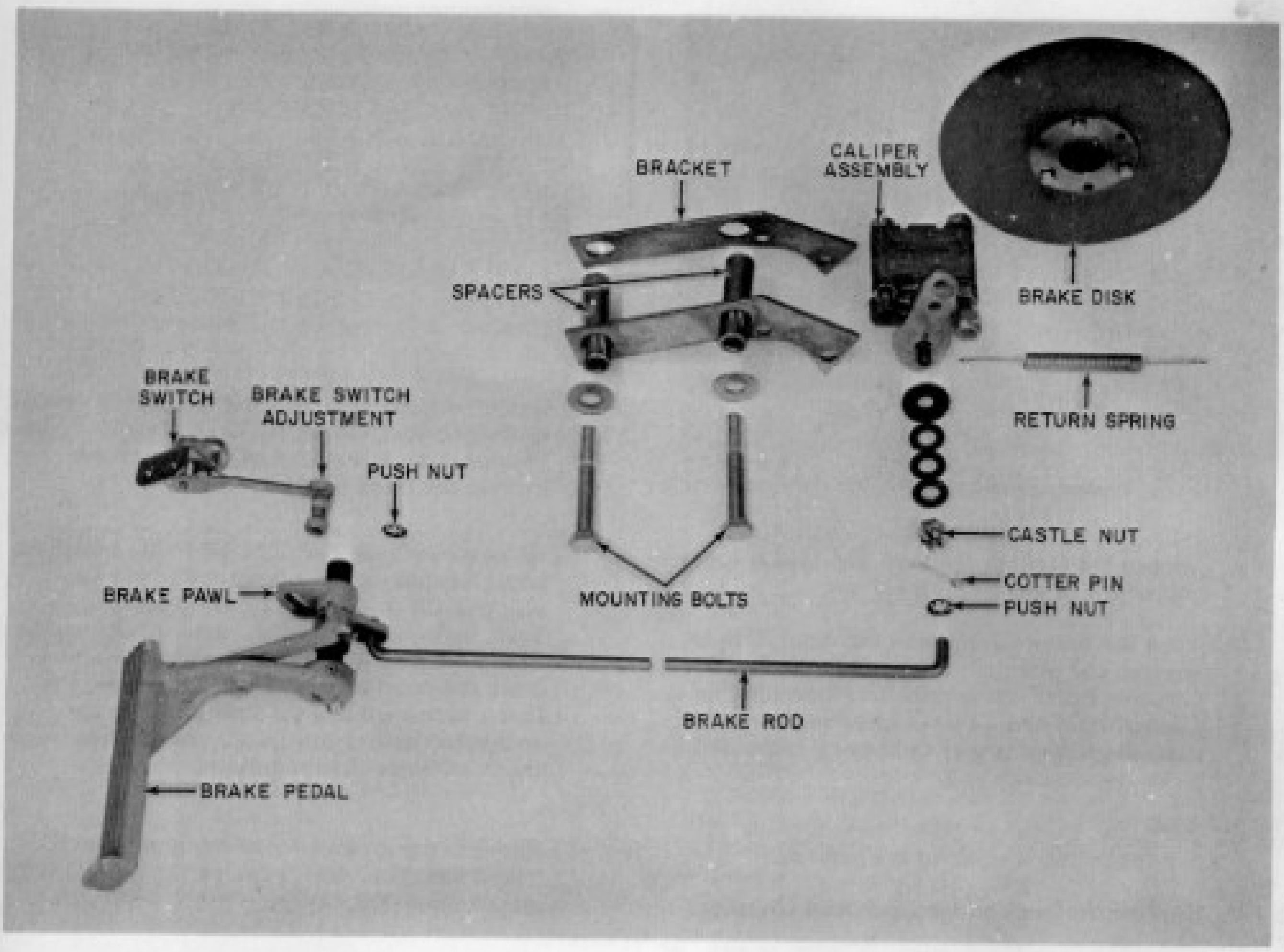


Fig. 1-18 Die-Cast Caliper Brake

Generally, 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:

1. Loosen the shoulder screw.

2. Reposition the shoulder screw in the slotted pawl and tighten it in place. Move the screw forward to delay actuation of the brake switch.

3. Retest the brake and measure for 1/4-inch travel as required.

4. Repeat steps 1 through 4 if required.

WARNING: FAILURE TO PROPERLY ADJUST THE BRAKE SWITCH COULD CAUSE INJURY TO THE OPERATOR AND EQUIPMENT DUE TO UNEXPECTED TRACTOR STARTUP UPON RELEASE OF THE BRAKE PEDAL.

1.16 BRAKE ADJUSTMENT - SMALL FRAME TRACTORS

1. Block the front wheels and move the range selector to neutral.

2. Lift the rear tractor wheels clear of the ground with a proper capacity jack (1000 lb rating) and add a safety block to back up the jack.

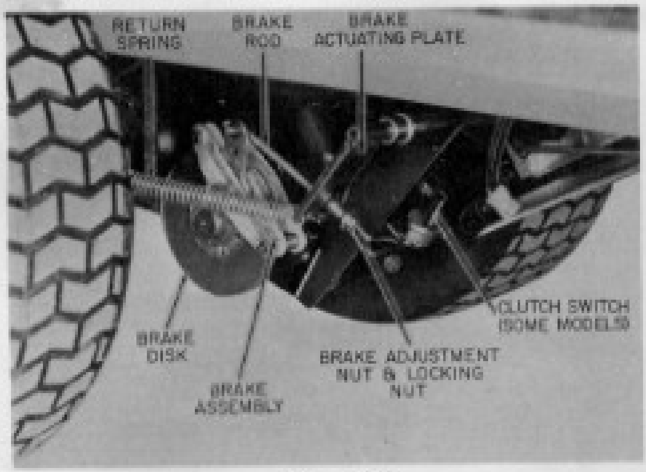


Fig. 1-19

3. Loosen the locking nut (see Fig. 1-19) located behind the brake adjustment nut.

4. Turn the brake adjustment nut clockwise to shorten the effective brake rod length. Turn the adjustment nut at one-half turn intervals. Check brake pedal travel after each interval until decreased travel is noticed under full pedal depression.

5. Retighten the brake adjustment locking nut and lower the tractor to the ground.

6. Test brake function for improved stopping.

CAUTION: ADJUSTING BRAKES TOO TIGHT WILL INTERFERE WITH PROPER DECLUTCHING OF THE TRANSMISSION, REDUCE THE TRACTOR RANGE BECAUSE OF "DRAGGING" BRAKES, AND GREATLY DECREASE BRAKE WEAR-PAD LIFE.

1.17 LIFT STRAP REPLACEMENT

The lift strap is replaced as follows:

1. Detach any front mounted accessory mounted to the tractor. Move the tractor so that there is approximately 4 feet of working room around the front of the tractor.

2. Remove the four carriage bolts attaching the front bumper to the frame and lower the electric lift unit to the floor. (See Fig. 1-20.) On some models, wire slack may be insufficient to lower the electric lift unit from the tractor frame. In this case, the three wires feeding the unit must be disconnected before lowering. Be sure to keep track of connection locations.

3. Remove the lower spacer the plastic belt guard rests on, then remove the plastic belt guard. See Fig. 1-21.

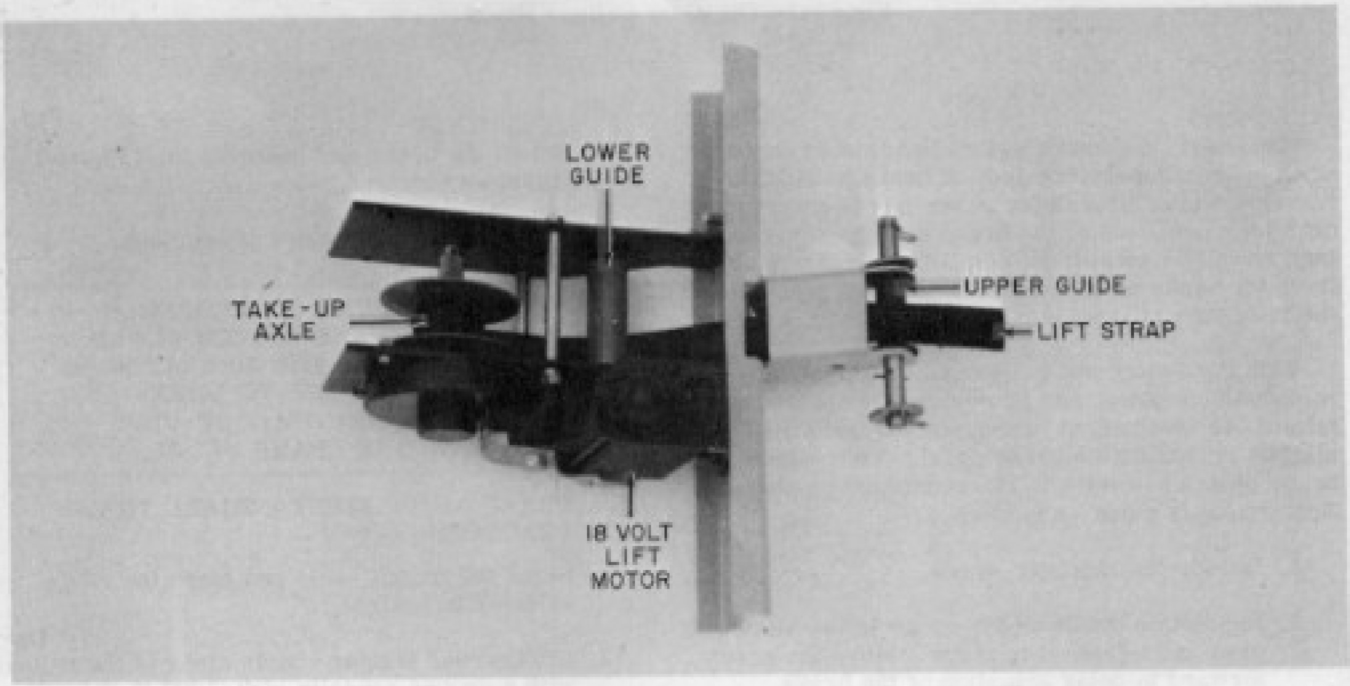


Fig. 1-20

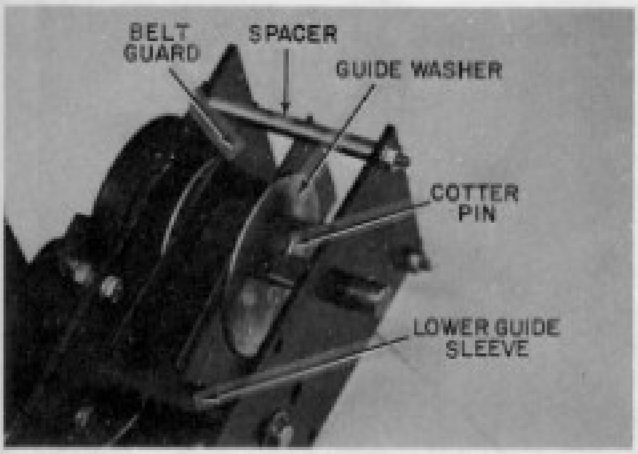


Fig. 1-21

4. Remove the cotter pin from the lift spool and slide the large guide washer away from the lift belt.

5. Unroll the lift strap from the spool as illustrated in Fig. 1-22.

6. Straighten the ends of the belt retaining clip and pull the belt and clip from the spool. Remove the clip from the end of the belt.

7. Place the clip through one of the loops on the end of the new lift strap and re-insert the clip into the spool holes. Bend the clip ends over as before.

8. Reposition the guide washer, replace the cotter pin, and replace the plastic belt guard and spacer.

9. Thread the lift strap as shown in Fig. 1-23 and remount the electric lift unit to the tractor.

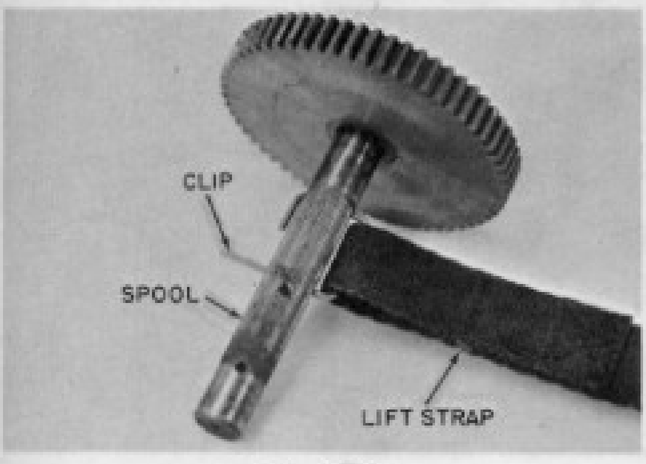


Fig. 1-22

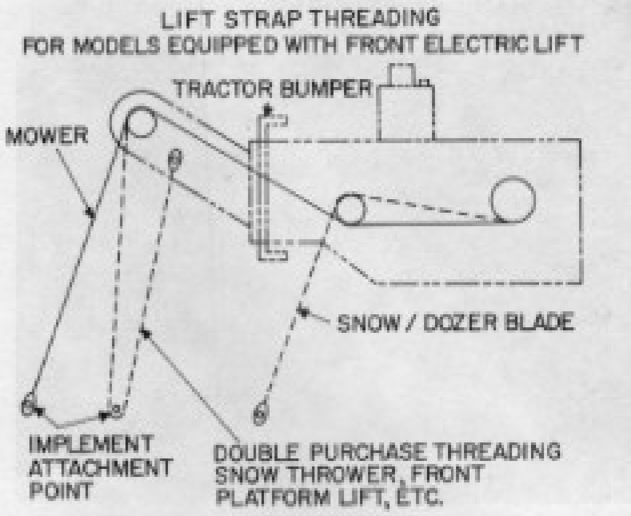


Fig. 1-23

10. Activate the lift switch on the dash to the "UP" position, thus rewinding the lift strap on the spool. If the lift strap raises in the switch "DOWN" position and vice-versa, then use the following procedure for reversal of direction. Hold the lift switch in the "UP" position until the lift strap is fully unwound. Continue this action and the strap will rewind itself on the spool, thus acting in the same direction as indicated by the lift switch mode.

1.18 BELT TIGHTENING

With the belt(s) properly adjusted, a 10-pound force will deflect a belt approximately 1/4 inch.

If increased tension is required, proceed as follows:

1. Loosen the four carriage bolts holding the motor plate. Insert a 1/4-inch wedge under the forward (rear on E12M model) part of the motor plate, and retighten the bolts finger tight.

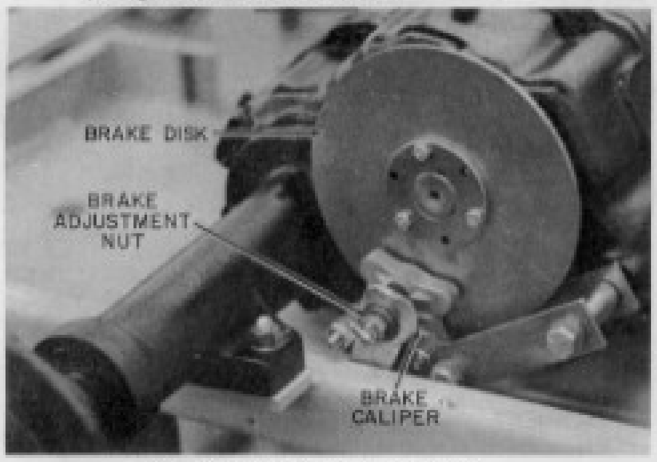
2. With belts in place, force the motor mounting plate away from the transaxle as far as possible. Tighten the two carriage bolts nearest the transaxle.

3. Remove the 1/4 inch wedge, and tighten the remaining two carriage bolts.

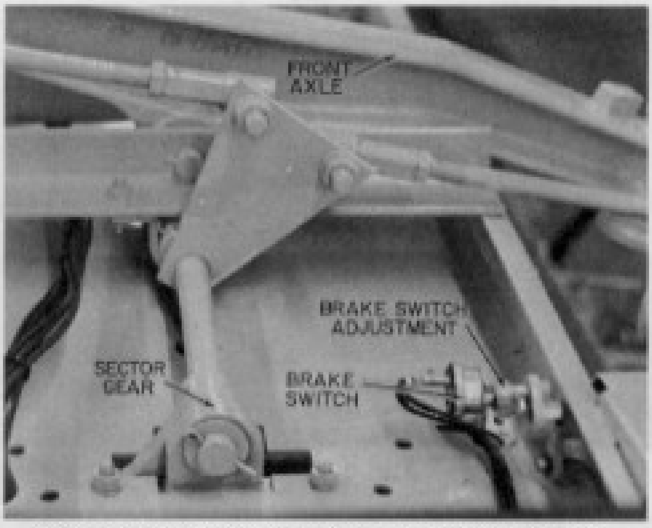
4. Recheck belt tension as outlined.

If it becomes necessary to replace one belt, it is recommended that both belts be replaced so drive power is shared equally.

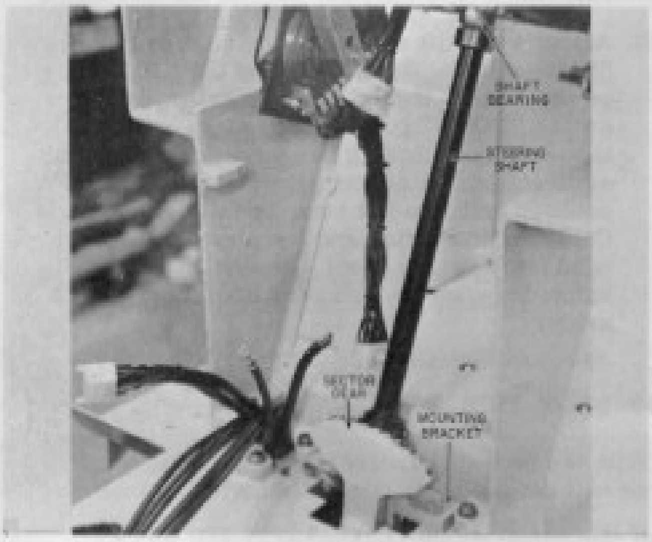
1.19 MECHANICAL COMPONENT LOCATIONS (Large-Frame Tractors)



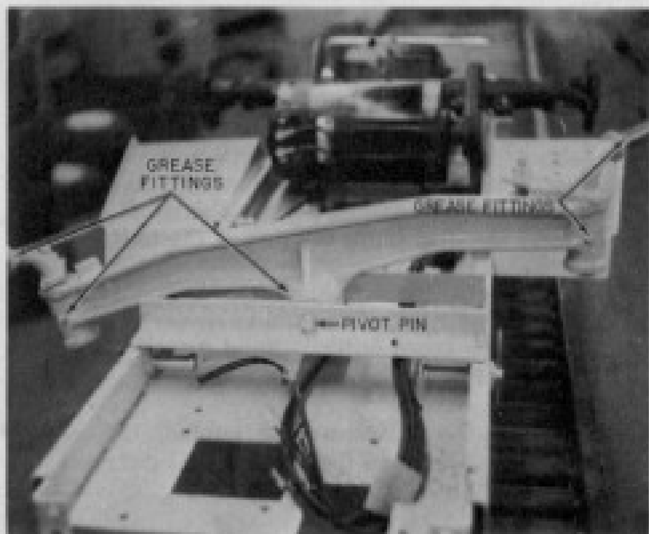
Die-Cast Brake Assembly



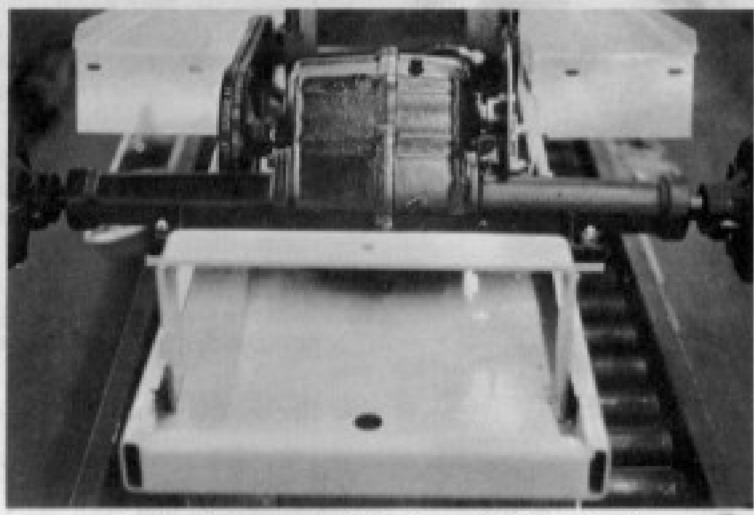
Typical Steering Assembly and Brake Switch



Steering



Typical Front Axle

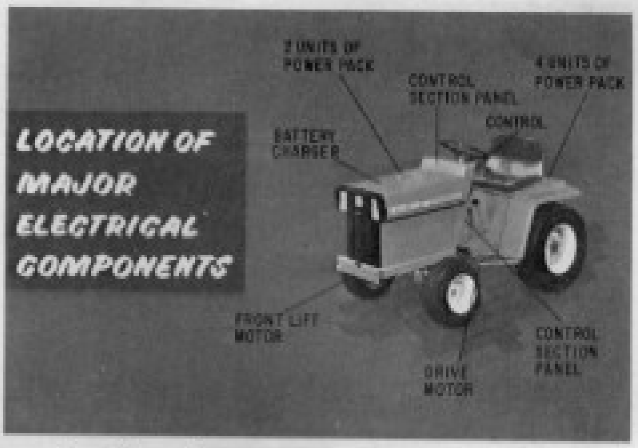


Typical Transaxle (Peerless 2300 Series)

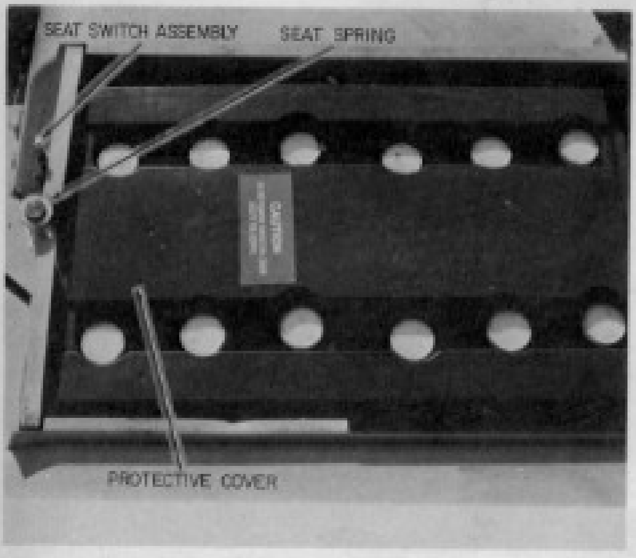
1.20 ELECTRICAL COMPONENT LOCATIONS (Typical Large-Frame Tractors)

MAJOR COMPONENTS

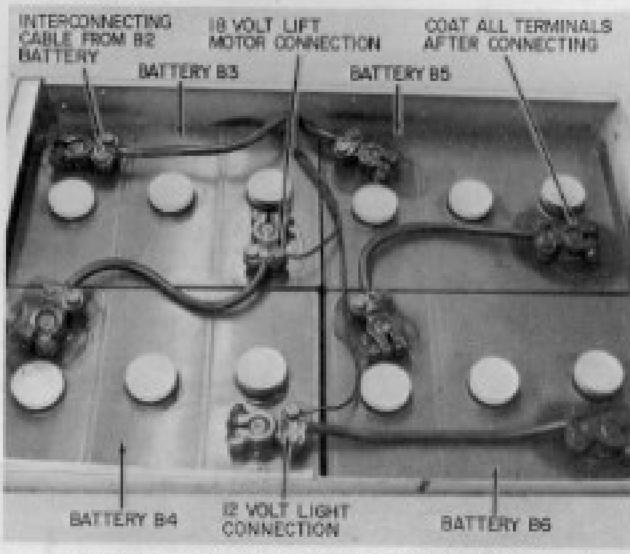
- Power Pack - Six 6-Volt Betteries
- Battery Charger - 120 Volts ac to 40 Volts dc
- Electric Lift - 18 Volts dc
- Drive Motor - 36 Volts dc
- Control Panels - 36 Volts dc
- Speed Control - 36 Volts dc



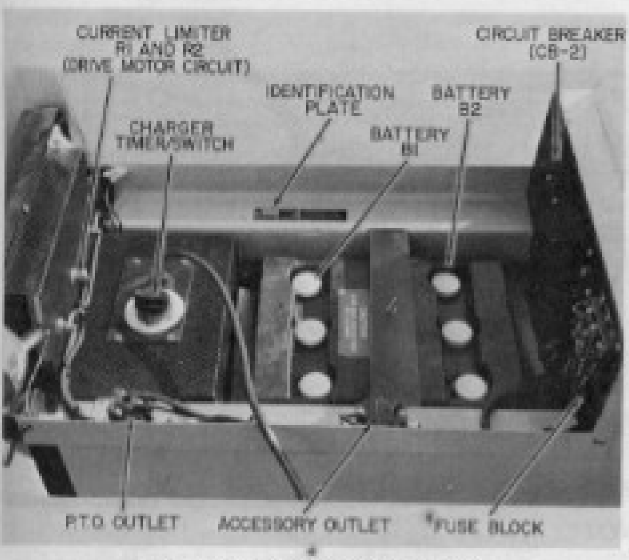
Location of Major Electrical Components



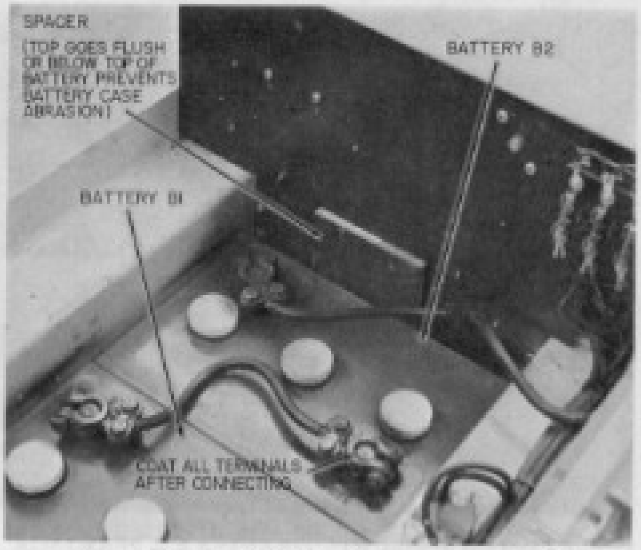
Rear Power Pack Section



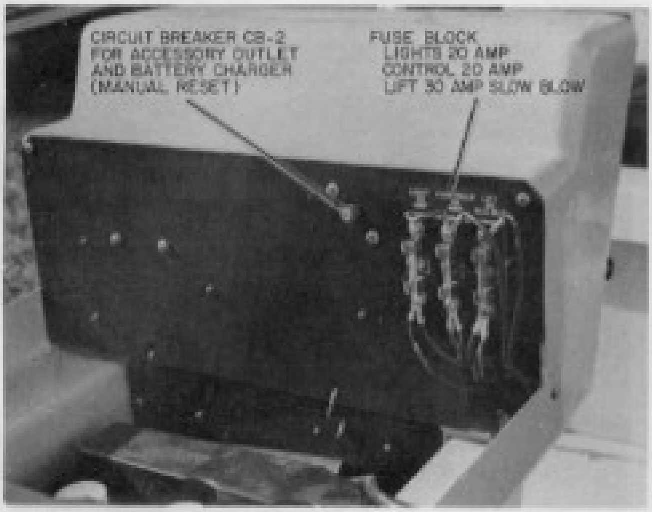
Rear Power Pack Section (Cover Removed)



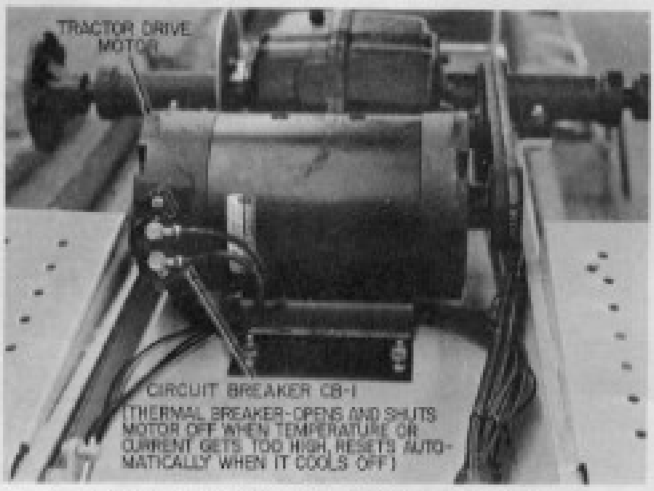
Front Power Pack Section



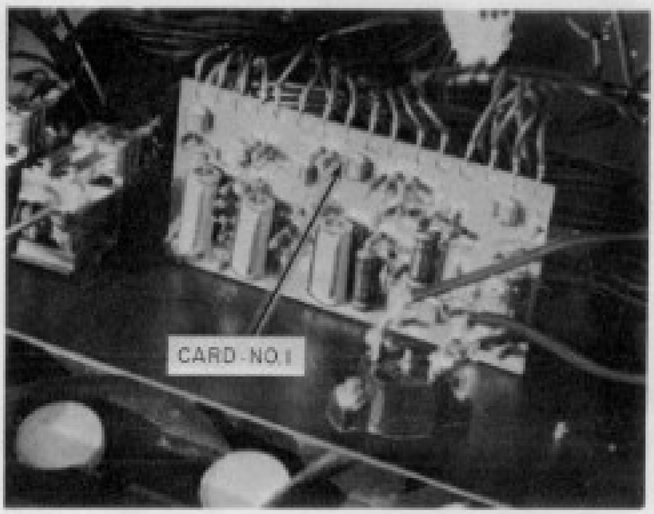
Front Battery Section (Cover Removed)



Upper Control Panel - Front Side



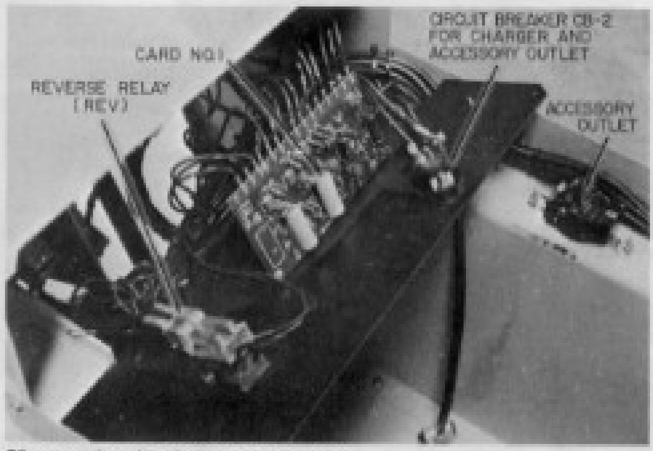
Drive Motor (Underside of Tractor)



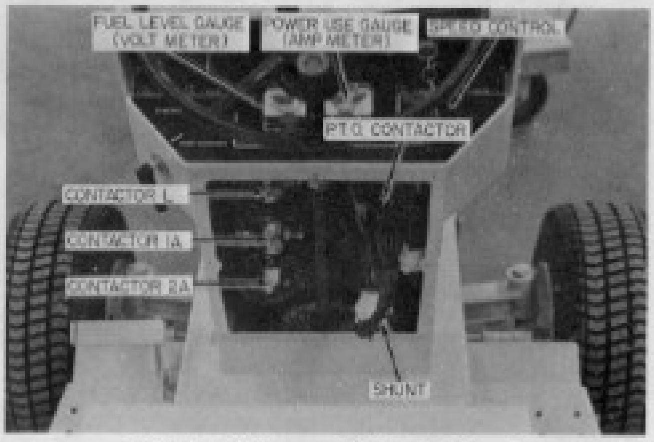
Upper Control Panel E15 (26AE15AA - 26AE15GA
(Rear Side) Hood Open - Panel Down

E-12S

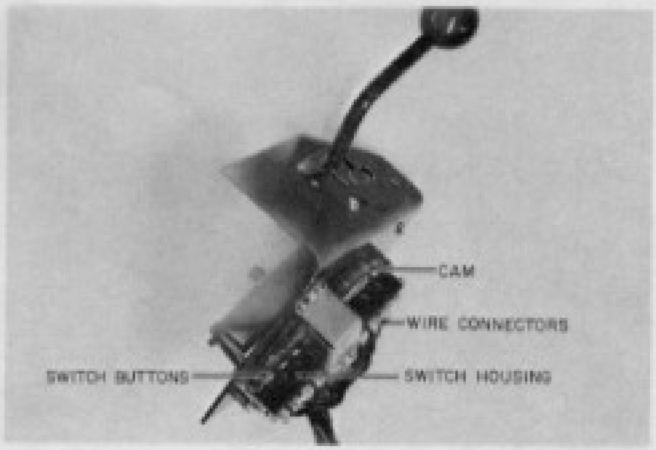
The E-12S Control is like the E-15 except the E-12S does not have a field weakening relay (FW) or card #3.



Upper Control Panel E-12S
(Rear Side) Hood Open - Panel Down

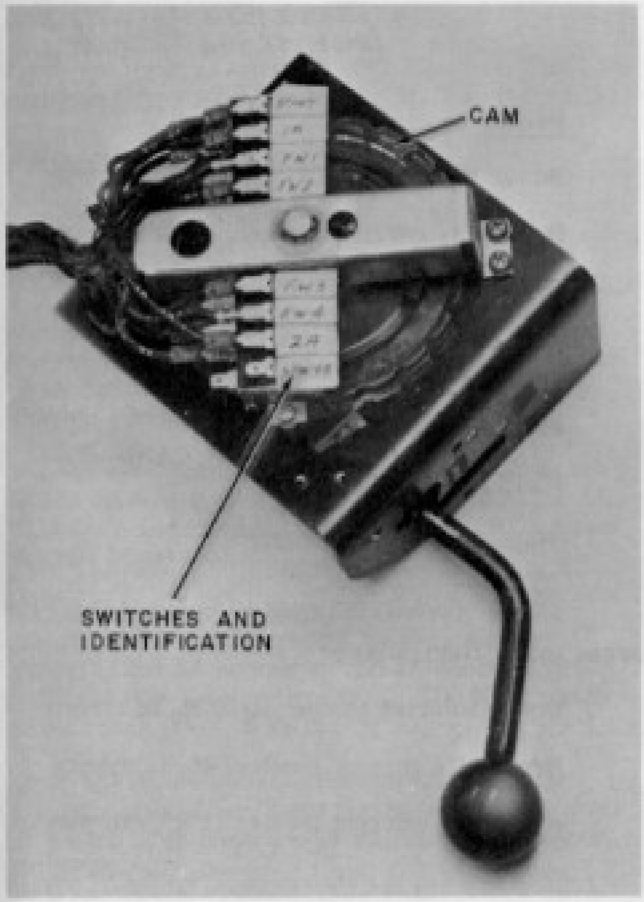


Dash and Lower Control Panel

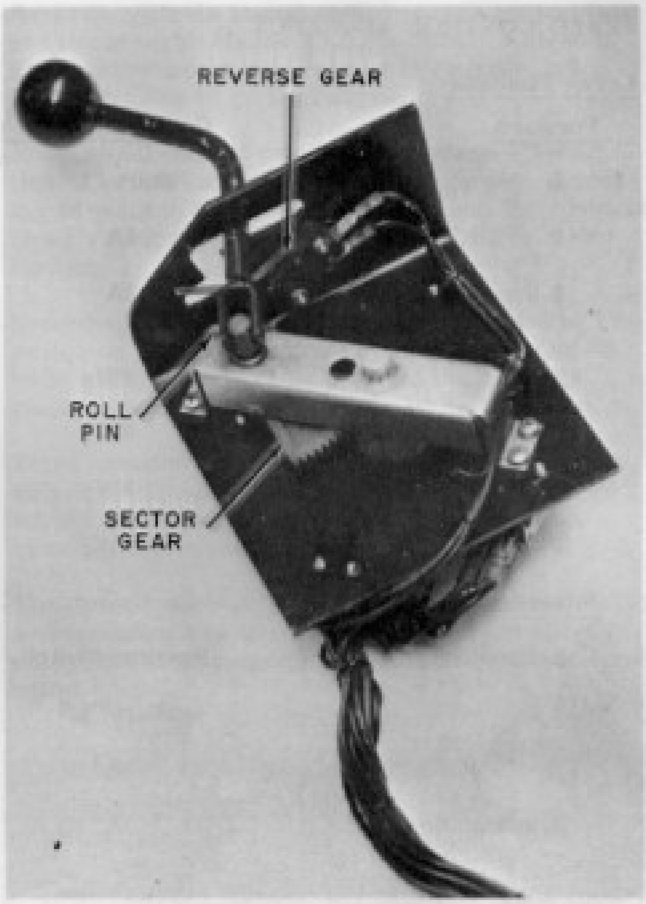


Speed Control

NOTE: THE SPEED CONTROL INITIATES ALL ELECTRICAL SPEED VARIATIONS, FORWARD AND REVERSE.

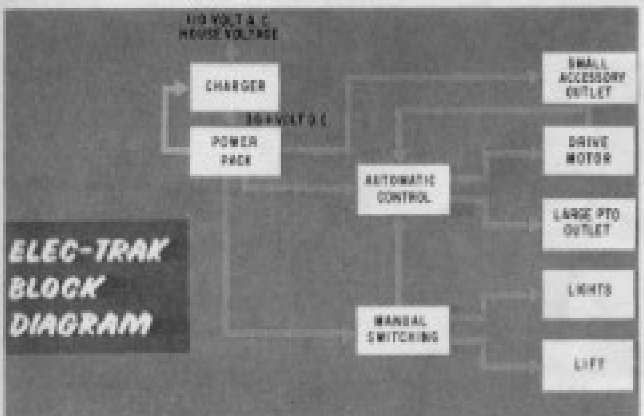


Speed Control (Side View)



Speed Control (Right Side)

1.21 ELECTRICAL OPERATION (Typical Large-Frame Tractor)



CONTROL SECTION COMPONENTS

		Speeds Forward	Speeds Reverse
- Speed Control	E-12	3	3
	E-15	7	3

- Contactors - L, 1A, 2A
- Relays - Field Weakening* (FW); Reverse (Rev)
- Circuit Cards #1 and #3*
- Current Limiters - R1 and R2

*Does not apply to E-12S

SPEED CONTROL SEQUENCE

Lever Position

Forward	Contactor/Switch	Results
1	Start "L"	Power to drive motor, R_1 & R_2 in circuit
2	1A	Bypass R_1 current limiter, R_2 in circuit
3 (maximum field - maximum torque)	2A	Bypass R_2 current limiter, FW* relay picks up, (FW contacts open)
4*	FW_1	Field Limiter 4 in field) ON CARD #3
5*	FW_2	Field Limiter 5 in field) ON CARD #3
6*	FW_3	Field Limiter 6 in field) ON CARD #3
7*	FW_4	Field Limiter 7 in field) ON CARD #3

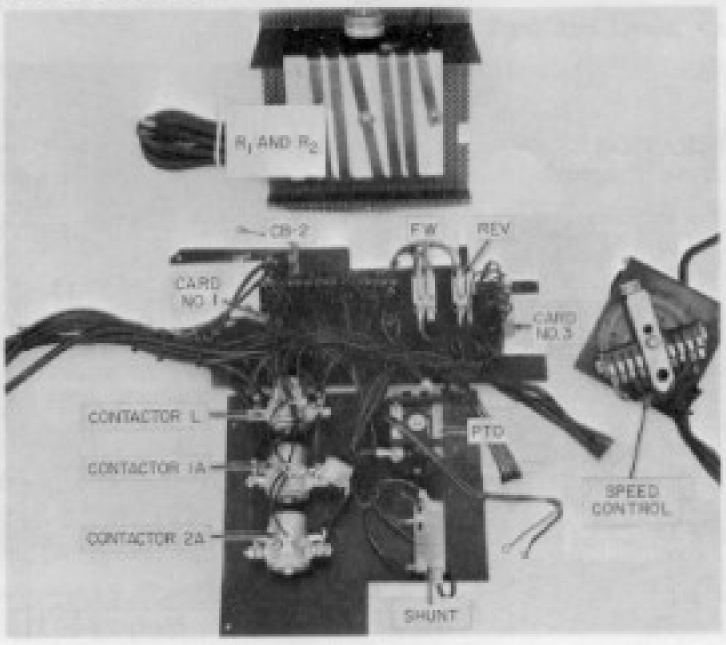
Reverse

Left-hand Neutral	Reverse Switch, reverses motor field polarity	
1	Start "L"	Power to drive motor, R_1 & R_2 in circuit
2	1A	Bypass R_1 current limiter, R_2 in circuit
3 (maximum field - maximum torque)	2A	Bypass R_2 current limiter (FW* will pick up)

*Does not apply to E-12S

E-15 CONTROLS WITH WIRING

- P. T. O. Contactor is Energized When P. T. O. Switch Is Turned ON.
- Shunt is Required to Connect Power-Use Meter (Amp Meter)



1.22 DRIVE-MOTOR OPERATION (Large-Frame Tractors)

CONTROL OPERATION

Forward Speeds 1, 2 and 3

-Power disconnect engaged

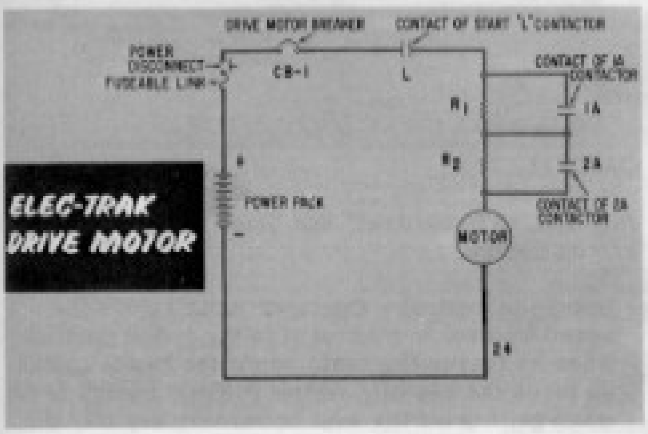
-Key on, on seat, and brake off

-First speed control position L (Start) switch on the speed control closes, supplying power to the L contactor coil and the L contacts close - the tractor starts, R1 and R2 in motor circuit.

-Second speed control position, 1A switch on the speed control closes, supplying power to the 1A contactor and the 1A contacts close - R1 current limiter bypassed.

-Third speed control position (Drive), the 2A switch on the speed control closes, supplying power to the 2A contactor and 2A contacts close - R2 current limiter bypassed. The field weakening relay (FW) picks up.

-Once any of the above contactors is energized, its contacts stay closed until the speed control lever is moved back toward neutral, removing power from its coil.



REVERSE OPERATION

-Move the speed control lever to left neutral. The reverse switch energizes the (REV) reverse relay.

-Reverse relay reverses the motor field polarity.

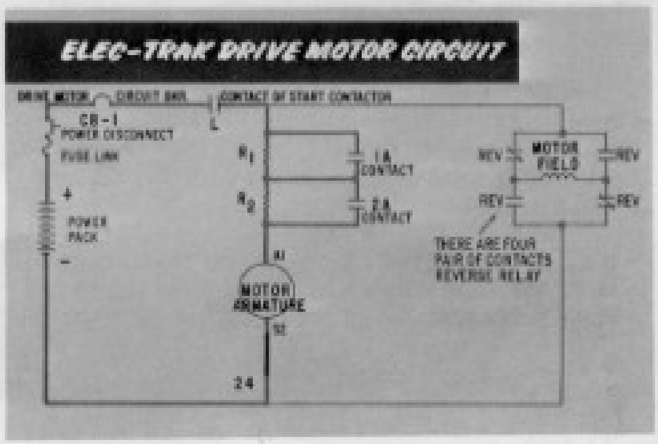
-Reverse contacts shown closed (≠) are opened (=), and the reverse contacts shown open are closed. The tractor motor now rotates in reverse, allowing the tractor to go backwards.

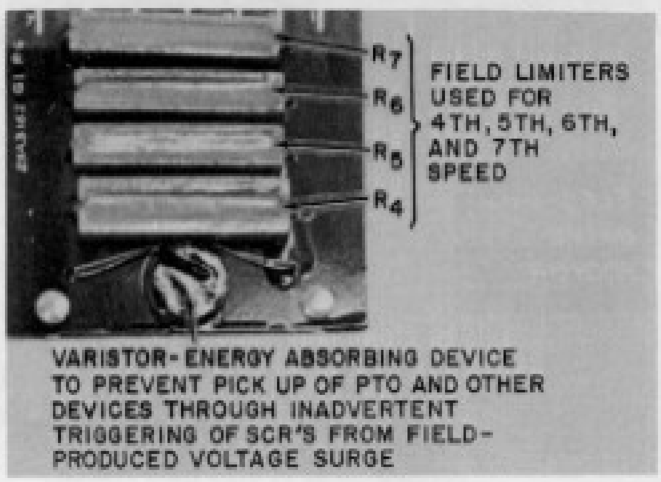
-First speed control position in reverse - the L (Start) switch on the speed control closes, supplying 36 volts to the L contactor coil and the contacts close - first reverse speed. R1 and R2 in motor circuit.

-Second speed control position in reverse - the 1A switch on the speed control closes, supplying 36 volts to the 1A contactor coil and the contacts close - second reverse speed. R1 is bypassed.

-Third speed control position in reverse - the 2A switch on the speed control closes, supplying 36 volts to the 2A contactor coil and the contacts close - third reverse speed. R2 is bypassed.

-The three speeds in reverse use the same switches and contactors as the first three forward speeds except the field polarity is reversed by the reverse relay.





TRACTOR SPEEDS

E-12S - Three Forward and three Reverse speeds, using L, 1A and 2A contactors and switches.

E-15 - Has seven Forward speeds
- First three use L, 1A and 2A
- Last four speeds - by adding current limiters in motor field - R4, R5, R6, and R7 on Card #3.

E-15 Forward Speeds 4, 5, 6, and 7

-The field weakening (FW) relay is energized in the 3rd speed control position, opening the FW contacts.

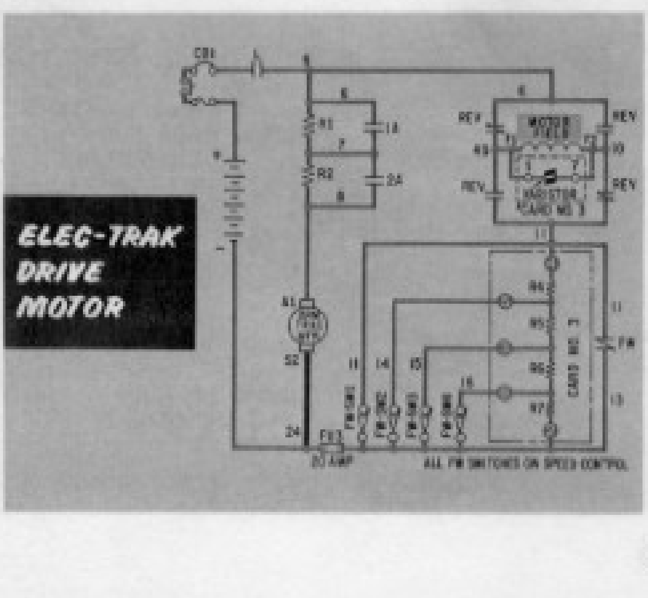
-Speed control in 4th position - the FW1 switch opens on the speed control, which puts current limiter R4 on card #3 in the drive motor field.

-Speed control in 5th position - the FW2 switch opens on the speed control, which puts current limiter R5 in series with R4 in the drive motor field.

-Speed control in 6th position - the FW3 switch opens on the speed control, which puts current limiter R6 on card #3 in series with R4 and R5.

-Speed control in 7th position - the FW4 switch opens on the speed control, which puts current limiter R7 on card #3 in series with R4, R5 and R6 in the motor field.

-Each time one of the above current limiters is added, the field voltage is reduced and the motor speed increases.



ELEC-TRAK CONTROL

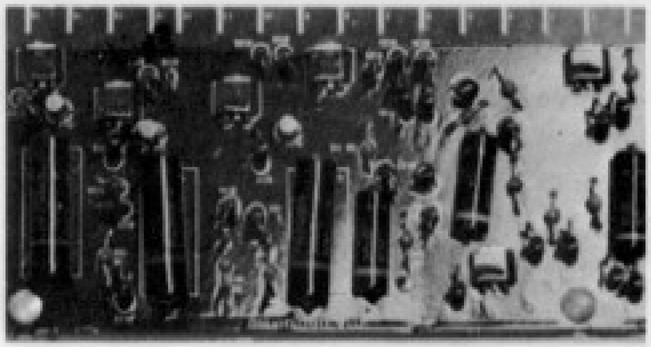
- The first three speeds forward and reverse use the same switches and contactors (L, 1A, 2A)

- When the speed control is moved to reverse, the reverse relay picks up and reverses the motor field polarity, causing the tractor to go backwards.

- The E-12S control only has L, 1A and 2A components, card No. 1 and reverse relay.

- The E-15 has same items as E-12S plus a field weakening relay, card No. 3 and corresponding switches.

- The current limiters on card No. 3 (R_4, R_5, R_6 and R_7), the field weakening relay (FW) and FW switches on speed control, directly control the 4th, 5th, 6th and 7th speeds on the E-15.



CARD #1

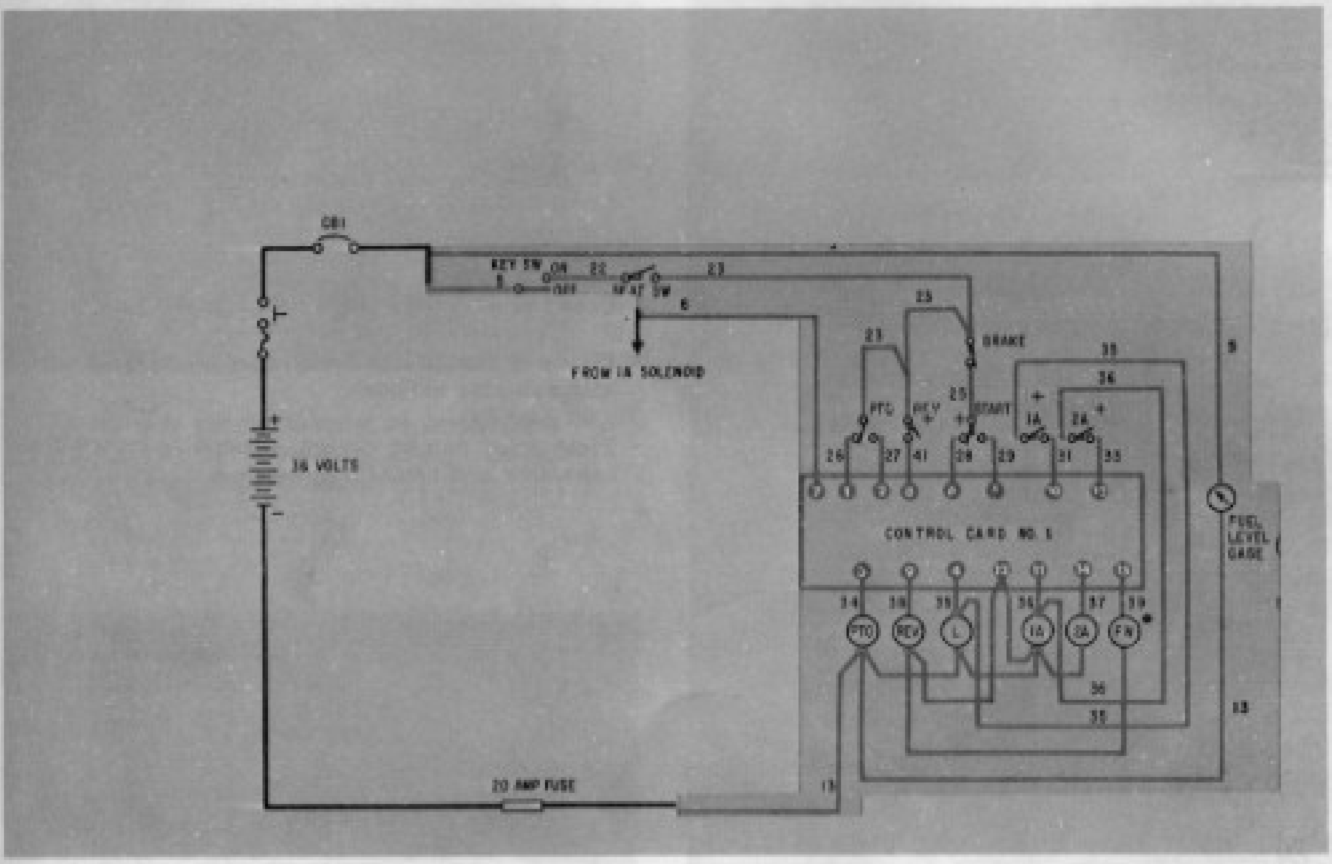
All "Return to Neutral" and Time Delay Circuits are on Card #1.

- Return to neutral - Operator must return the speed/control to neutral if in the speed position when he leaves the seat, opens the brake switch or turns the key off. If the P. T. O. switch is on when getting off the seat or turning key off, the P. T. O. switch must be turned "off" and back to the "On" position.

- After the 1A and 2A switches are closed, there is a time delay before the respective contactors are energized.

- The input for the P. T. O. and the L contactor coils goes through card No. 1 to supply the "return to neutral" function.

- The input for the 1A and 2A contactor coils control input goes through card No. 1 to supply the time delay for these contactors. The 1A contactor energizes about 1 second after the 1A switch is closed. The 2A contactor energizes about 1 second after the 2A switch is closed.
- The FW coil is automatically energized a moment after the 2A contactor is energized.
- The (REVERSE) coil input goes through card No. 1 to prevent rapid speed/control movement from forward to reverse. If the speed control is moved too fast from forward (above 3rd speed) to reverse, the reverse Relay coil (REV) and L contactor coil will not energize. The operator must return speed control lever to neutral and then to reverse to move the tractor backwards.



CARD #1

Return to Neutral and Time Delay

+ Switches on speed control
* Does not apply to E-12S

TWO BASIC CIRCUITS ON CARD #1

Return to Neutral

- Speed/Control
- P. T. O. Outlet

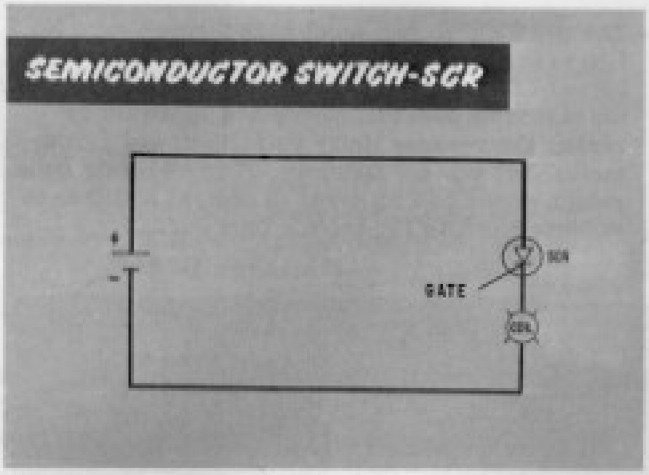
Time Delay

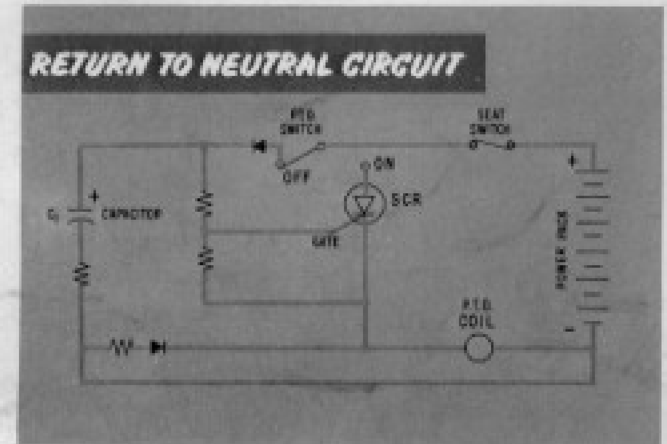
- 1A Contactor (1 second)
- 2A Contactor (1 second)

- Reverse Relay - if speed control is above third speed, (2A) and the speed/control is moved too fast into reverse, the reverse relay and L contactor will not pick up.

BASIC COMPONENT ON CARD #1

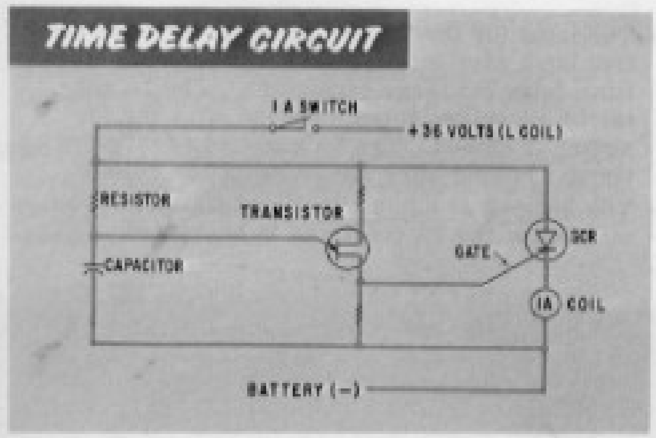
- The SCR will not conduct until the gate is pulsed with current.
- Once the coil current is interrupted, it will not conduct until gate is again pulsed.





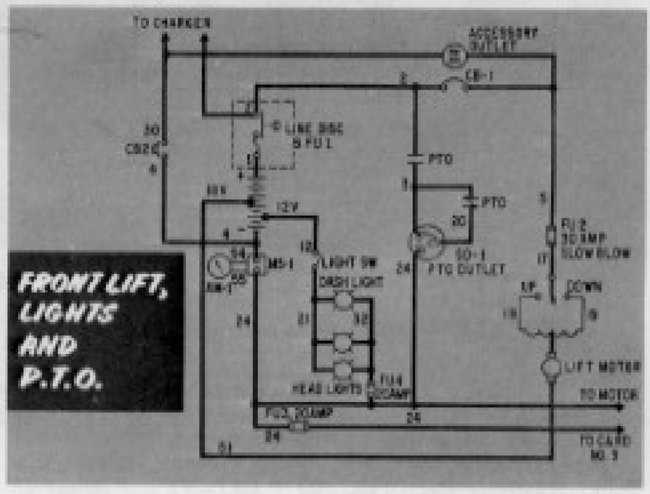
RETURN TO NEUTRAL CIRCUIT

- With the PTO switch off, capacitor C_1 is charged by the 36-volt power pack.
- When the PTO switch is on, the capacitor discharges through the resistors and fires the SCR gate.
- The SCR conducts and the PTO coil is energized.
- When the operator gets off the seat, the circuit is broken, and the PTO is de-energized.
- When the operator gets back on the seat, nothing happens until the PTO switch is turned to "Off" and back "ON".
- When the PTO switch is turned off, the capacitor charges. Turn on switch fires the gate - PTO coil energizes.
- Similar circuit is used for the speed/control return to neutral function.



TIME DELAY CIRCUIT

- Uses the SCR but delays firing of the gate.
- Firing of the gate is delayed by using transistor with resistor network.
- Time delay can be varied, depending on value of capacitor and resistor in series.

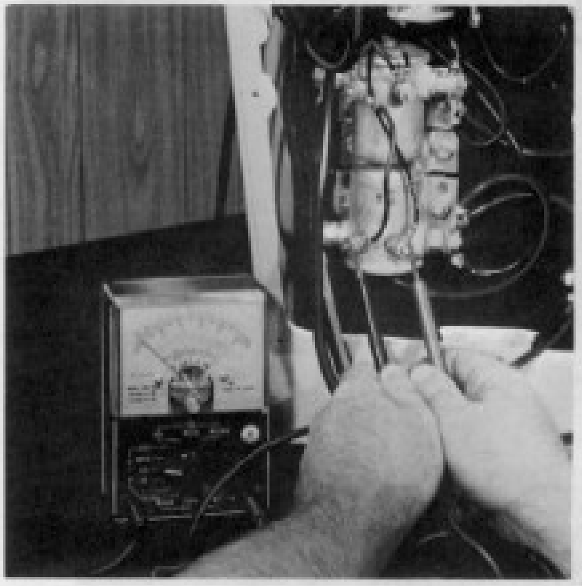


1.23 COMPONENT TESTING

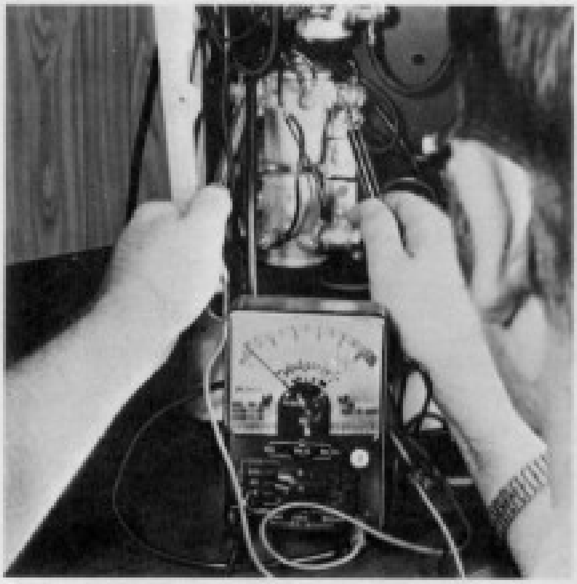
The following set of pictures and captions illustrates component troubleshooting using a multi-tester (VOM) on an E12 tractor, and should be used as a guide for troubleshooting all similar components on all model ELEC-TRAK tractors.

RELAY AND CONTACTOR TROUBLESHOOTING

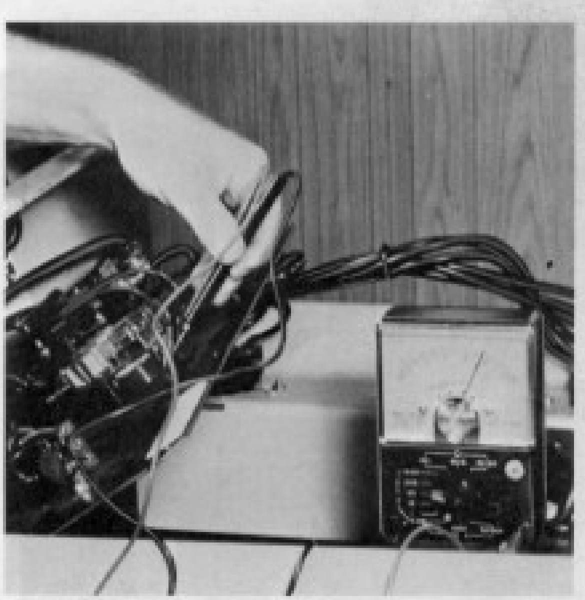
1. Multitester reads 36-volts at small studs (coils) of 1F contactor when speed control is pushed forward.



2. Multitester reads 0-volts at small studs (coil) of 2R contactor when speed control is pushed forward. 2R coil energizes only in reverse.

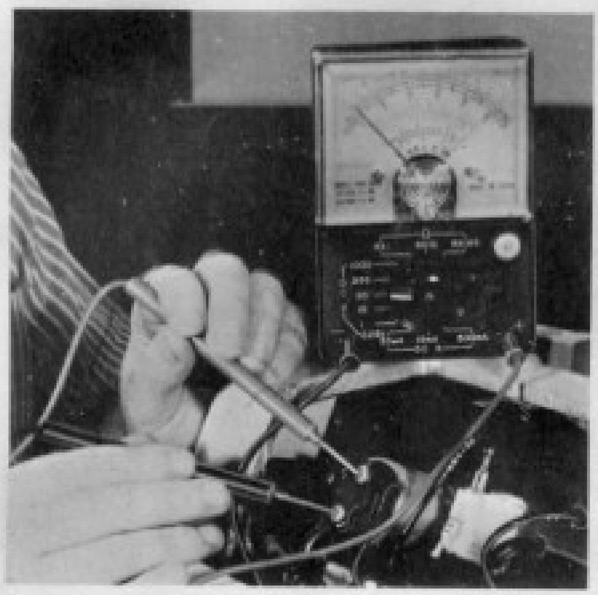


3. Multitester reads 0-volts at large studs (contacts) of 1F contactor when speed control is pushed forward. 0-volts indicates contacts of 1F contactor are closed. 36-volts in the same position indicates contacts open.



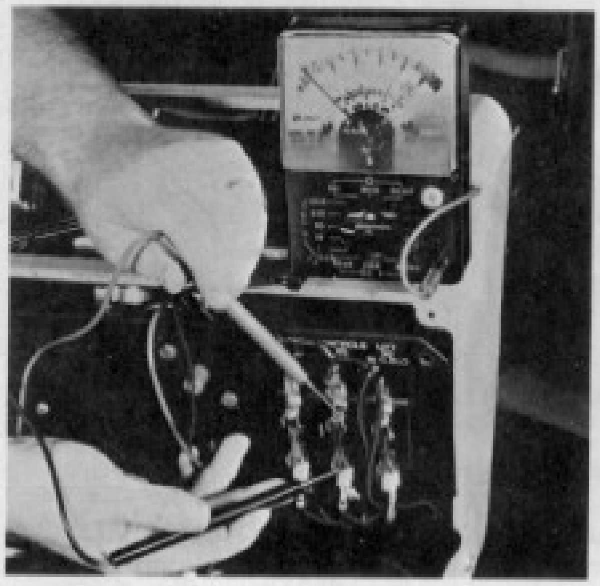
4. Multitester reads 36-volts on front terminals of the relay coil as soon as relay is energized.

SWITCHES, CIRCUIT BREAKERS AND FUSE TROUBLESHOOTING



5. Multitester reads 0-volts across key switch terminals when key switch is closed and tractor is in normal operating condition.

6. Multitester reads 36-volts across key switch terminals when key switch is open and tractor is in normal operating condition.



7. Multitester reads 0-volts across fuse holder when fuse is good and in the holder.

8. Multitester reads 36-volts across fuse holder when fuse is not in holder or bad.

9. Multitester reads 0-volts across power disconnect terminals when power disconnect is engaged.

10. Multitester reads 36-volts across power disconnect terminals when power disconnect is out.

11. Multitester reads 36-volts across wires 16 and 41 to the reverse switch terminals when speed control is in a forward position (switch is open).

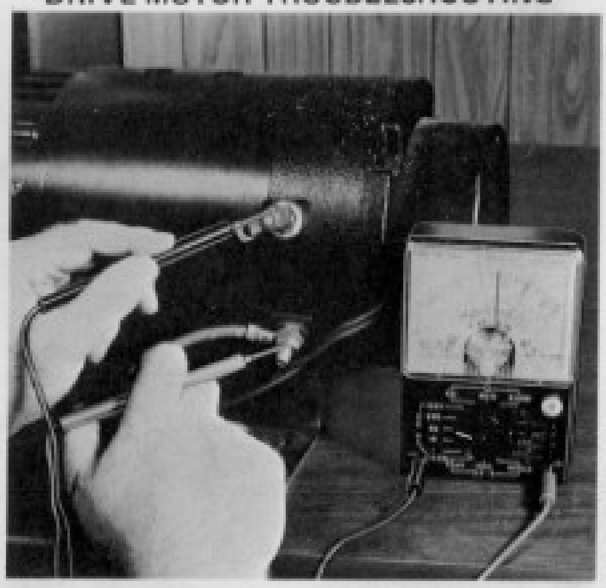
12. Multitester reads 0-volts across wires 16 and 41 to the reverse switch terminals when speed control is in the reverse position (switch is closed).

13. Multitester reads 36-volts across the 1A switch terminals when speed control is in neutral or the first speed (switch is open).

14. Multitester reads 0-volts across the 1A switch terminals when speed control is in the second speed or third speed (switch is closed).

15. Multitester reads 0-volts across CB2 circuit breaker terminals (breaker is closed) when tractor is operating. Multitester would read 36-volts across CB2 circuit breaker terminals if it needed to be reset (breaker is open). Open only while recharging or using accessory receptacle.

DRIVE MOTOR TROUBLESHOOTING

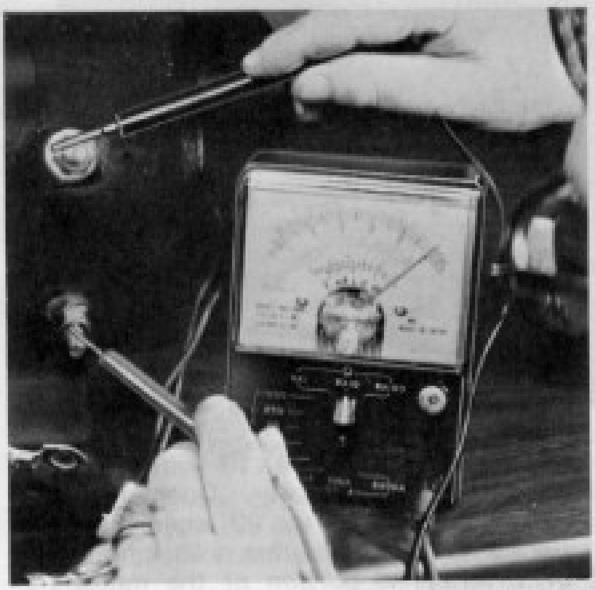


16. Multitester reads 28-volts across motor armature terminals in first speed.

17. Multitester reads 32-volts across motor armature terminals in second speed.

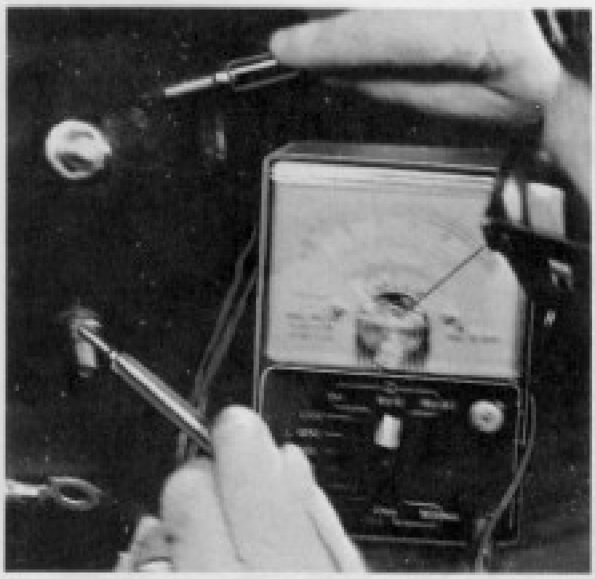
18. Multitester reads 36-volts across motor armature terminals in third speed.

19. Multitester reads 36-volts in first three speeds on wires 62 and 22 on Plug 3 connecting the motor field.

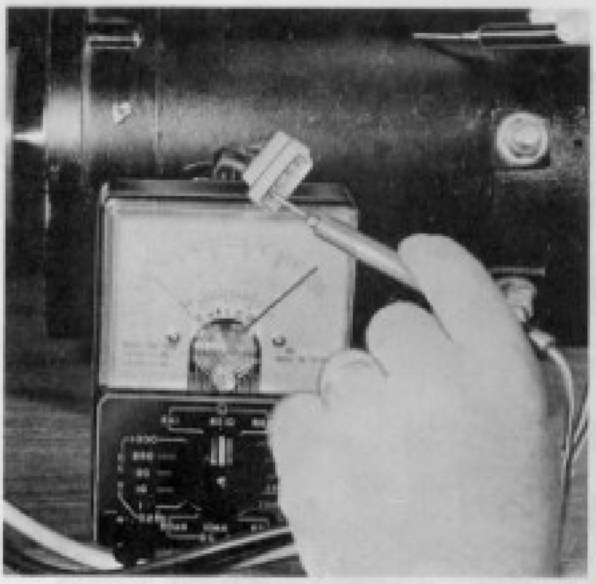


20. Multitester set on RX10 wires disconnected from motor. Full-scale deflection on multitester across motor armature terminal is normal.

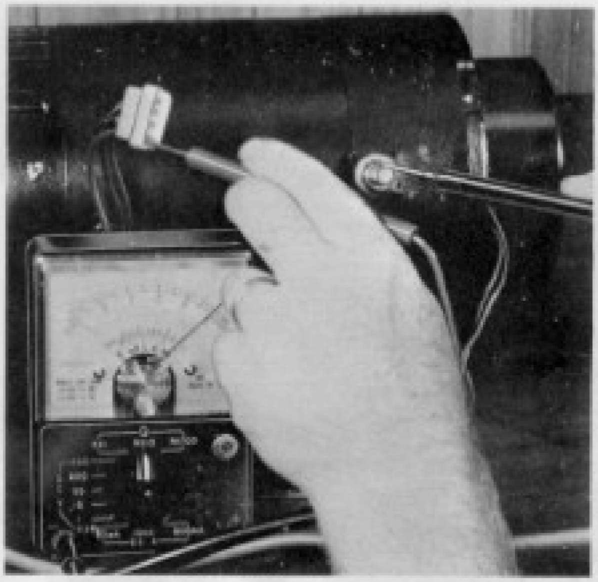
21. Multitester set on RX10 wires disconnected from motor. Approximately 16 ohms reading on multitester from wire 62 to wire 22 on plug 3 connecting the motor field is normal.



22. Multitester set on RX10 wires disconnected from motor. One probe placed on motor armature stud, the other probe placed on scratched portion of the motor case. Approximately ∞ ohms reading on the multitester is normal. More than 1/2-scale deflection indicates the motor armature shorted to the case. (Picture shows short.)



23. Multitester set on RX10 wires disconnected from motor. One probe placed on wires 62 or 22, connecting the motor field; the other probe placed on a scratched portion of the motor case. Approximately ∞ ohms reading on the multitester is normal. More than 1/2-scale deflection indicates the motor field is shorted to the motor case. (Picture shows short.)



24. Multitester set on RX10 wires disconnected from motor. One probe placed on wires 62 or 22 connecting the motor field. The other probe placed on the motor armature stud. Approximately ∞ ohms reading on the multitester is normal. More than 1/2-scale deflection indicates the motor armature is shorted to the motor field. (Picture shows short.)

1.24 TROUBLESHOOTING PROCEDURES

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 Troubleshooting 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" for the E15. The first step requires you 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 dc 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 dc 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.

Most electrical troubleshooting is done by tracing the circuitry on the troubleshooting sketch for the appropriate tractor model to find logical voltage and continuity check points,and the procedures given in the troubleshooting charts.

The troubleshooting sketch is a combination schematic drawing and wiring diagram. It shows not only the electric-electronic circuits of the tractor, 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 E15 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 plug 1 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 and thus may be a much lighter gage. The PTO and drive-motor armature circuits are drawn as heavy lines to represent high-current circuits.

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

Many of the tests to be performed and the steps to be taken must be carried out in the 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 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.

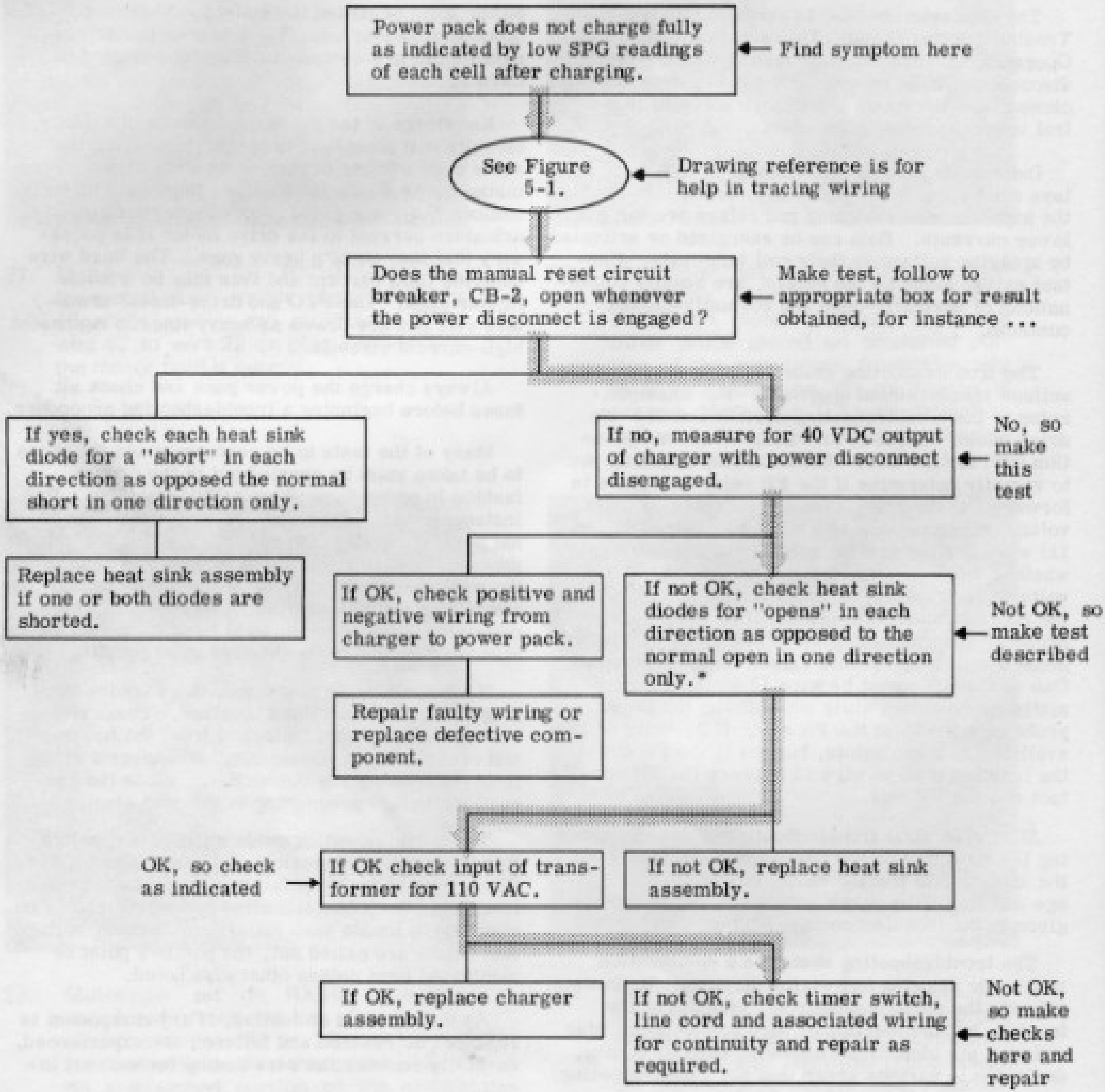
The troubleshooting guide utilizes test points that are readily accessible and easily identifiable. Therefore, if multiple failures occur in the same test area, the troubleshooting procedure should be repeated to locate each failure. Wherever voltage test points are called out, the positive point is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

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.

1.25 HOW TO USE THE TROUBLESHOOTING CHARTS

Locate the appropriate symptom in the box at the top of one of the charts. Follow the line from box to box as the test results obtained indicate. When you reach a dead-end box on the chart, make the repair indicated, or go to the next chart listed in the last box.



* 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.

Use instructions in the GENERAL INFORMATION and text for appropriate model to find specific assistance in making the required tests.

E8M, E8HM, AND E10M ELEC-TRAK TRACTORS

2.1 E8M/E10M THEORY OF OPERATION

A basic explanation of the E8M/E10M circuitry is usually helpful in making the detailed theory easier to understand. The block diagram in Fig. 2-1 is a simplified representation of the entire tractor circuitry. Notice how the function blocks are interconnected.

After the house voltage is fed into the charger, it is changed to an appropriate dc 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, a circuit breaker is also in this circuit, but for this explanation the receptacle is considered wired direct to the power pack.

Electrical accessories 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 clutch switch. All of these switches deliver commands to the drive motor or PTO operated equipment.

2

Successful troubleshooting of the ELEC-TRAK tractor requires an understanding of the electric circuits and mechanics involved in normal operation. Major areas that usually require instruction are: 1) start circuit, 2) PTO circuit, 3) charger. These three areas will be discussed individually, but with attention directed to the overall tractor response. The troubleshooting sketch should be closely followed during the explanation.

Start Circuit

The E8M/E10M start circuit is relatively simple compared to the E15 or E20 tractors. Refer to Fig. 2-4 and notice that with the seat switch closed and the key switch turned to "On", as soon as the

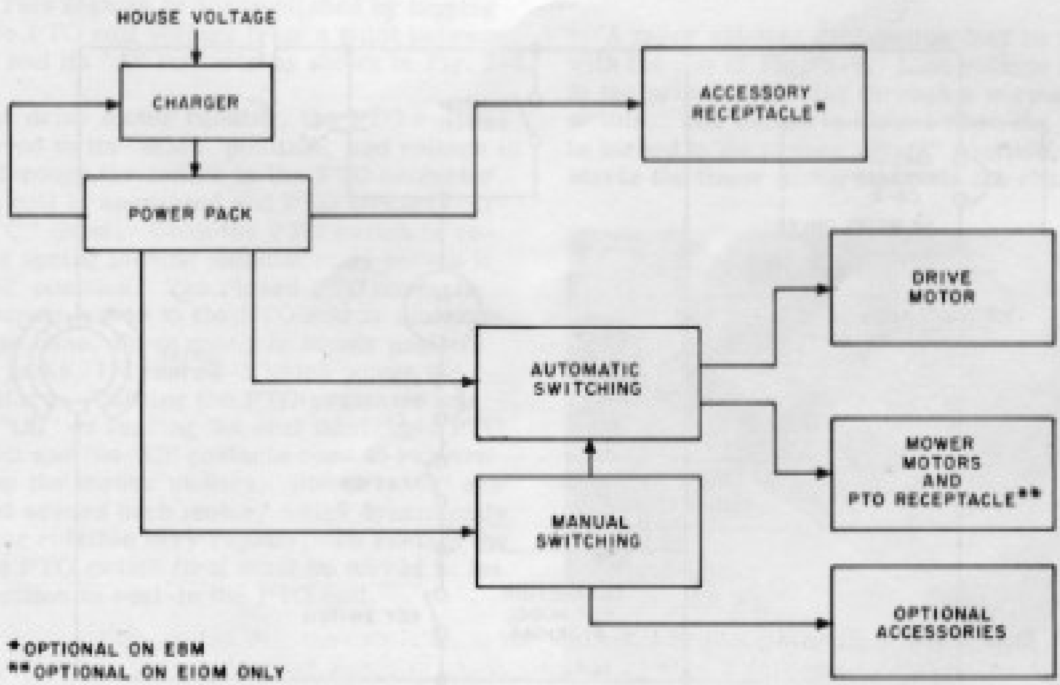


Fig. 2-1. E8M/E10M block diagram

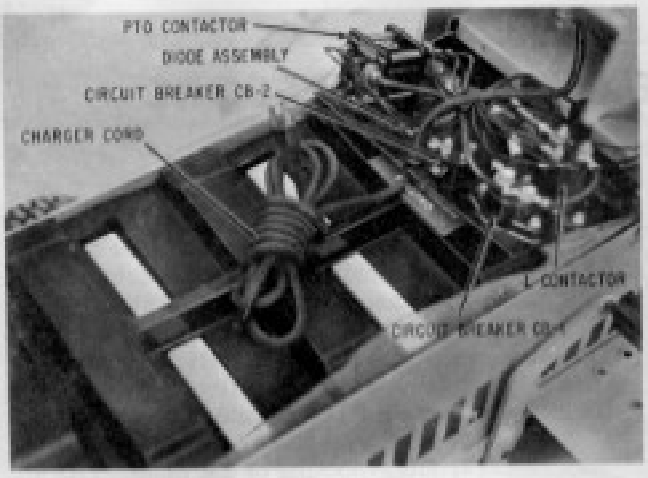


Fig. 2-2. Upper control panel

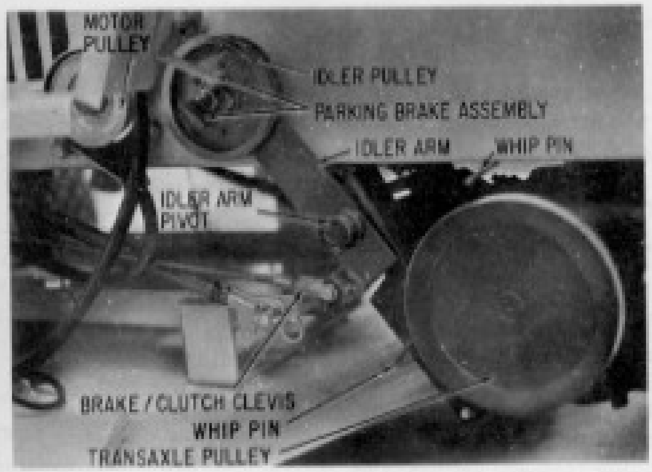


Fig. 2-3. Drive system

clutch switch is closed the L coil is energized. The clutch switch is physically mounted on the transaxle assembly and is actuated when the clutch/brake pedal is depressed.

When the L coil is energized, the two normally open contacts close. Contacts "A" bypass the clutch switch and "seal-in" the voltage to the L coil. The clutch/brake pedal can now be released, allowing the clutch switch to open, and the contactor remains energized. Contacts "B" are also closed. This allows power to reach the drive motor, which now runs. Notice that there is no field voltage required for motor operation, as there is for the larger units. The reason is that the motor is a permanent-magnet type, similar to the mower motors, so it needs only armature voltage for operation.

The L contactor coil voltage can be interrupted by turning the key switch to "Off" or by leaving the seat, which opens the seat switch. Either action shuts the drive motor off. The L contactor coil voltage is also interrupted by operation of CB-1, which is located in the drive motor to sense overload or overtemperature conditions.

Notice that the fuel level gage wiring has been changed after the 26AE10AA model so that it will indicate charging and the state of charge without turning the key on.

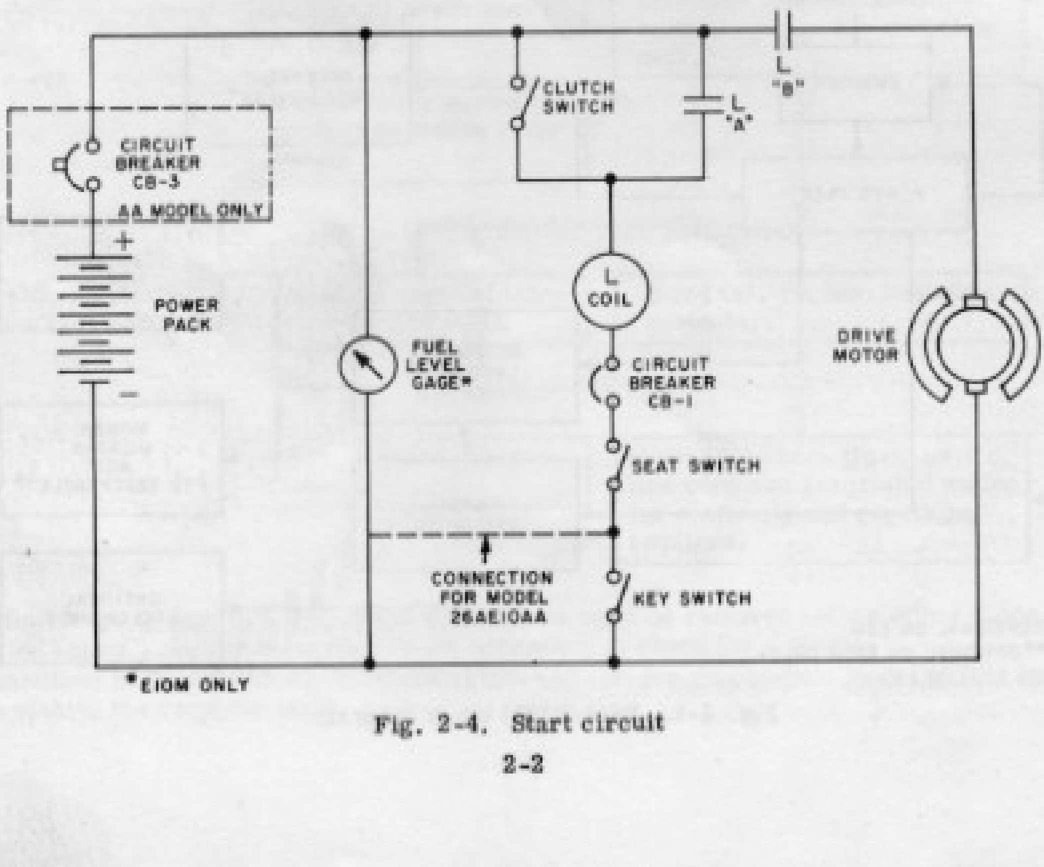


Fig. 2-4. Start circuit

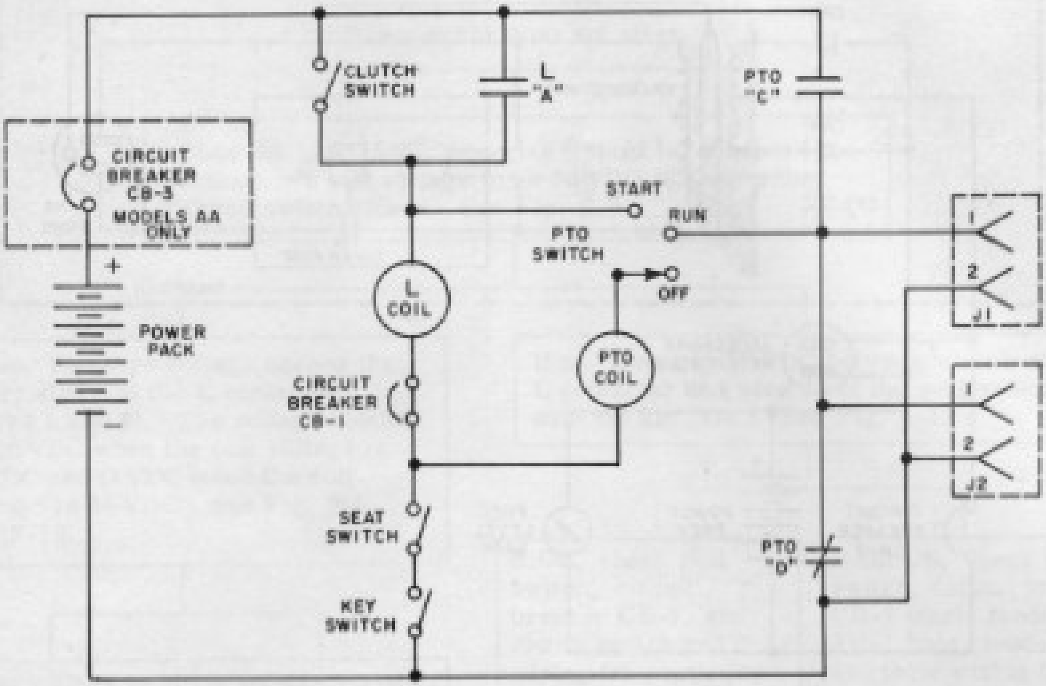


Fig. 2-5. PTO circuit

PTO Circuit

The PTO circuit requires that the L contactor be supplied voltage before its PTO contactor can be energized, so, in normal operation, the drive motor will be running before the mower motors can be started. This feature is accomplished by tapping off positive PTO coil voltage from a point between the L coil and its "A" contacts as shown in Fig. 2-5.

With the drive motor running, the PTO switch can be moved to its "Start" position, and voltage is available through the switch to the PTO contactor coil. The coil is energized and PTO contacts "D" open and "C" close. When the PTO switch is released, its spring loading automatically moves it to its "Run" position. The closed PTO contacts "C" now supply power to the PTO coil to seal it in. At the same time, these contacts supply positive voltage to jacks J1-1 and J2-1 which power the mower motors. Turning the PTO switch or key switch to "Off" or leaving the seat interrupts PTO coil current and the "C" contacts open to remove power from the mower motors. Contacts "D" are then closed across each motor, which dynamically brakes their rotation very rapidly. To restart the motor, the PTO switch first must be moved to the "Start" position to seal-in the PTO coil.

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 automatically adjusts the charging rate according to the state-of-charge of the power pack.

A more detailed explanation may be appropriate with the use of Fig. 2-7. Line voltage is applied to the primary winding through a normally open switch. The switch is closed when the timer knob is turned to its proper "Start" position, which starts the timer motor and puts the charger into

Fig. 2-6. Battery charger removal

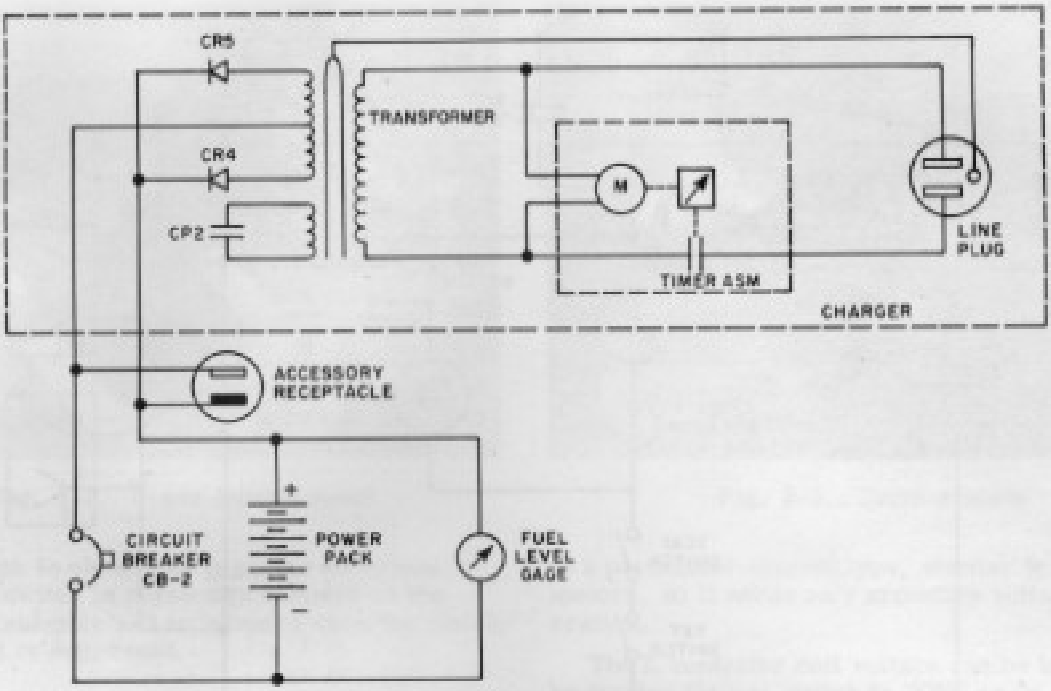


Fig. 2-7. Charger

operation. The timer motor drives a cam which causes the contacts to open when the proper amount of time has elapsed.

The secondary winding reduces the line voltage to a useable charging level which is then full-wave rectified by the action of diodes CR4 and CR5. The diodes accept the 60-Hertz sine wave as an input from the secondary winding, and output a pulsating positive dc voltage which charges the power packs. The third winding, in conjunction with capacitor CP2, increases the charging energy per cycle.

WARNING: SINCE THE E8M AND E10M TRACTORS ARE NOT EQUIPPED WITH A POWER DISCONNECT, THE BATTERY CLAMP TERMINATING WIRE NUMBER 2-01 MUST BE LIFTED FROM THE POSITIVE POST OF BATTERY B2 BEFORE PROCEEDING WITH SERVICING OF THE TRACTOR UNLESS VOLTAGE MEASUREMENTS MUST BE MADE. SEE FIG. 2-8.

CONTINUITY MEASUREMENTS: Remember, when making continuity measurements there must be no power in the circuit, and one end of the circuit under test must be disconnected if additional circuitry interferes with the test. The circuit under test has good continuity if the meter indicates zero ohms on a properly "zeroed" R x 10 setting.

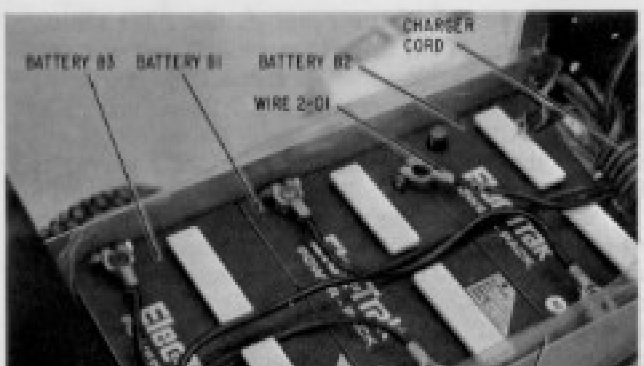
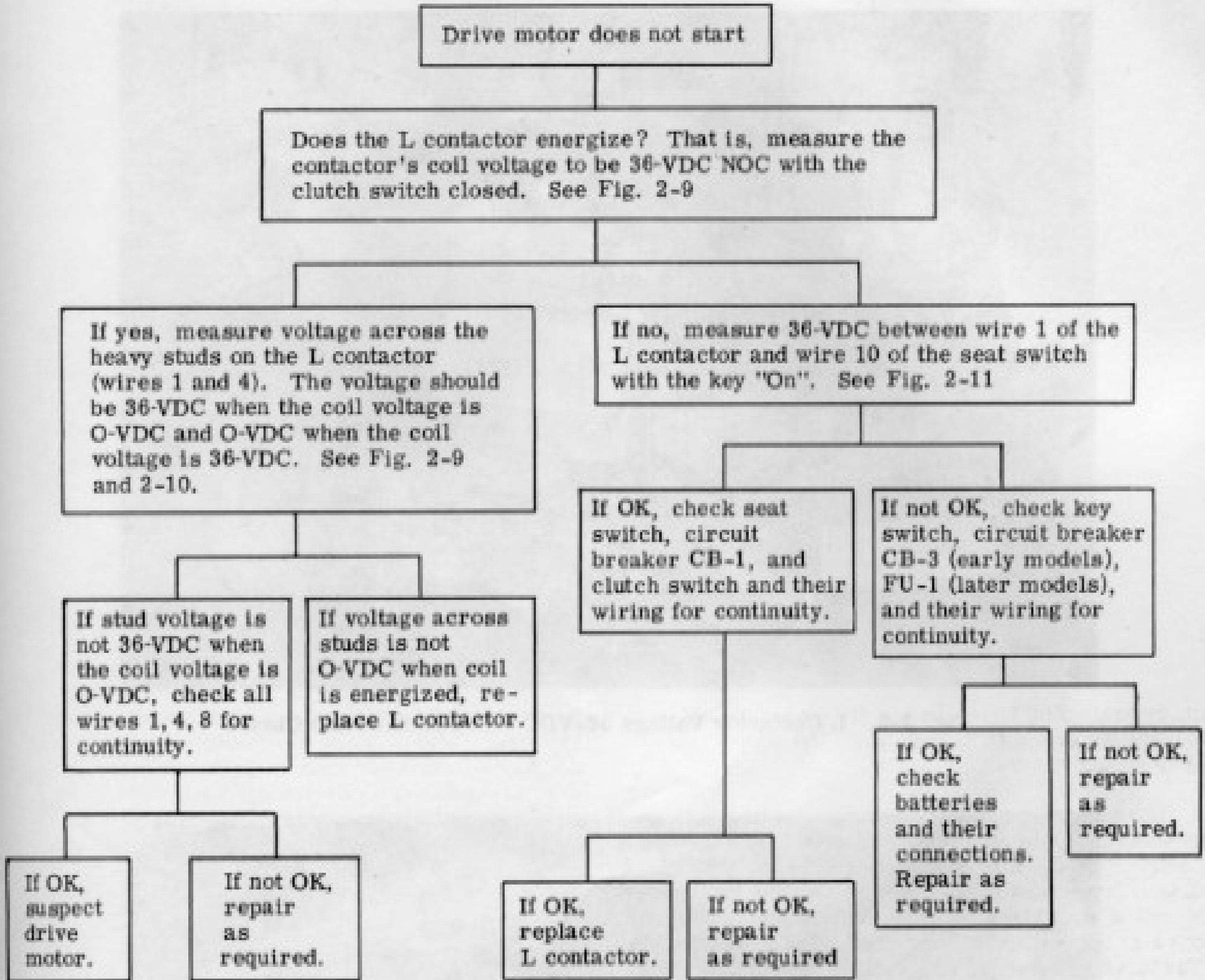


Fig. 2-8



WARNING: Remove battery cable from battery B2+ before attempting repair or replacement. See Fig. 2-8.

Fig. 2-9. L Contactor Voltage 36-VDC with Clutch Switch Closed

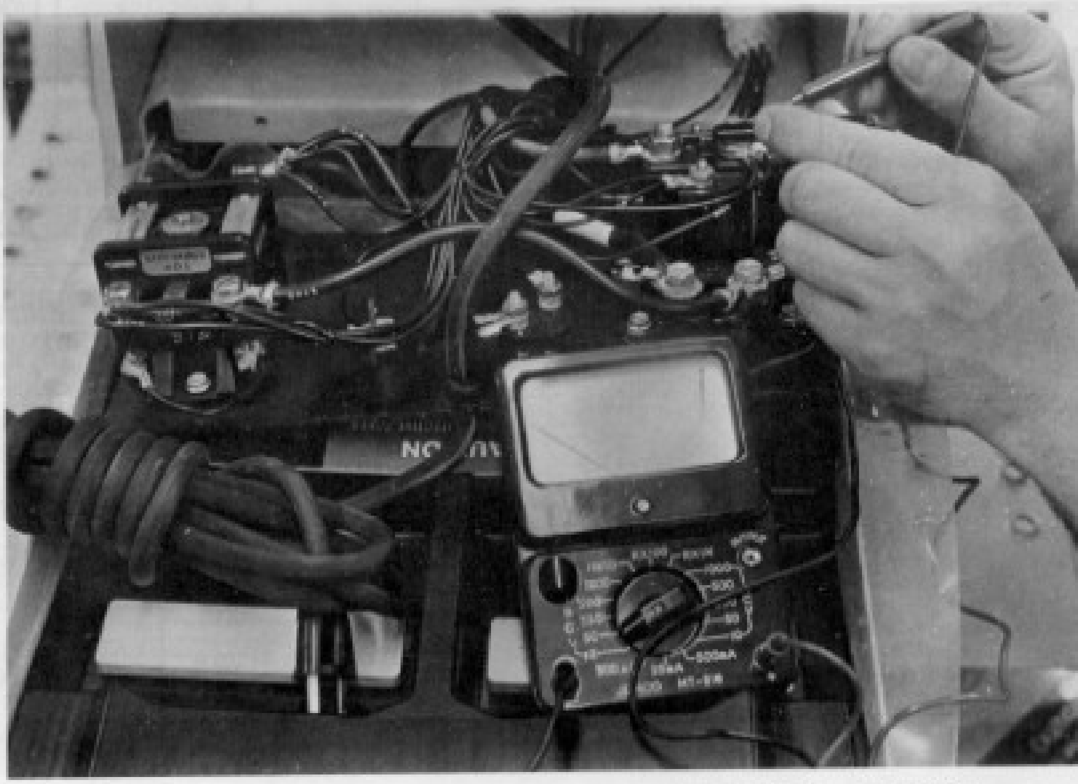


Fig. 2-10. L Contactor Voltage 0-VDC with Coil Voltage 36-VDC

Drive motor starts but shuts off when the clutch/brake pedal is released NOC.

Measure 36-VDC on the L contactor studs terminating wire 1 and 5 NOC but with the clutch/brake pedal released. See Fig. 2-12

If OK, measure O-VDC on L contactor studs terminating wires 1 and 5 NOC with the clutch/ brake pedal depressed. See Fig. 2-13

If not OK, check wires 1 and 5 to the L contactor studs for continuity. Repair as required.

If not OK, replace L Contactor.

WARNING: Remove battery cable from battery B2+ before attempting repair or replacement. See Fig. 2-8.

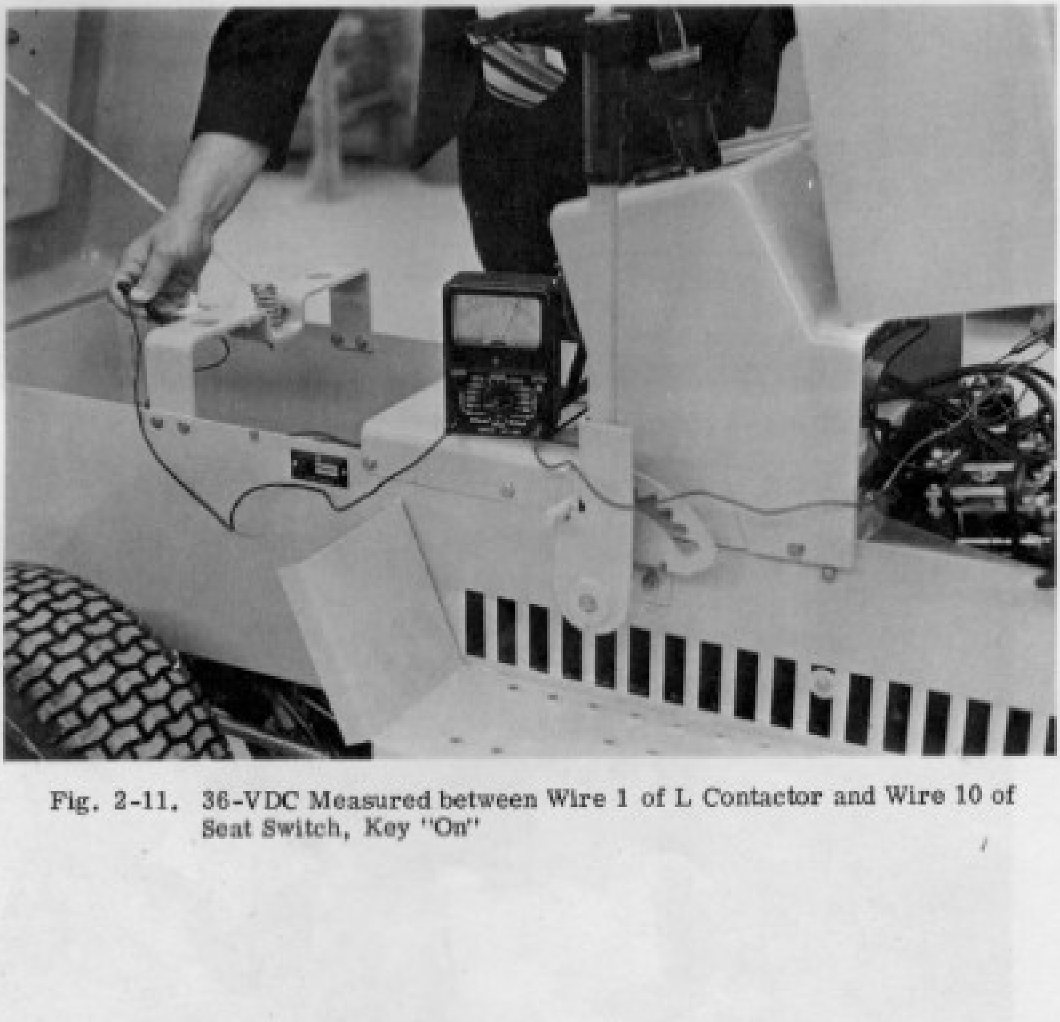


Fig. 2-11. 36-VDC Measured between Wire 1 of L Contactor and Wire 10 of Seat Switch, Key "On"

Fig. 2-12. L Contactor Voltage 36-VDC Across Studs 1 and 5, NOC, Clutch/Brake Pedal Released

Fig. 2-13. L Contactor Voltage 0-VDC Across Studs 1 and 5, NOC, Clutch/Brake Pedal Depressed

Drive motor does not shut off with key of by getting off seat.

When key switch or seat switch are opened while drive motor is running, does the L contactor coil voltage go to O-VDC? See Fig. 2-10.

If yes, replace L contactor

If no, suspect faulty switches or shorting around switches.

WARNING: Remove battery cable from battery B2+ before attempting repair or replacement. See Fig. 2-14.

Drive motor restarts NOC without depressing clutch/brake pedal.

Clutch switch shorted internally, held closed mechanically or has an external electrical short bypassing switch.

WARNING: Remove battery cable from battery B2+ before attempting repair or replacement. See Fig. 2-8.

- Mower motors do not start NOC when PTO switch is turned to "Start."
  - Does PTO contactor energize? That is, measure the PTO contactor's coil voltage to be 36-VDC NOC with the PTO switch held in the "Start" position. See Fig. 2-14
    - If OK, check voltage between J1-1 and J1-2 to be 36-VDC when the PTO contactor is energized. See Fig. 2-15.
      - If OK, check mower motor wiring and circuit breaker for continuity.
        - If OK, suspect a faulty mower motor.
        - If not OK, repair as required.
      - If not OK, check PTO "NO" contacts for proper closure when energized.
        - If OK, check wiring to PTO contactor contacts and J1-1, 2 J2-1, 2 for continuity. Repair as required.
        - If not OK, replace PTO contactor.
    - If not OK, check PTO switch in the "Start" position and its wiring and the wiring to the PTO coil for continuity.
      - If OK, replace PTO contactor.
      - If not OK, repair as required.

WARNING: Remove battery cable from battery B2+ before attempting repair or replacement. See Fig. 2-8.

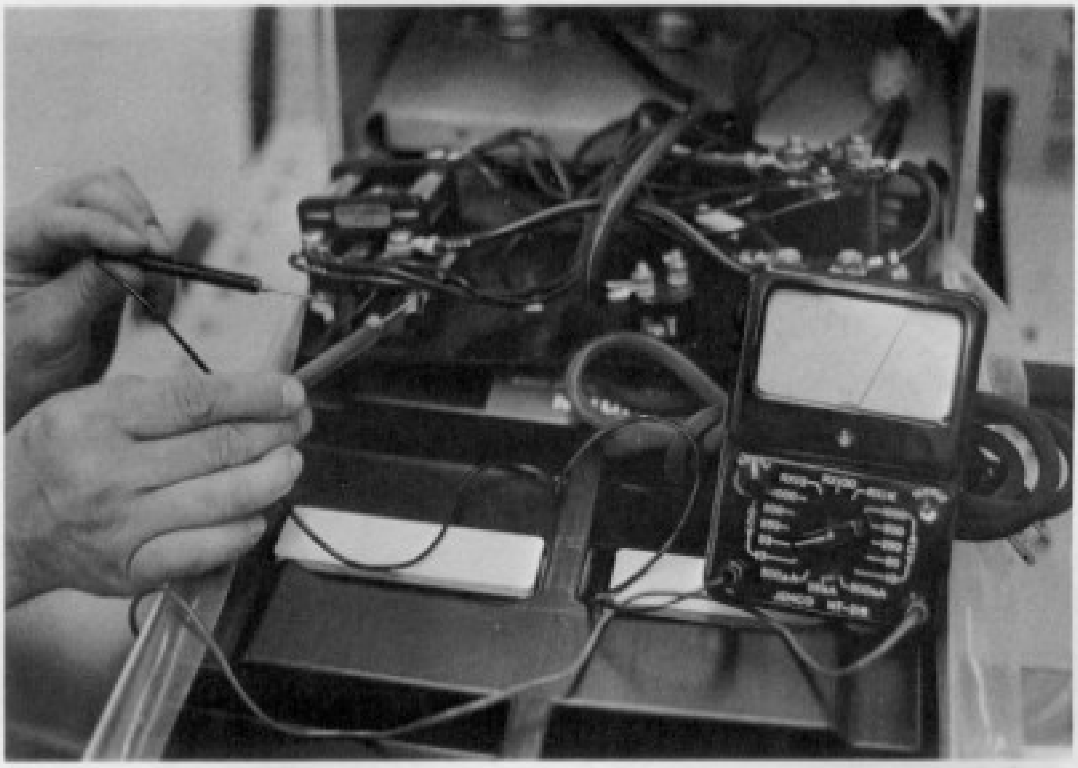
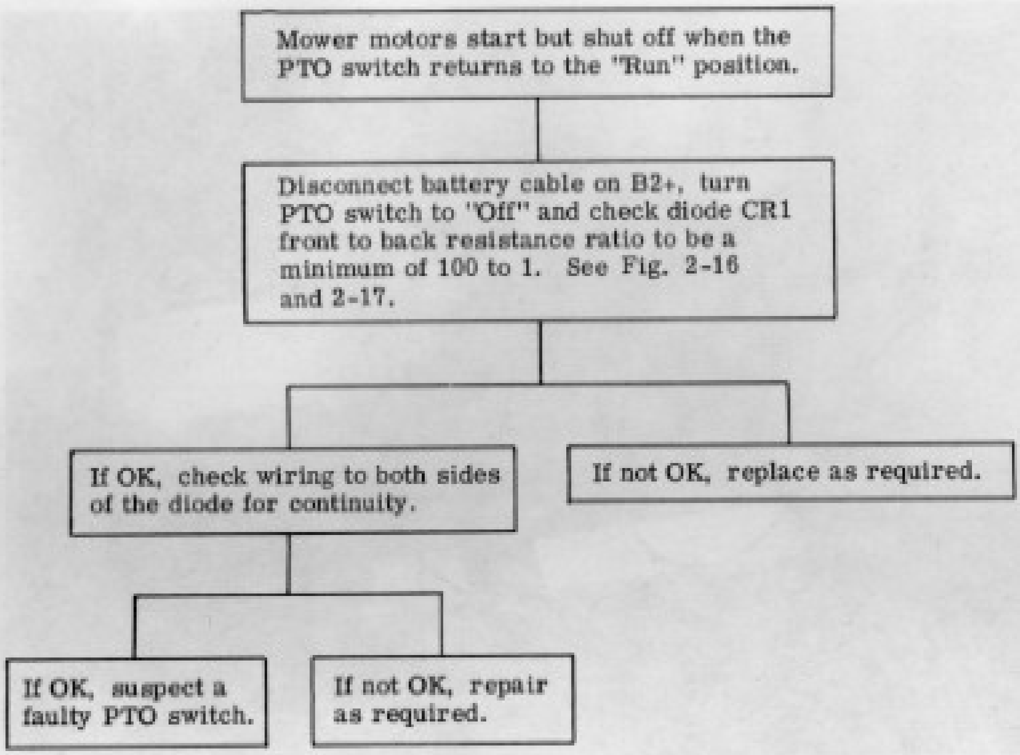


Fig. 2-14. PTO Contactor Coil Voltage 36-VDC, NOC, PTO Switch in "Start"

Fig. 2-15. Voltage between J1-1 and J1-2 is 36-VDC with PTO Contactor Energized



WARNING: Remove battery cable from battery B2+ before attempting repair or replacement. See Fig. 2-8.

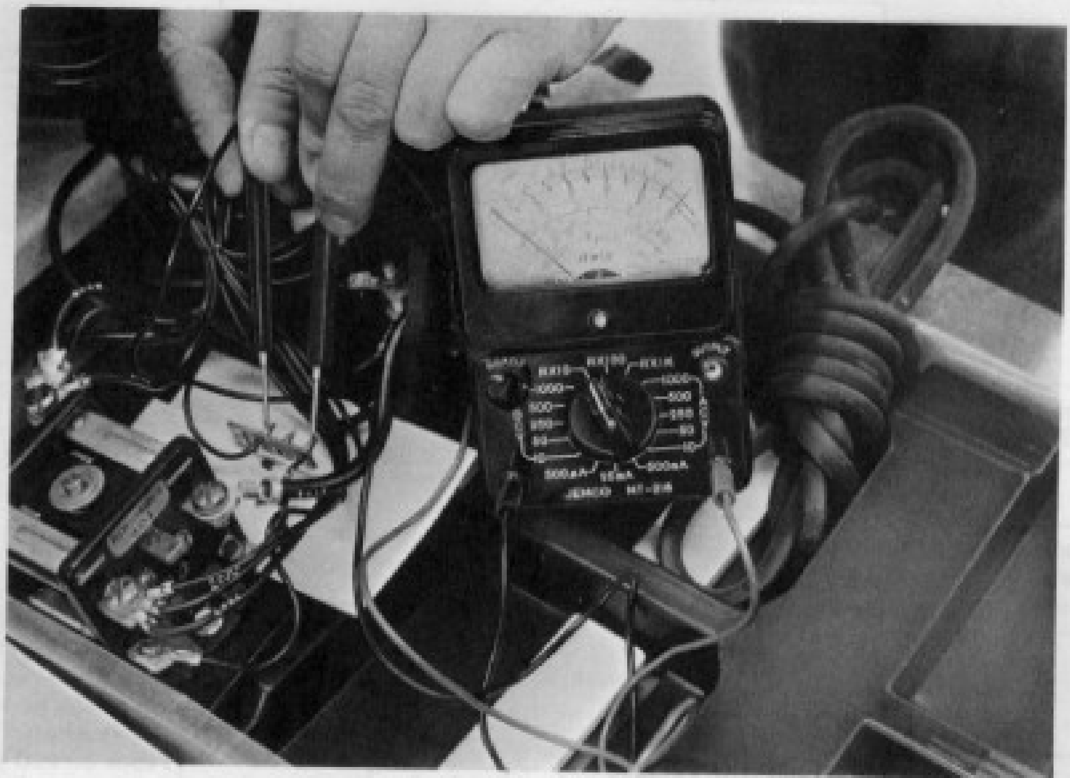


Fig. 2-16. CR1 Front-to-back Resistance Measurement

Fig. 2-17. CR1 Front-to-back Resistance Measurement

Power pack does not charge fully as indicated by the SPG of each cell.

Does the manual reset circuit breaker CB-2 trip (button pop out) as soon as button is pushed in?

If yes, remove the charger as shown in Fig. 2-18 and 2-19. Then continue.

With all power removed, check the charger heat sink diode's front-to-back resistance ratio to be a minimum of 100:1. See Fig. 2-19 and 2-20.

If OK, check for shorting of wires 1-04 and 30 out of the charger.

If OK, replace charger assembly.

If not OK, repair as required.

If not OK, replace heat sink assembly. Solder wires with a low wattage soldering iron.

If no, measure for 40-VDC output of charger to the free battery cable number 2 and battery cable number 8. See Fig. 2-21

If OK, check positive and negative wiring from charger to power pack for continuity.

Repair as required.

If not OK, during charging with the batteries connected, measure the voltage drop across the terminals of the manual reset circuit breaker CB-2 to be O-VDC.

If not OK, replace circuit breaker CB-2.

If OK, check heat sink diodes for "opens." Note at least one diode lead must be removed before the front-to-back resistance ratio can be measured. If either diode measures more than 1000 ohms in each direction, that diode is open.

If not OK, replace heat sink assembly.

If OK, check input to transformer for 115-V a-c. Measure between P4-1 and P4-8 and P4-2 and P4-7.

If OK, replace charger assembly.

If not OK, check timer switch, line cord and associated wiring.

WARNING: Remove battery cable from B2+ before attempting repair or replacement. See Fig. 2-8.

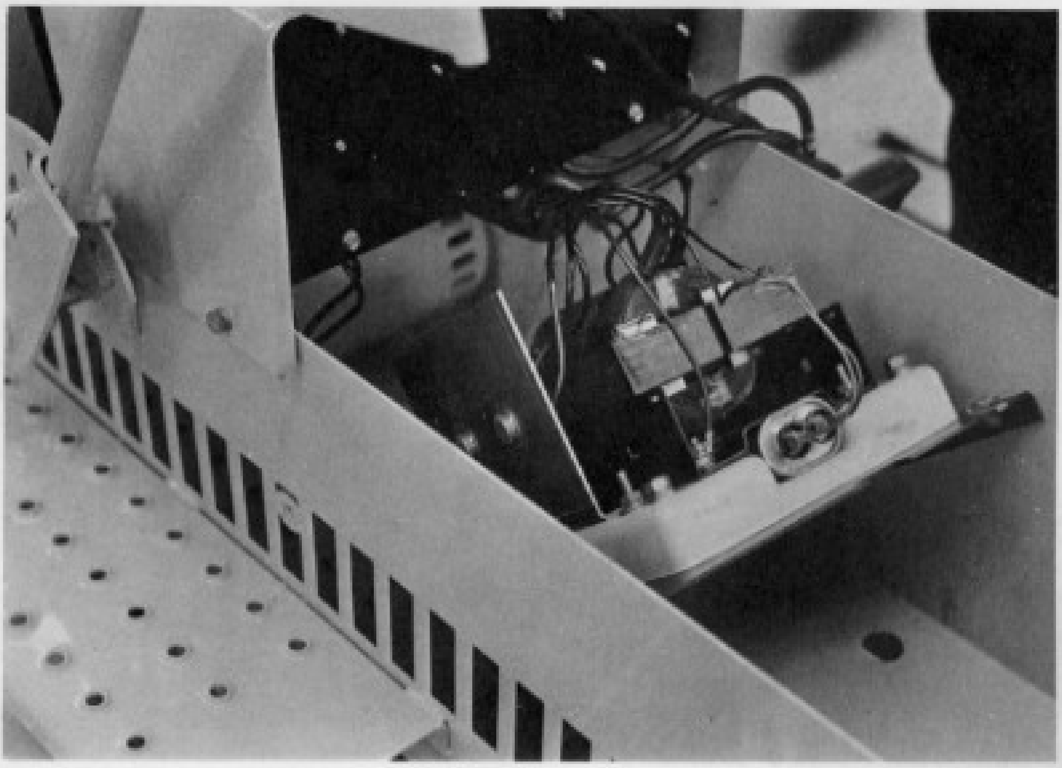


Fig. 2-18. Charger Removal

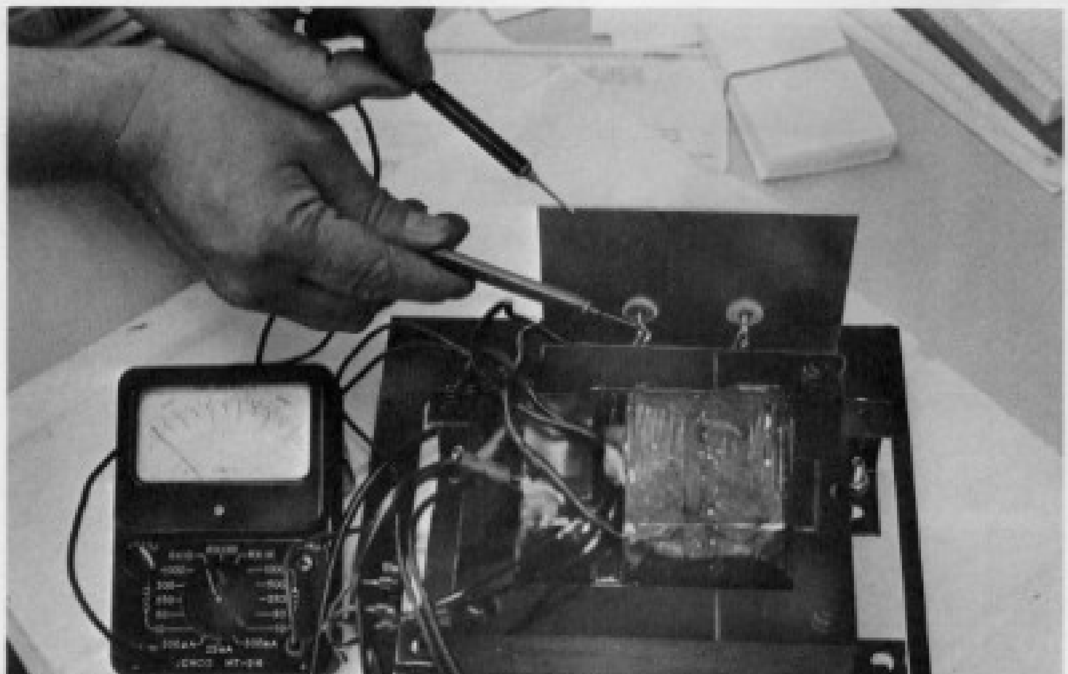


Fig. 2-19. Charger Heat Sink Diode Resistance Measurement

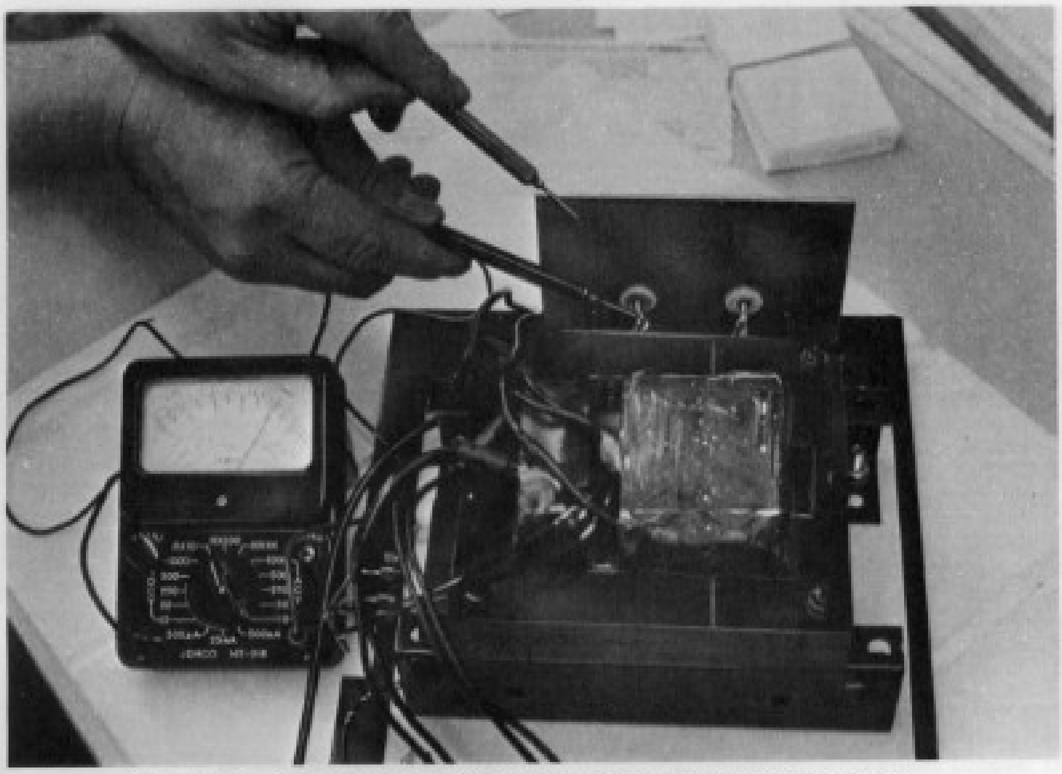


Fig. 2-20. Charger Heat Sink Diode Resistance Measurement

Fig. 2-21. Charger Output 40-VDC at Battery Cables 2 and 8

Charger does not shut off.

Does timer knob turn after starting the charger?

If yes, replace timer motor on timer assembly.

If no, check timer motor input (not timer switch) for 115 V a-c.

If OK, replace timer assembly.

If not OK, check timer motor wiring and repair as required.

WARNING: Remove battery cable from B2+ before attempting repair or replacement. See Fig. 2-8.

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 troubleshooting section which reads "Power Pack does not charge fully."

If yes, check for a defective battery as outlined in section 1.10 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.

WARNING: Remove battery cable from B2+ before attempting repair or replacement. See Fig. 2-8.

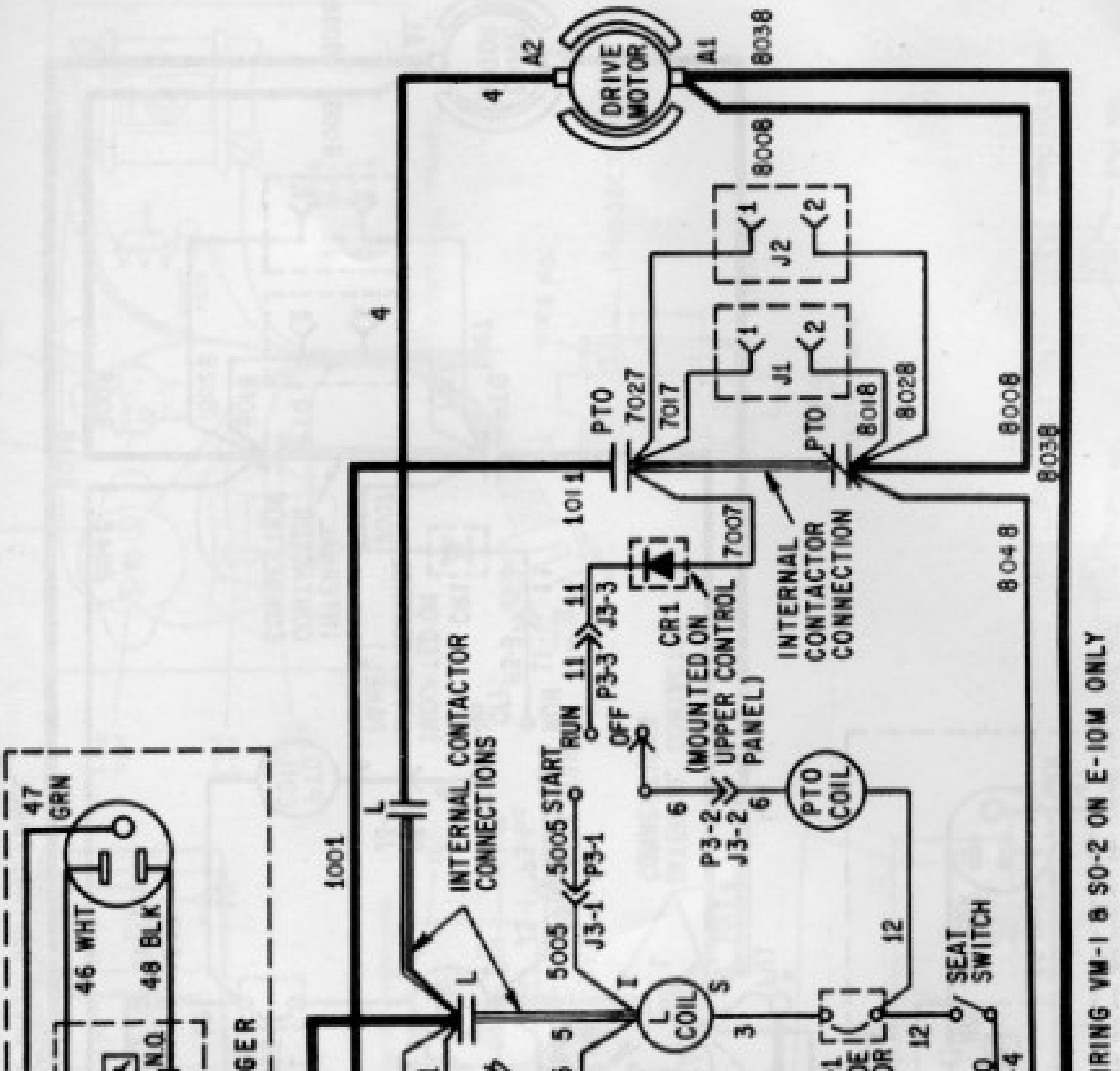


Fig. 2-22 E8M/E10M Troubleshooting Sketch (AA Models)

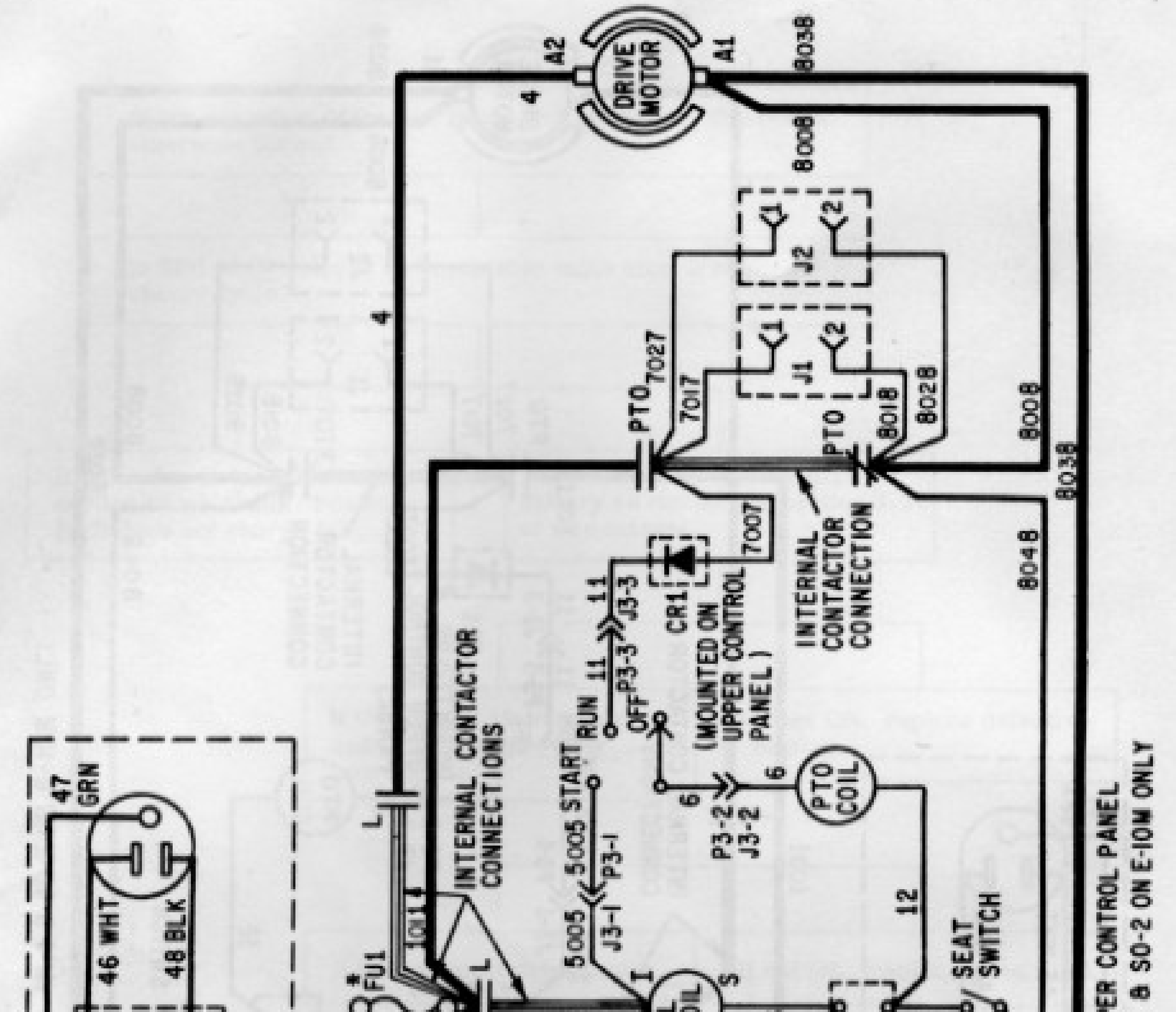


Fig. 2-23 E8M/E10M Troubleshooting Sketch (BA Models)

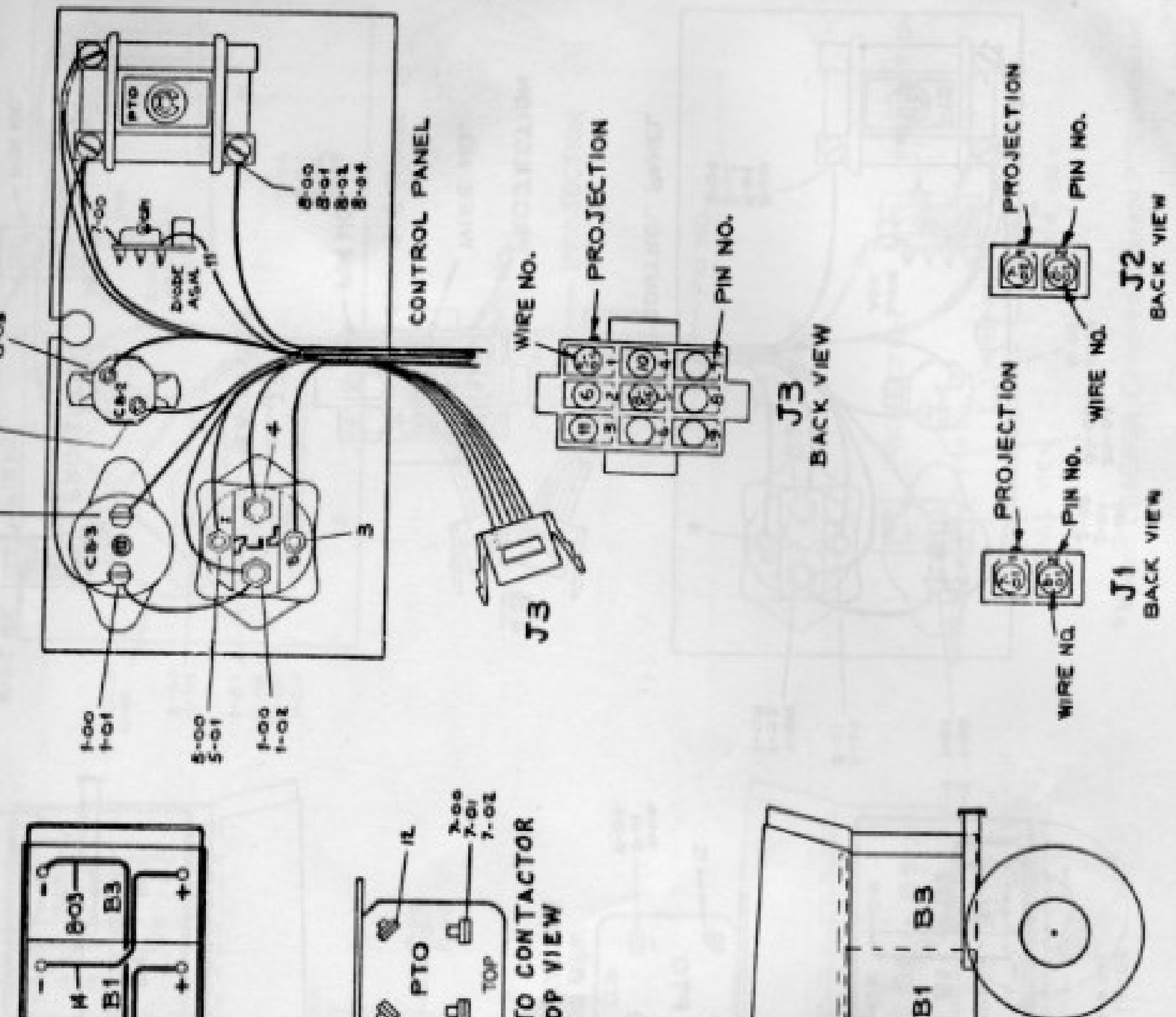


Fig. 2-24 26AE8A Tractor, Power Pack and Control Panel Wiring and Layout

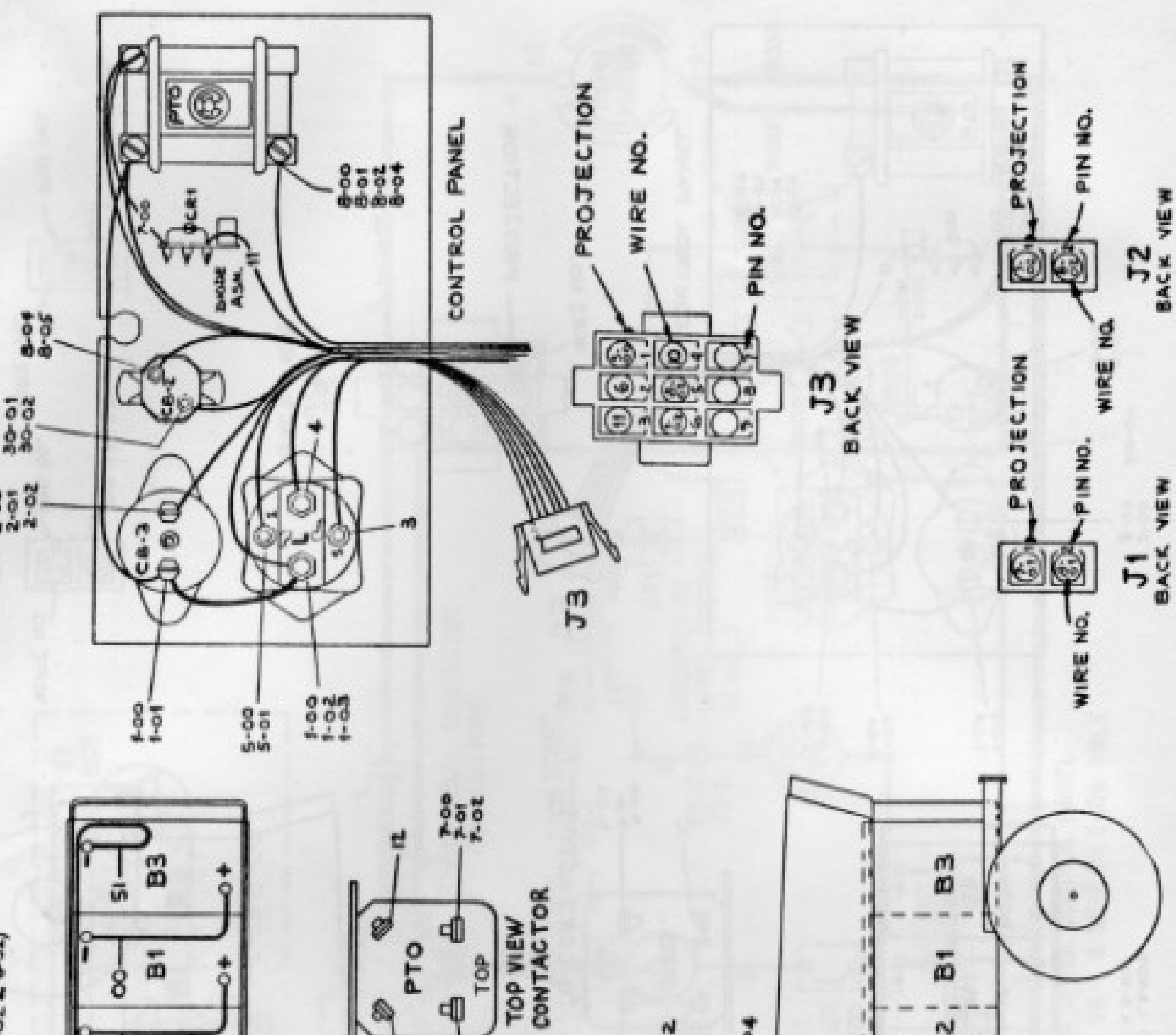


Fig. 2-25 26AE10A Tractor, Power Pack and Control Panel Wiring and Layout

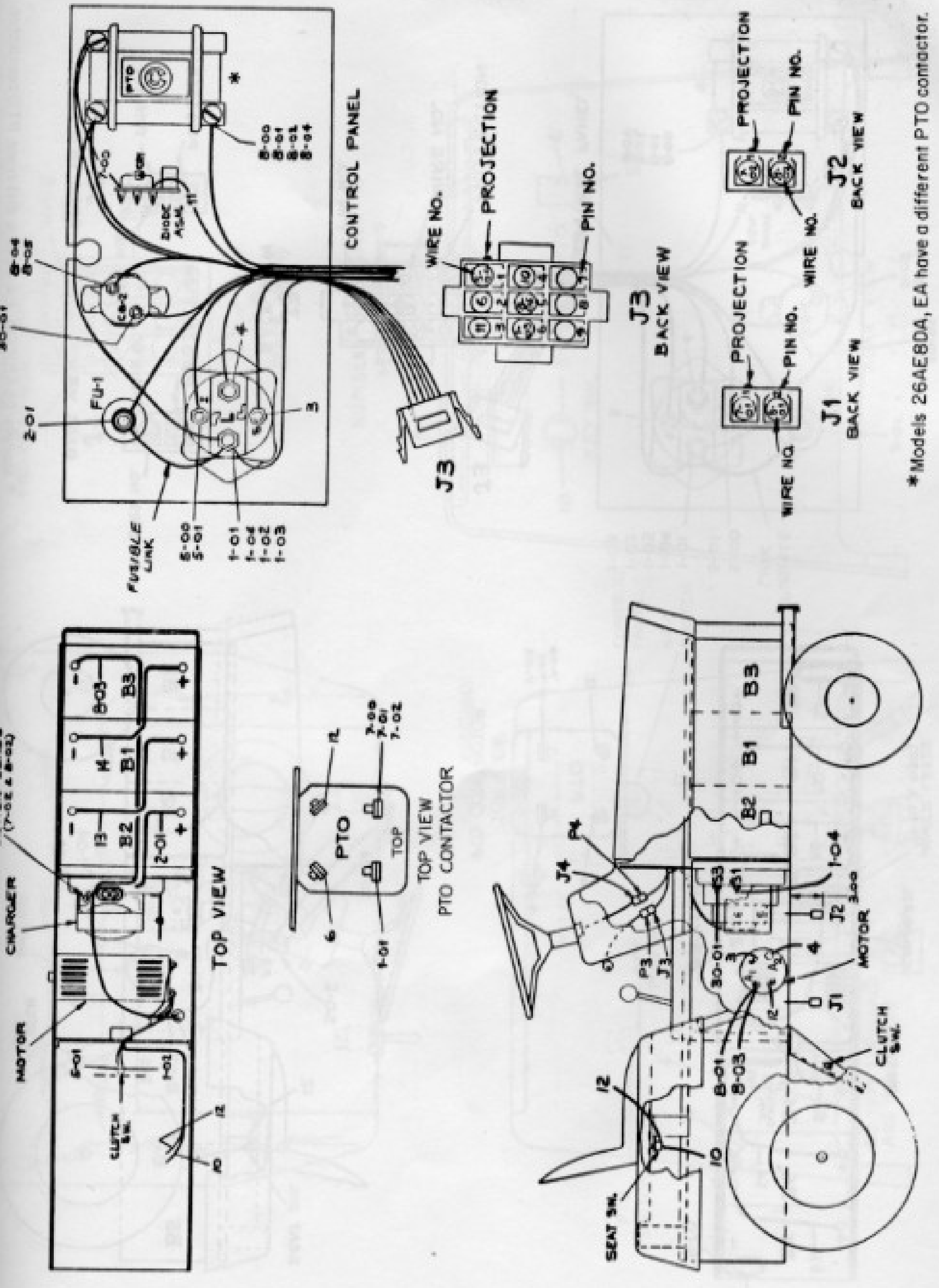


Fig. 2-26 26AE8B Tractor, Power Pack and Control Panel Wiring and Layout

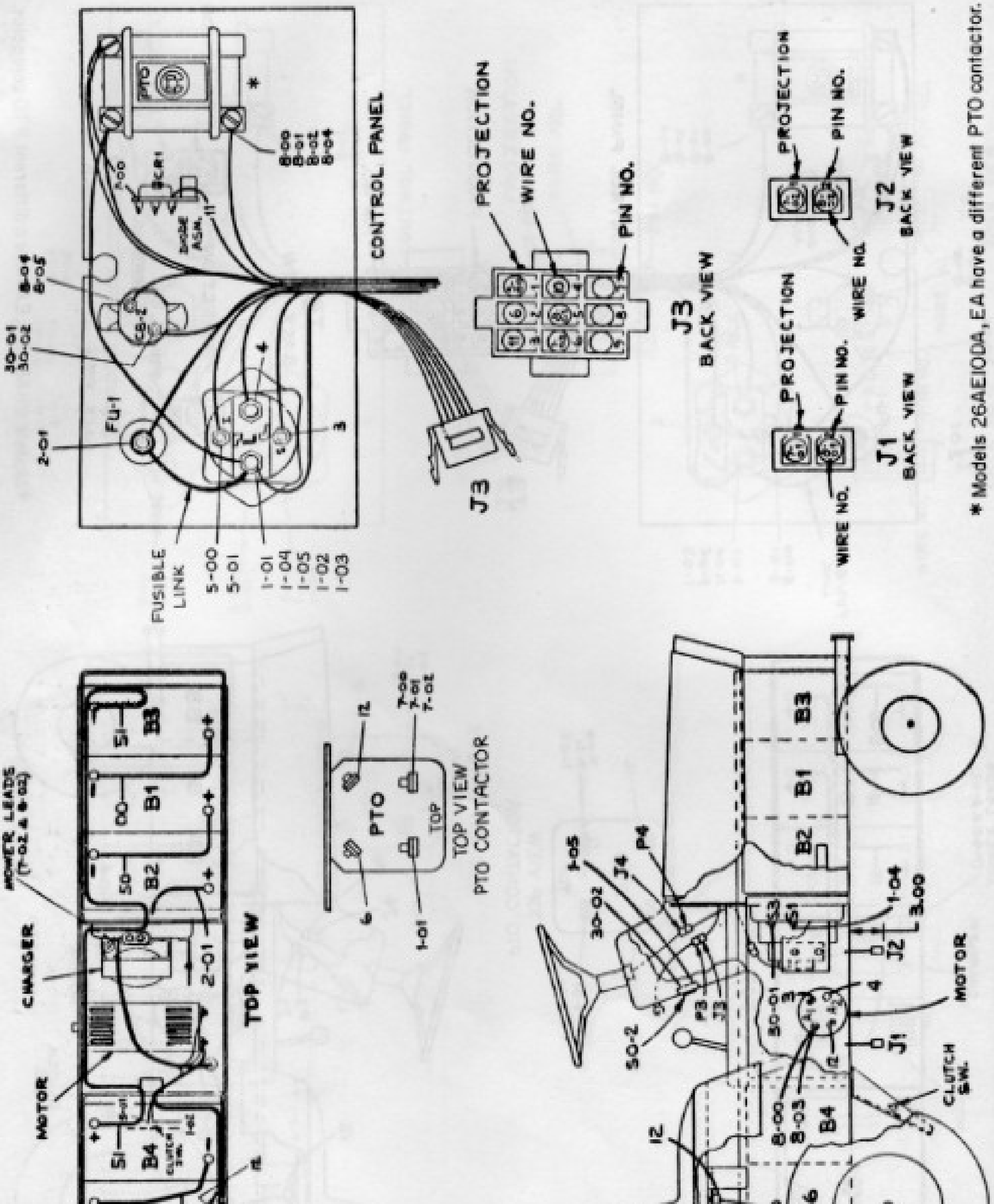


Fig. 2-27 26AE10B Tractor, Power Pack and Control Panel Wiring and Layout

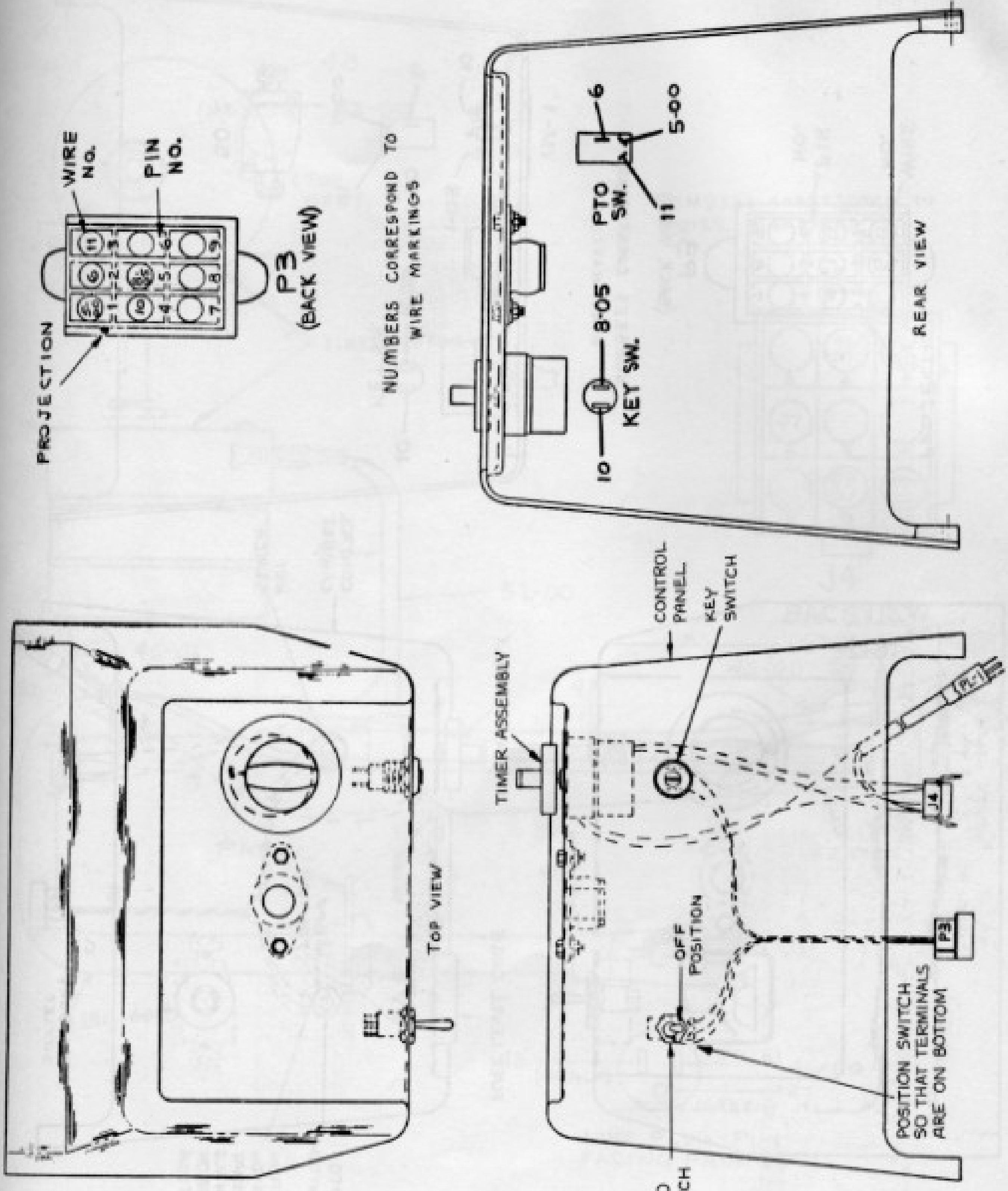


Fig. 2-28 E8M Control Cabinet Wiring

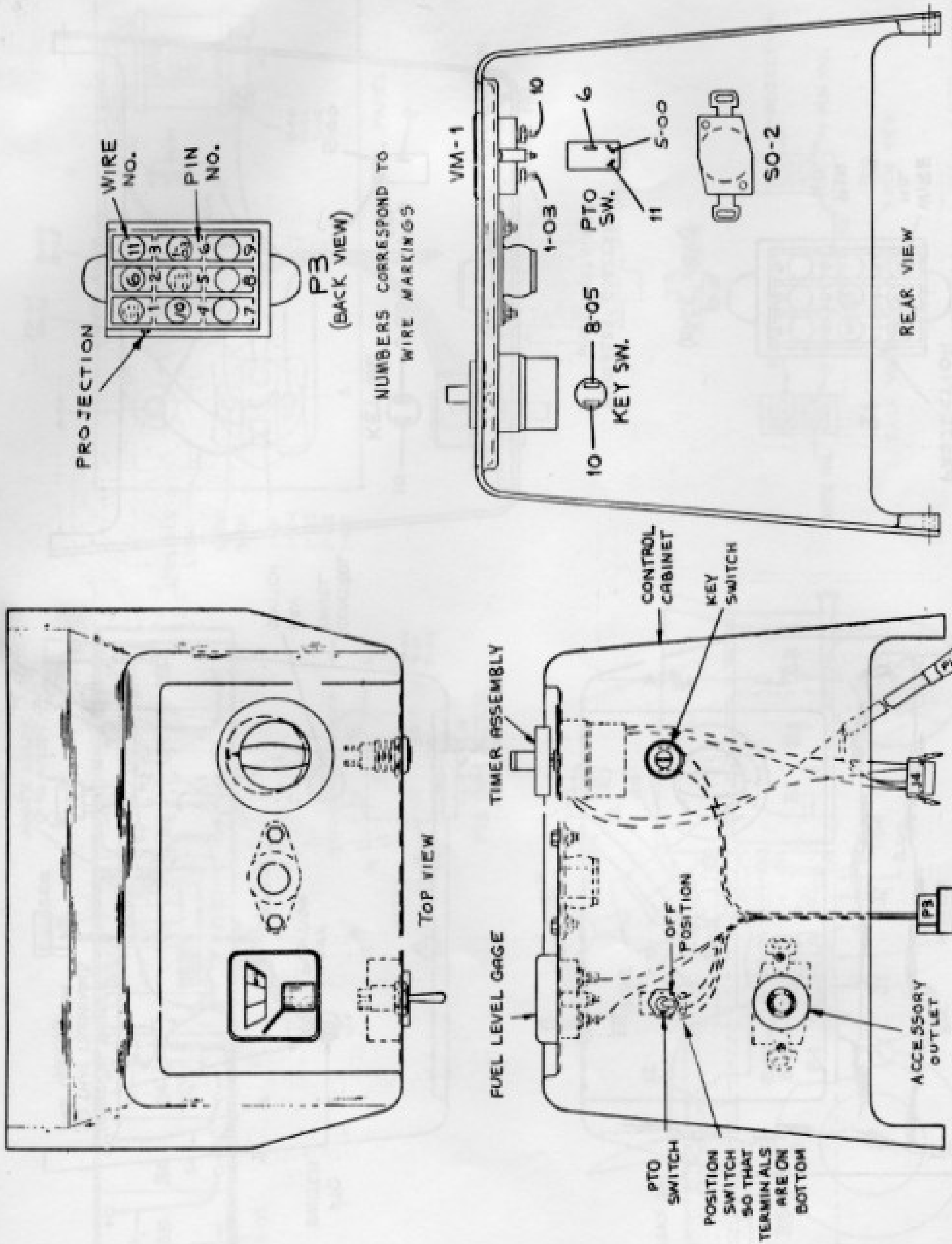


Fig. 2-29 E10M Control Cabinet Wiring

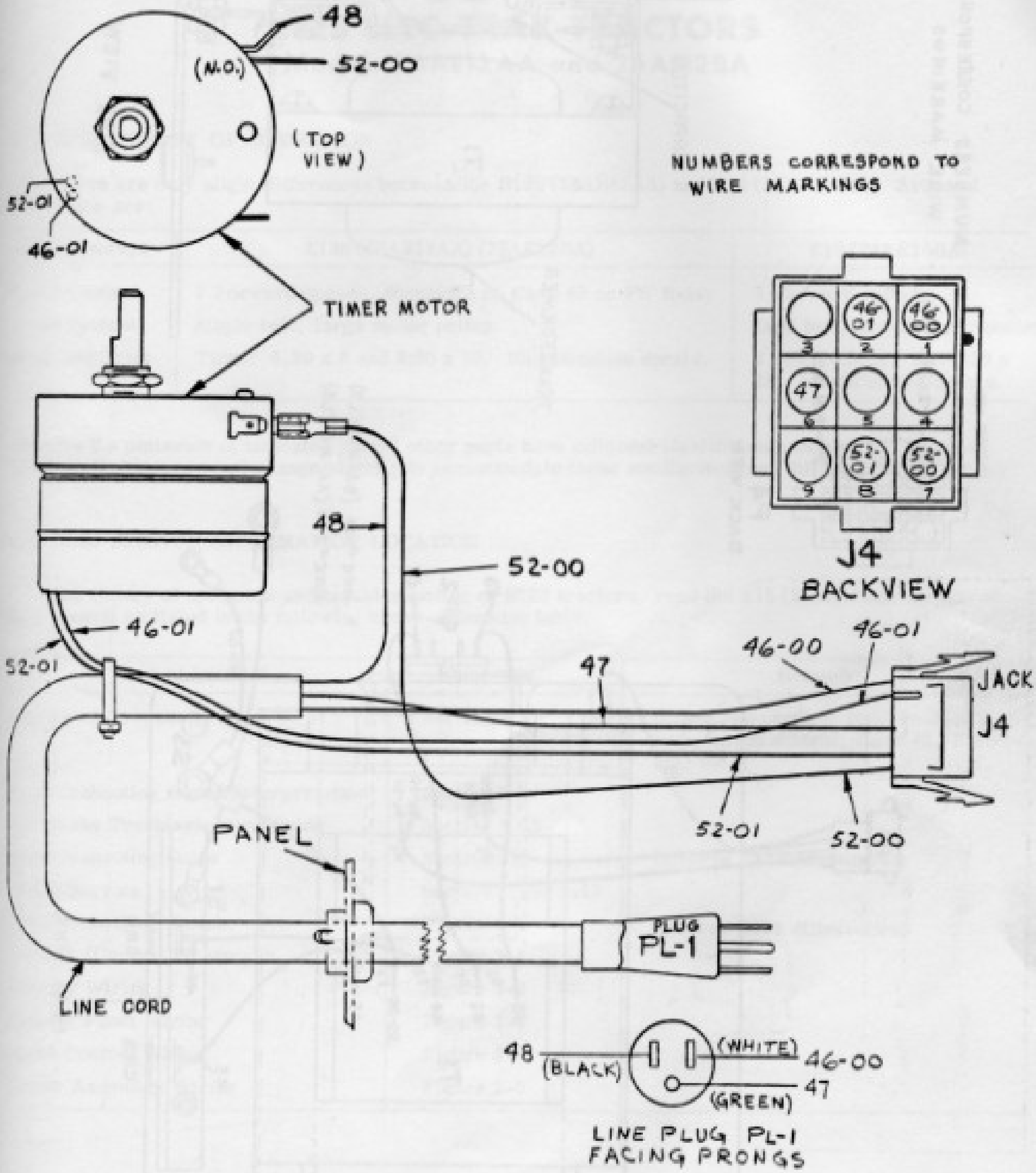


Fig. 2-30 E8M and E10M Charger Timer Wiring

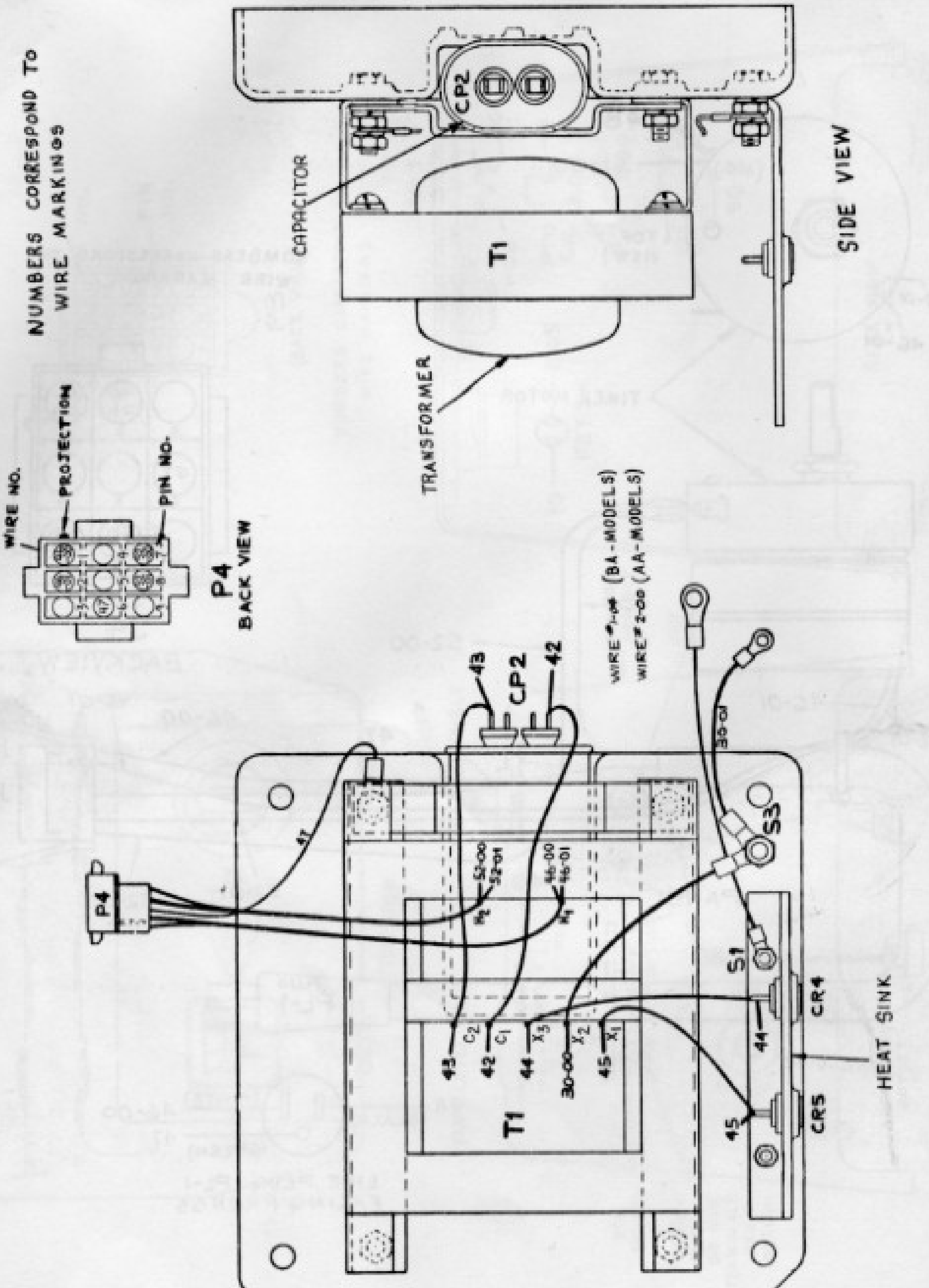


Fig. 2-31 Battery Charger Wiring

E12S ELEC-TRAK TRACTORS
Models 26AE12AA and 26AE12BA

3

3.1 E12S THEORY OF OPERATION

There are only slight differences between the E12S (26AE12AA) and E15 (26AE15BA). Areas of difference are:

Area Involved	E12S (26AE12AA) (26AE12BA)	E15 (26AE15BA)
Speed Control	3 Forward speeds, therefore no Card #3 or 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.

3.2 E12S SERVICE INFORMATION LOCATION

For theory of operation and troubleshooting of E12S tractors, read the E15 (26AE15BA) section of this manual as listed in the following cross-reference table.

Area of Interest	Reference	Remarks
Theory of Operation	Section 5.1	Ignore reference to field weakening, i.e., speed control, Card #3, FW relay, etc.
Troubleshooting Sketch Interpretation	Section 1.24	
Use of the Troubleshooting Guide	Section 1.25	
Troubleshooting Guide	Section 5.2	Observe E12S differences.
Brake Service	Section 1.14, 1.15	
Troubleshooting Sketch	Figure 5-1	Observe E12S differences.
Card #1 (Control) Schematic	Figure 3-1	
Tractor Wiring	Figure 3-2	
Control Panel Wiring	Figure 3-3	
Speed Control Wiring	Figure 3-4	
Timer Assembly Wiring	Figure 3-5	

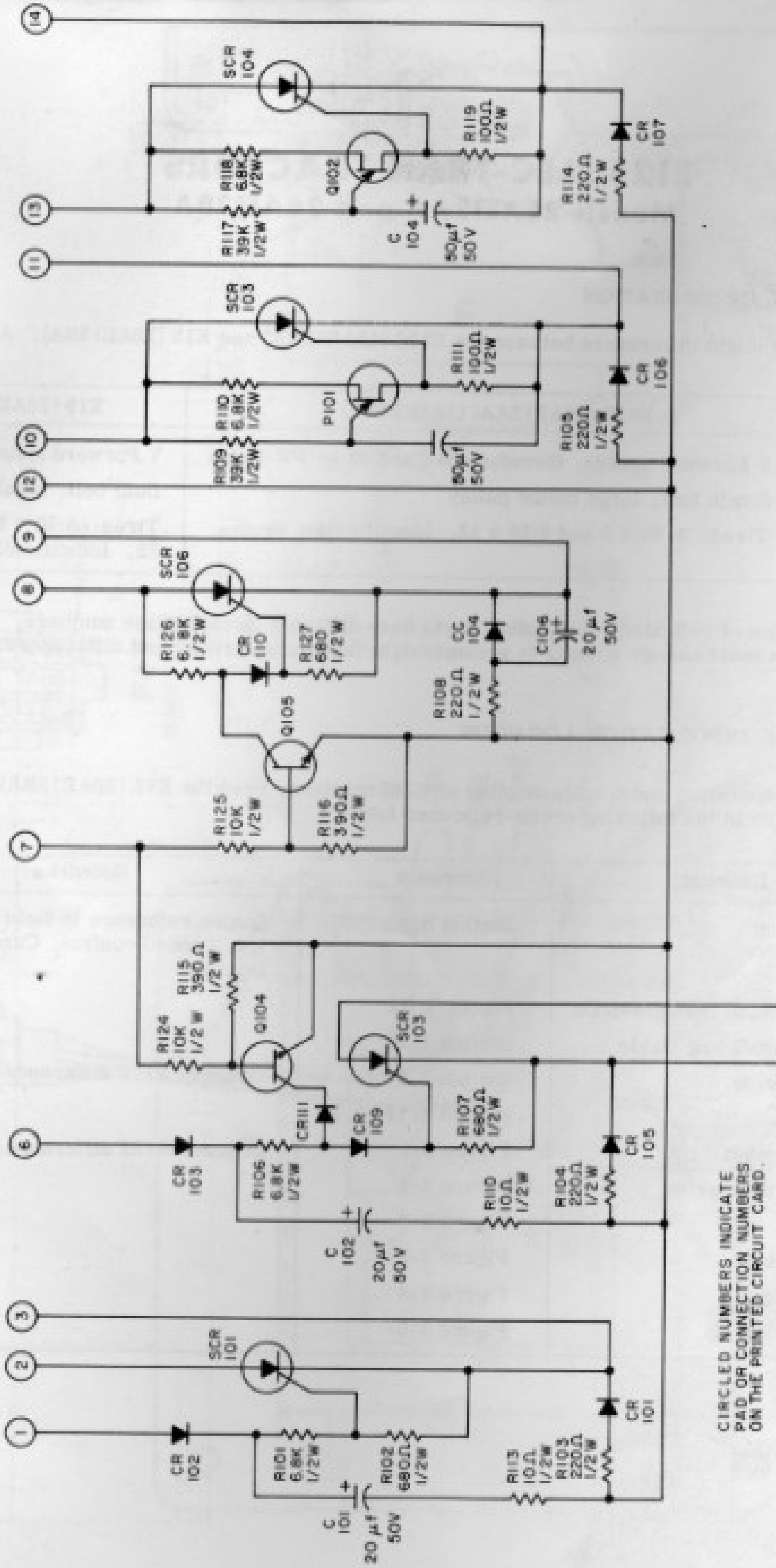


Fig. 3-1 E12s Card #1 (Control) Schematic

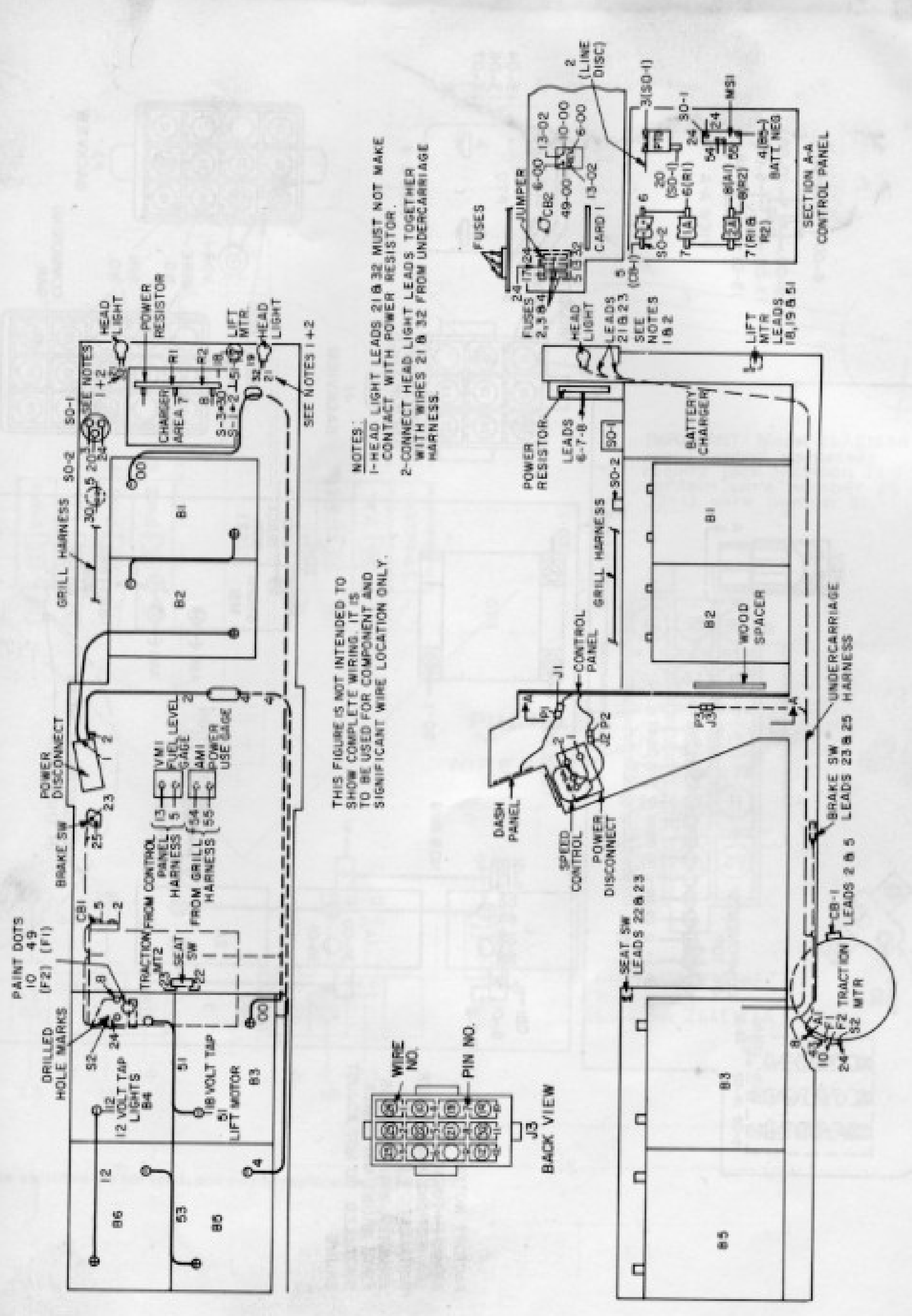


Fig. 3-2 E12s Tractor Wiring

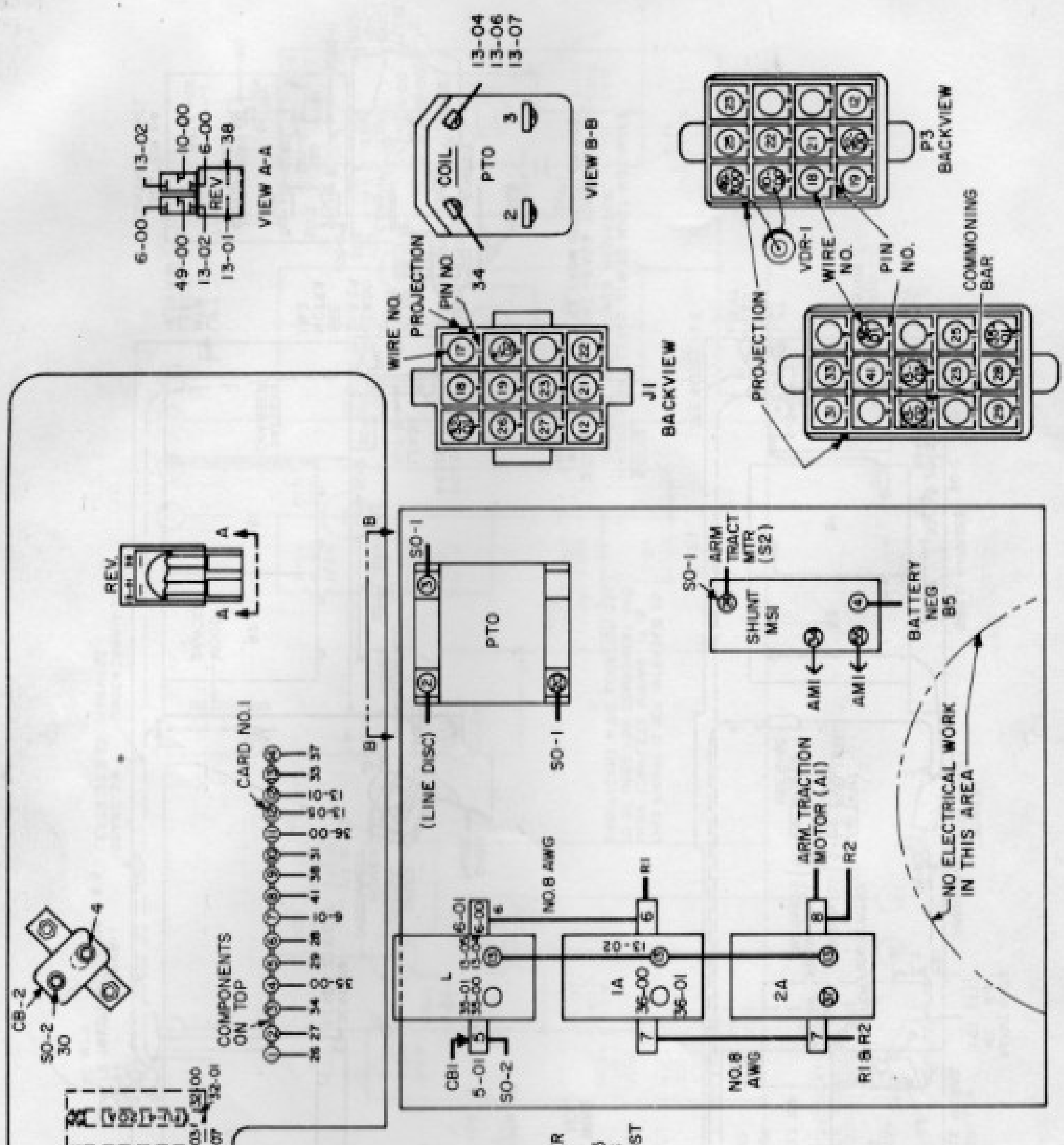
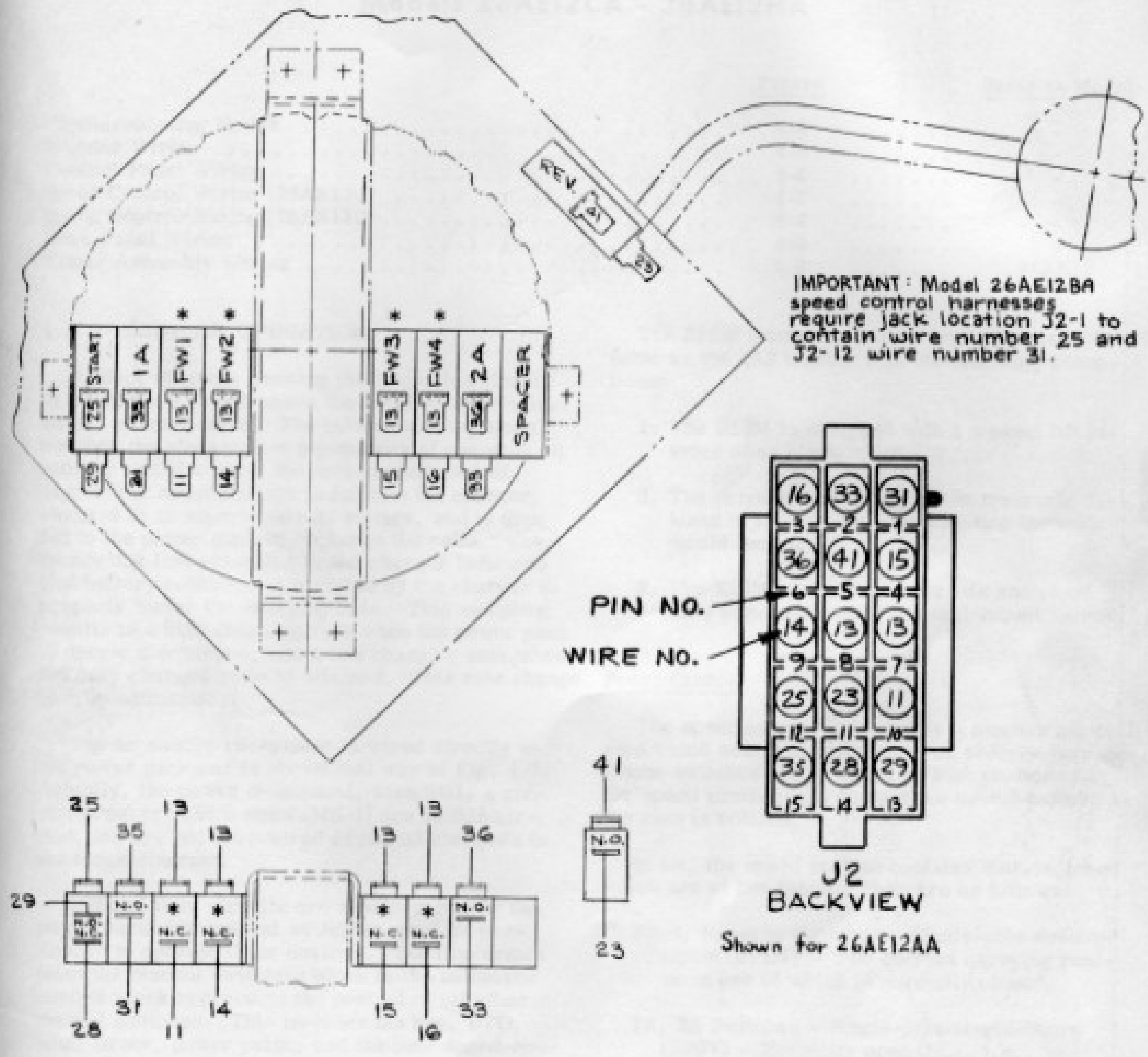


Fig. 3-3 E12s Control Panel Wiring



*These switches are not used, and may be replaced with spacers

Fig. 3-4 E12s Speed Control Wiring

E12 ELEC-TRAK TRACTORS

Models 26AE12CA - 26AE12HA

4.1 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 dc 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 Fig. 4-1. 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.

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 you 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 overall tractor response.

The E12M tractor and circuitry is basically the same as the E12 tractor with the following exceptions:

1. The E12M is equipped with a manual lift instead of an electric lift.

2. The drive motor is behind the transaxle instead of in front (to accommodate the mid-mount mower).

3. The E12M has a longer chassis and wheel base to accommodate the mid-mount mower.

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):

4

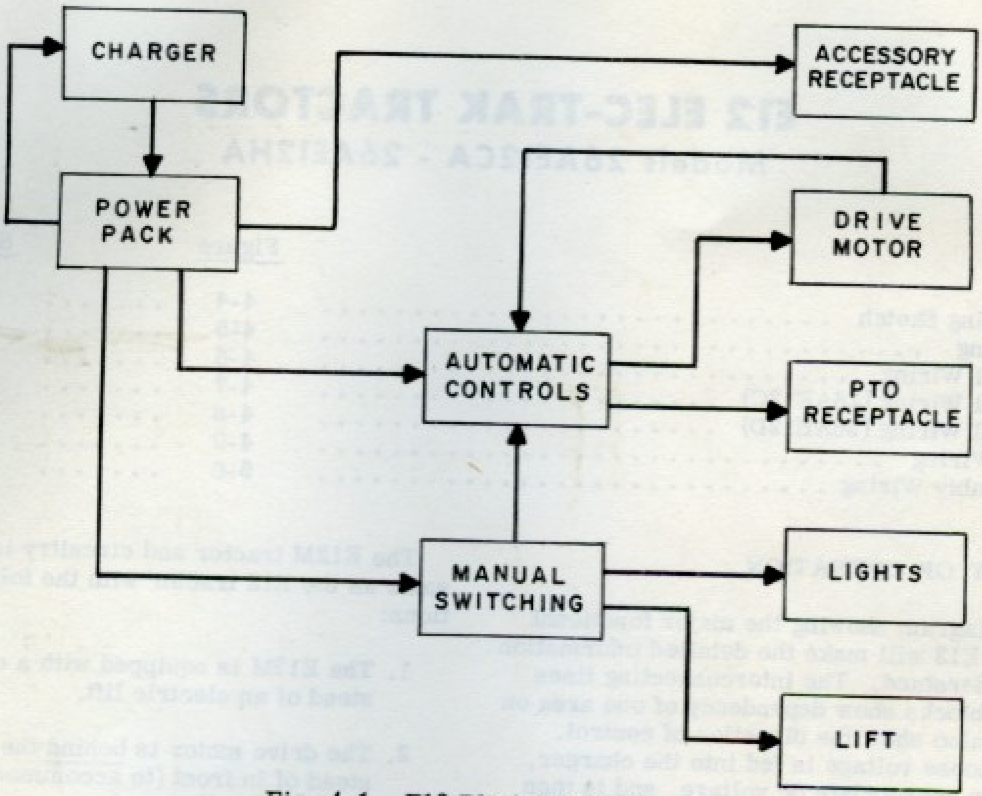


Fig. 4-1. E12 Block Diagram

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 Fig. 4-2.

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 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.

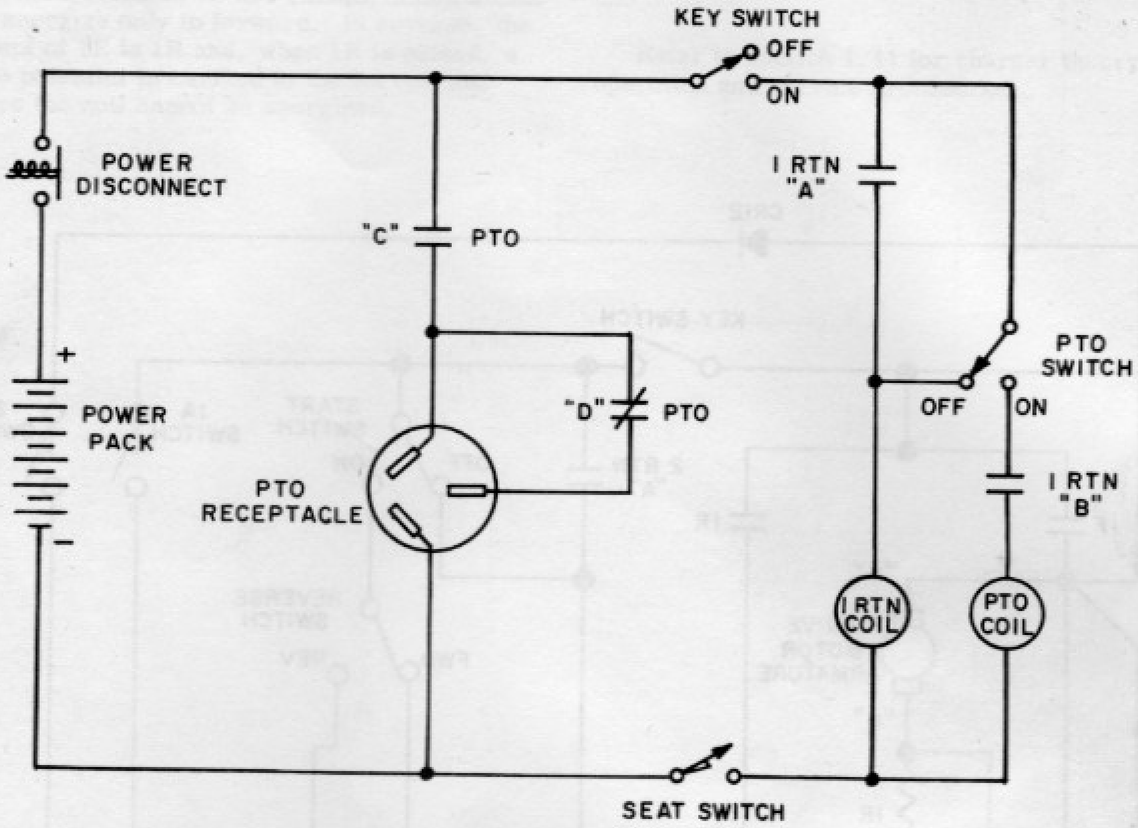


Fig. 4-2. E12 PTO Circuit

Speed Control Circuit

In examining the "Start" circuit, simplified in Fig. 4-3, 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.

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 in the E20 model (see page 6-7), 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 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.

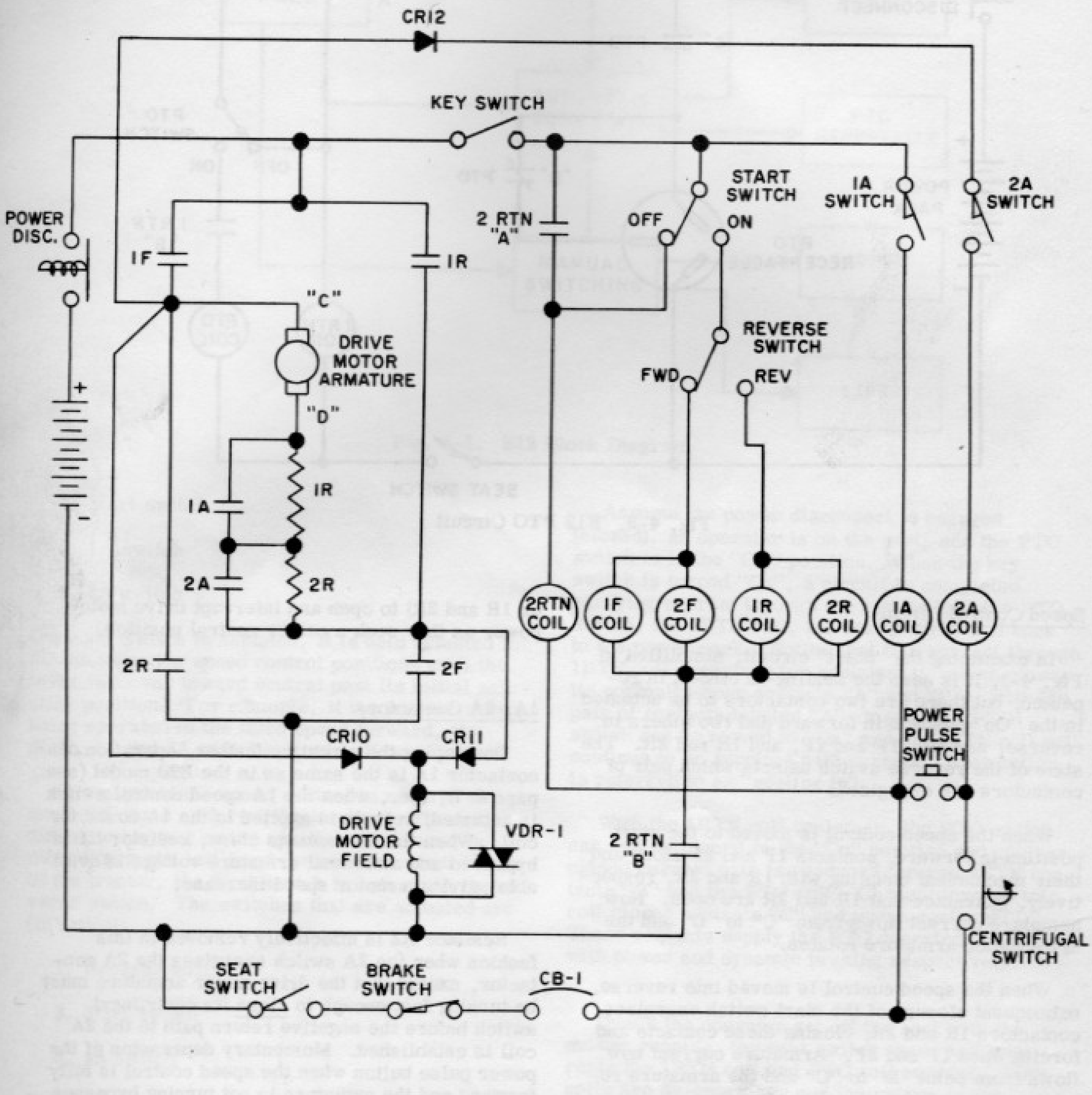
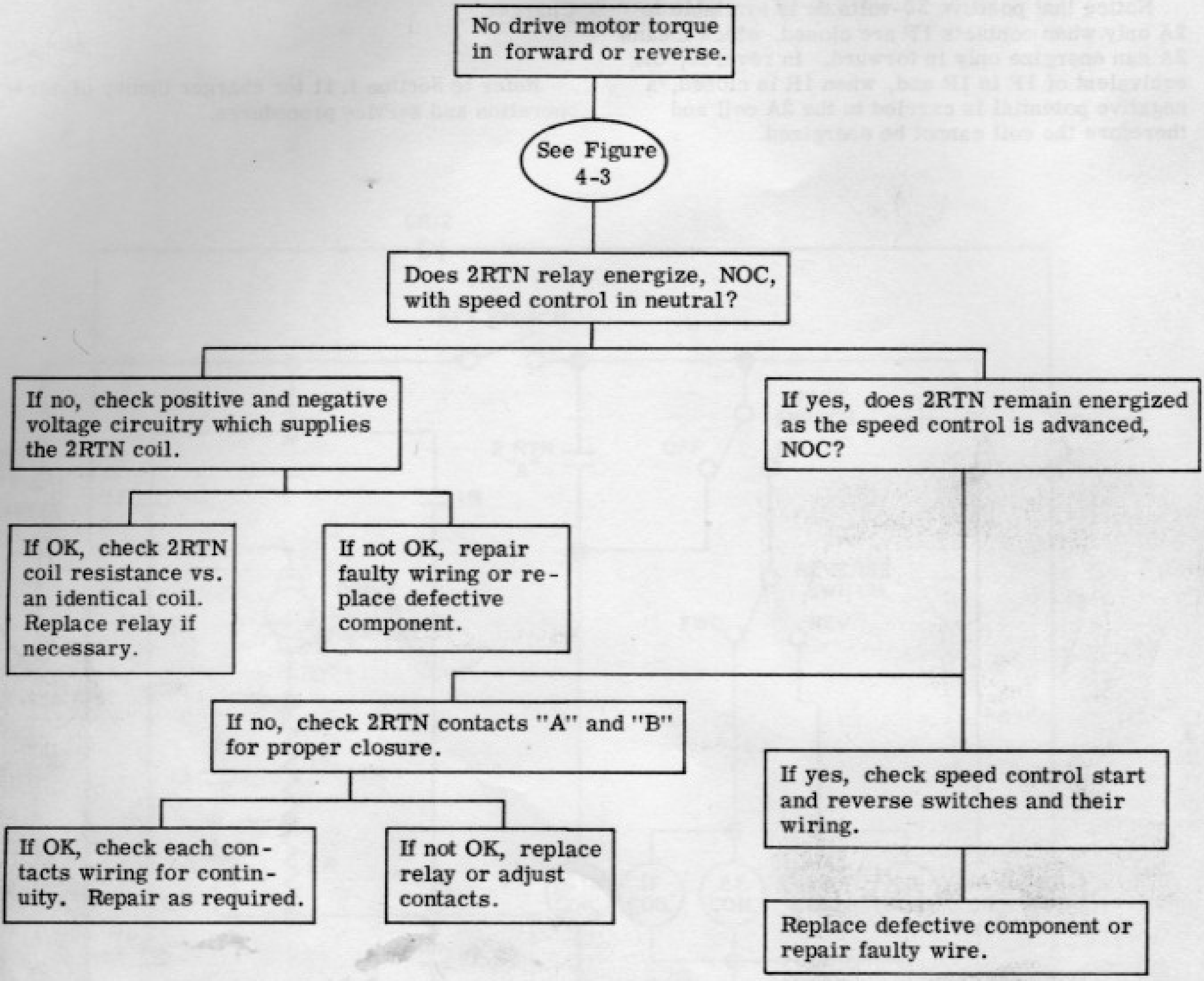


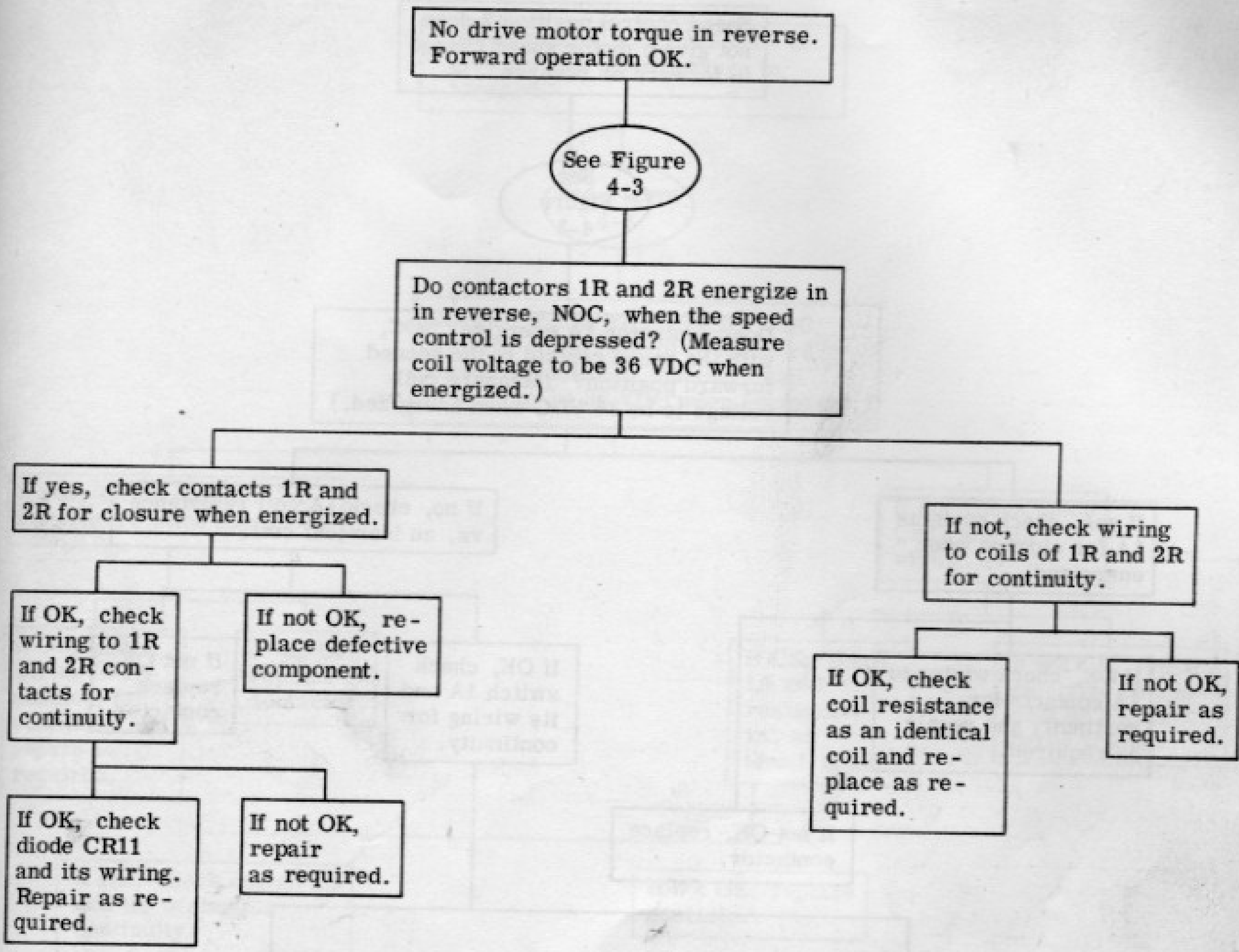
Fig. 4-3. E12 Drive Motor Circuit and Control

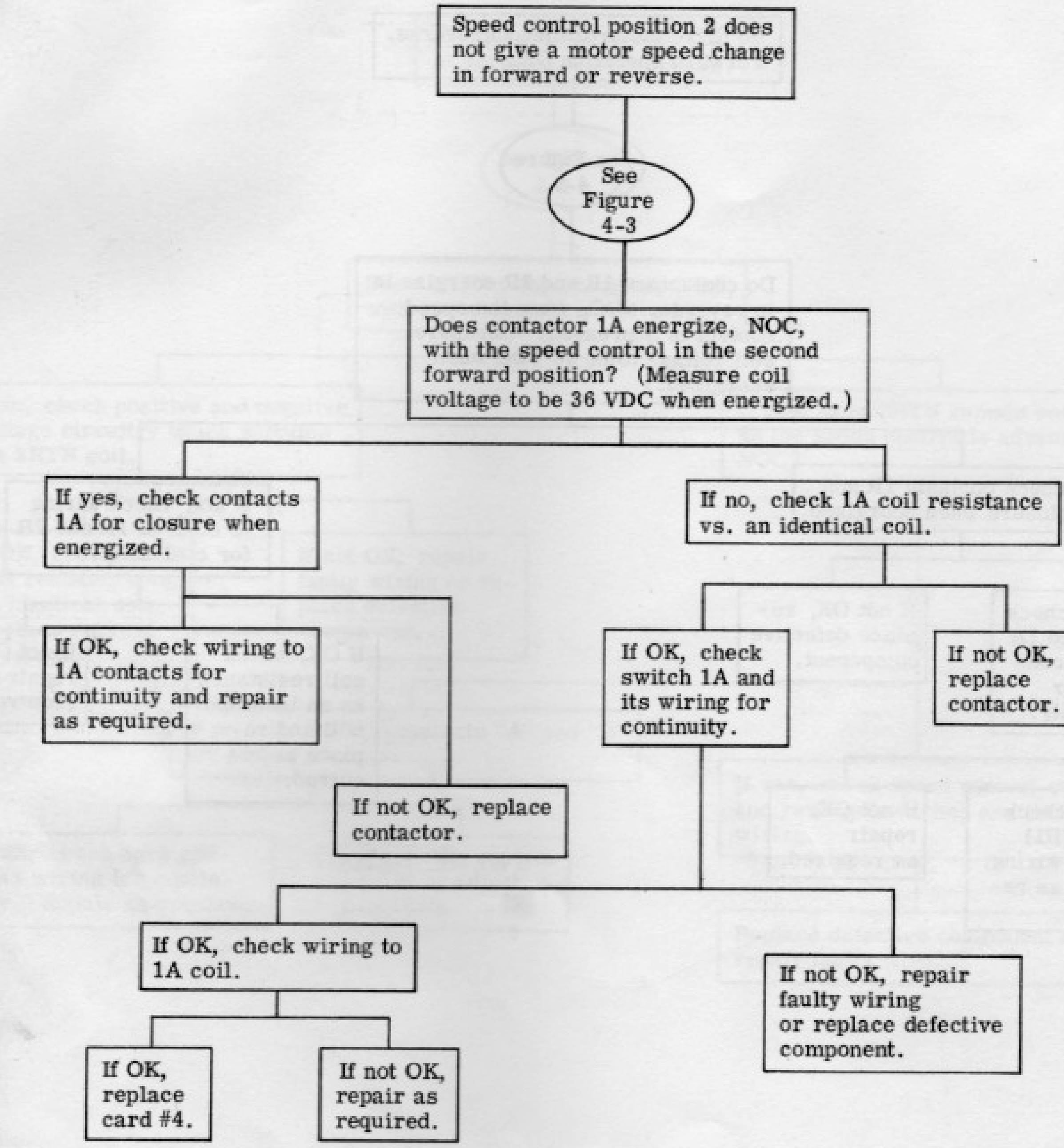
Notice that positive 36-volts dc is available to 2A only when contacts 1F are closed, which means 2A can energize only in forward. In reverse, the equivalent of 1F is 1R and, when 1R is closed, a negative potential is carried to the 2A coil and therefore the coil cannot be energized.

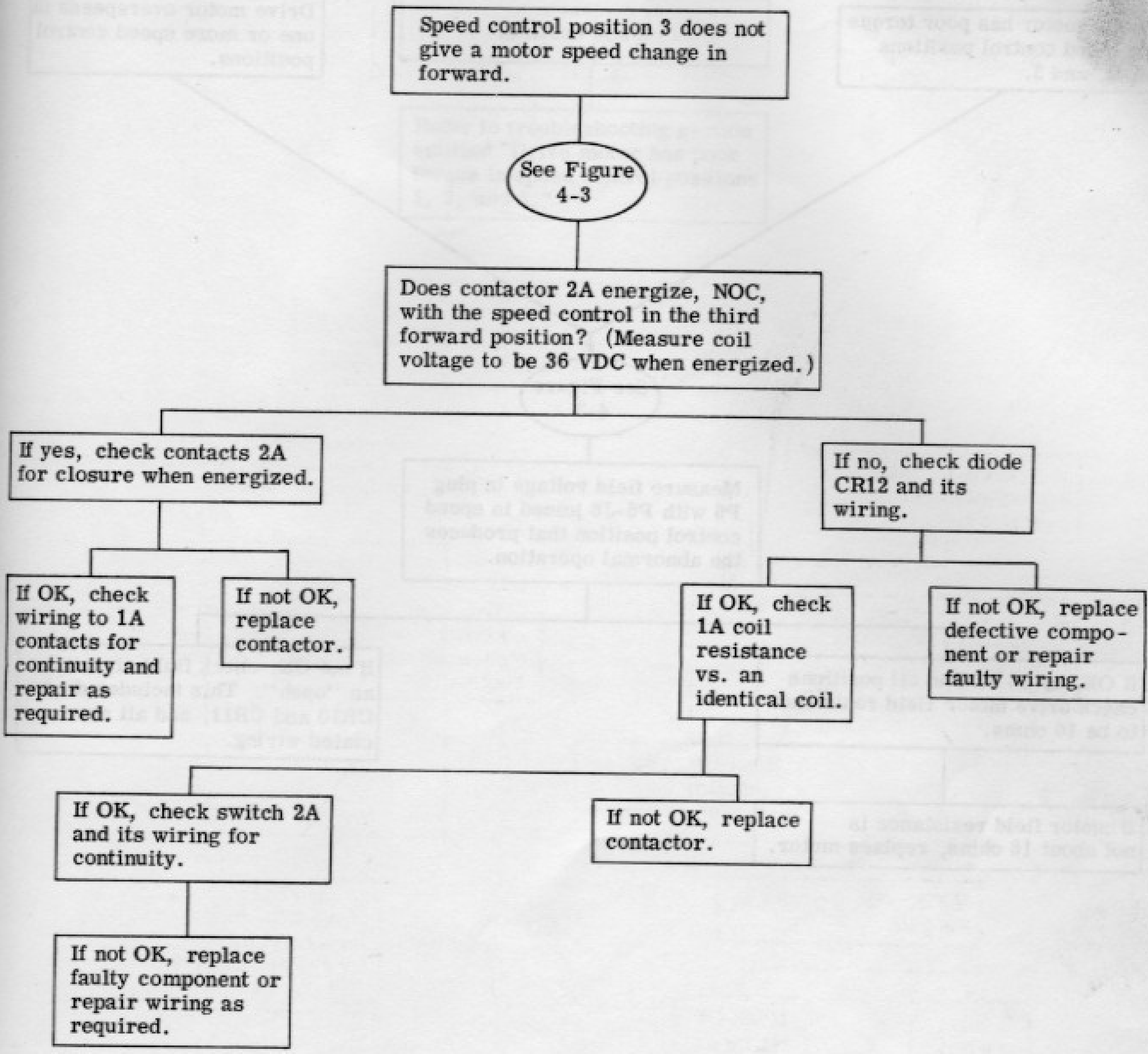
Charger

Refer to Section 1. 11 for charger theory of ›er-operation and service procedures.


No drive motor torque in forward or reverse.
See Figure 4-3
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 4-3
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 OK, check wiring to 1R and 2R contacts for continuity.
If not OK, replace defective component.
If OK, check diode CR11 and its wiring. Repair as required.
If not OK, repair as required.
If not, check wiring to coils of 1R and 2R for continuity.
If OK, check coil resistance as an identical coil and replace 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 4-3
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 4-3
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 4-3

Measure field voltage in plug P6 with P6-J6 joined in speed control position that produces the abnormal operation.

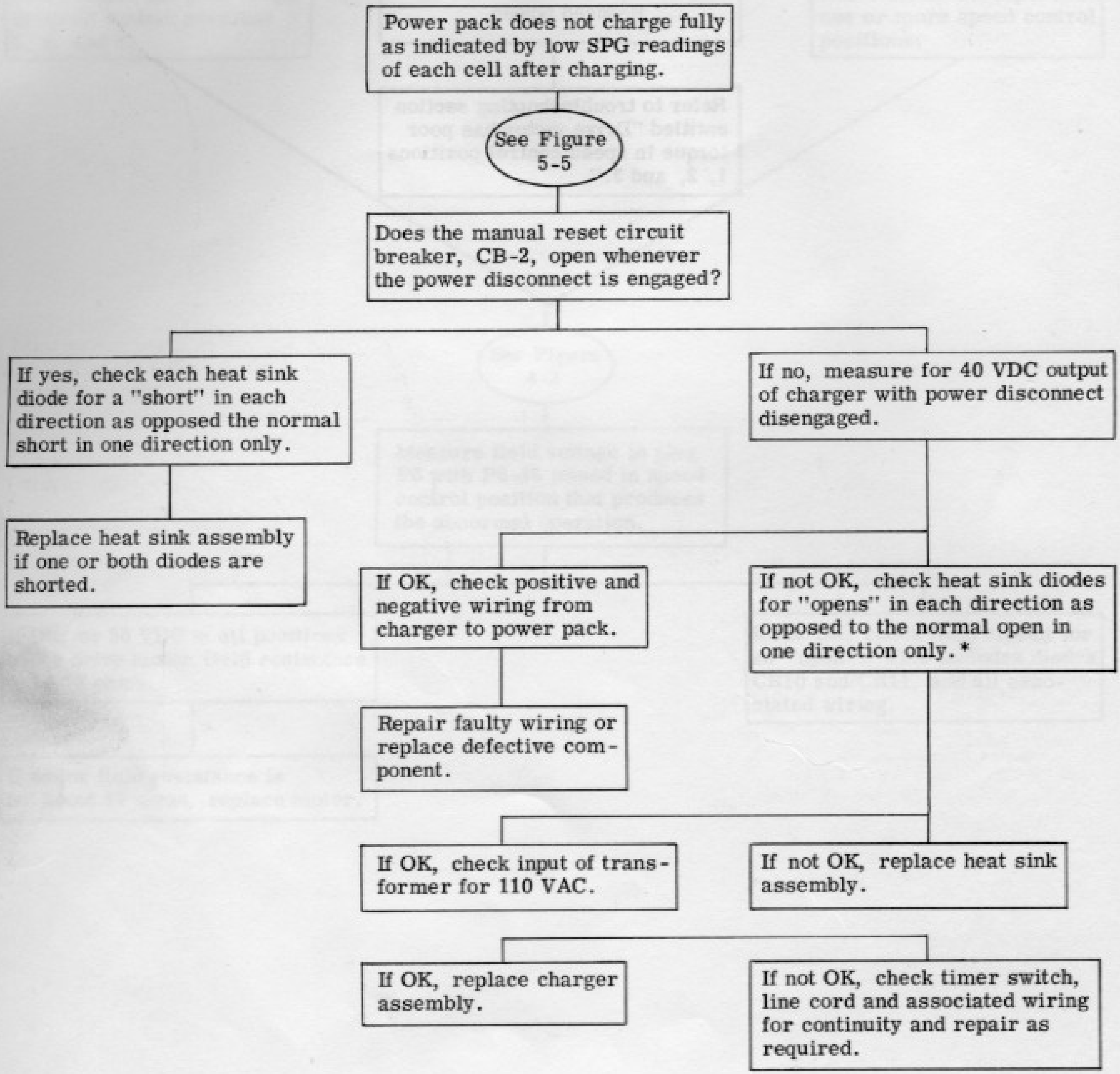
If OK, or 36 VDC in all positions check drive motor field resistance to be 16 ohms.

If not OK, check field circuit for an "open". This includes diodes CR10 and CR11, and all associated wiring.

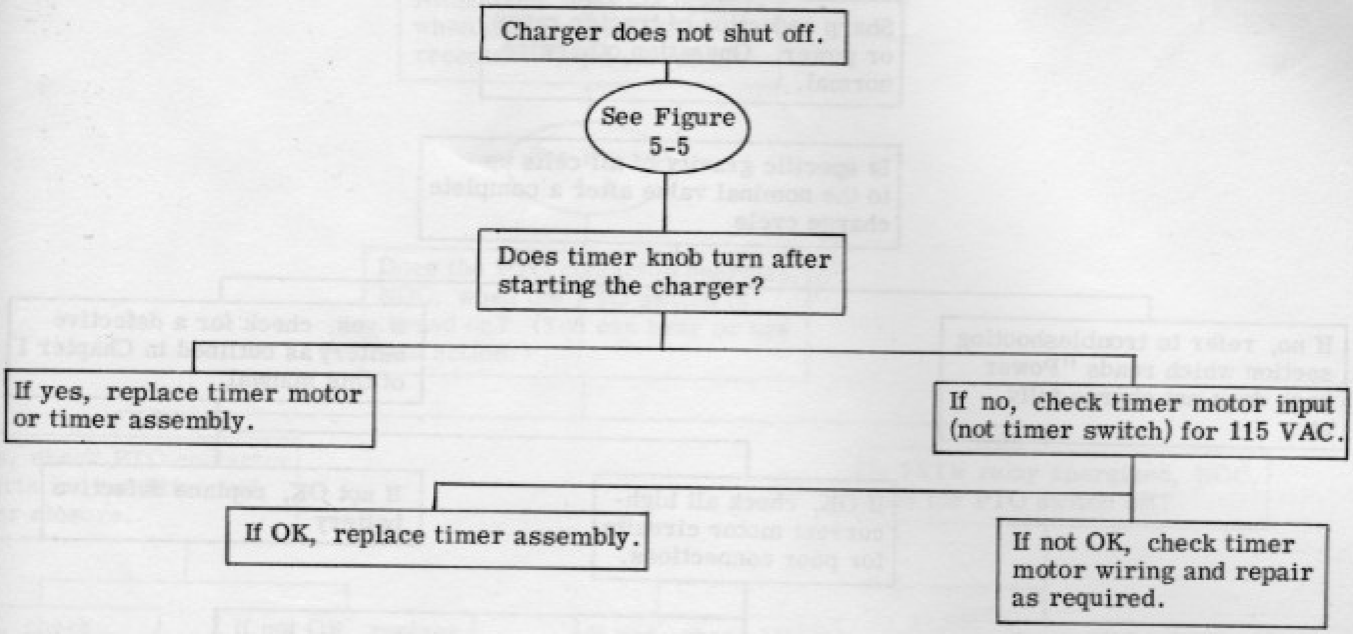
If motor field resistance is not about 16 ohms, replace motor.

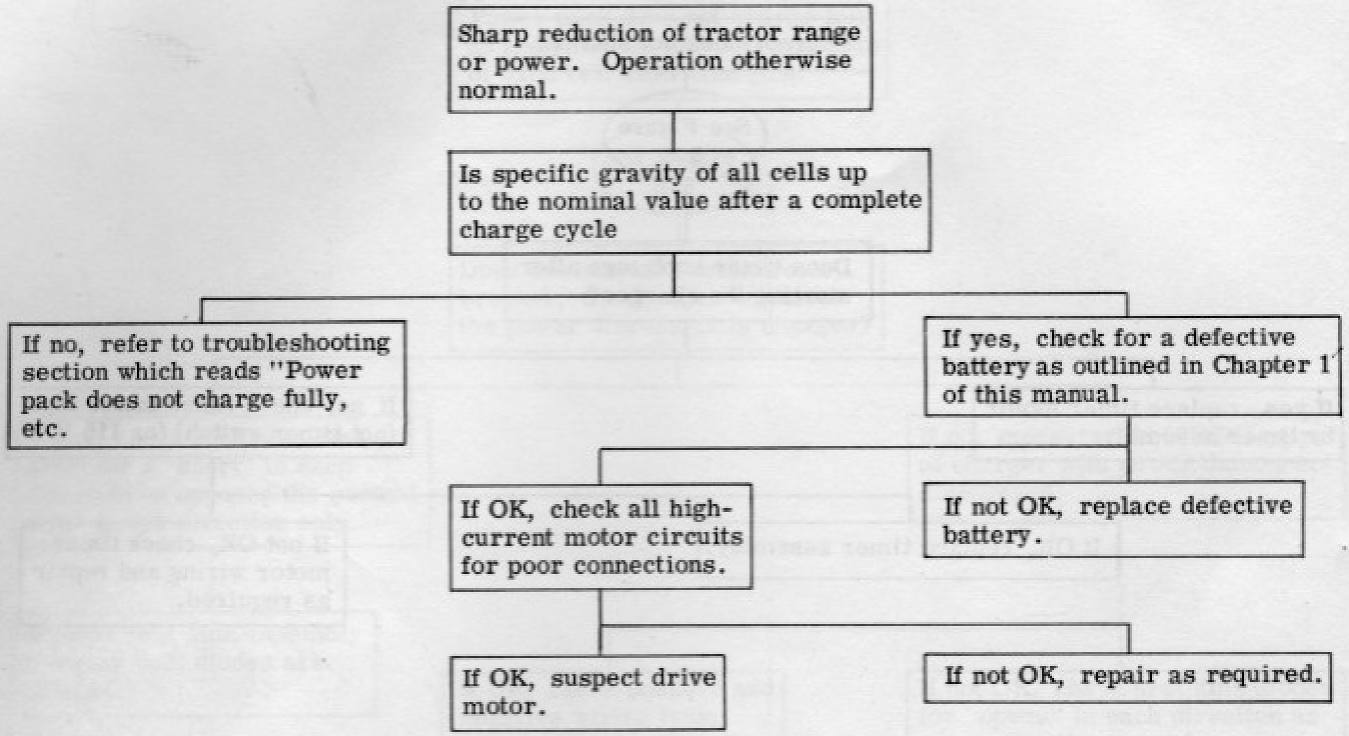
Reduced power.

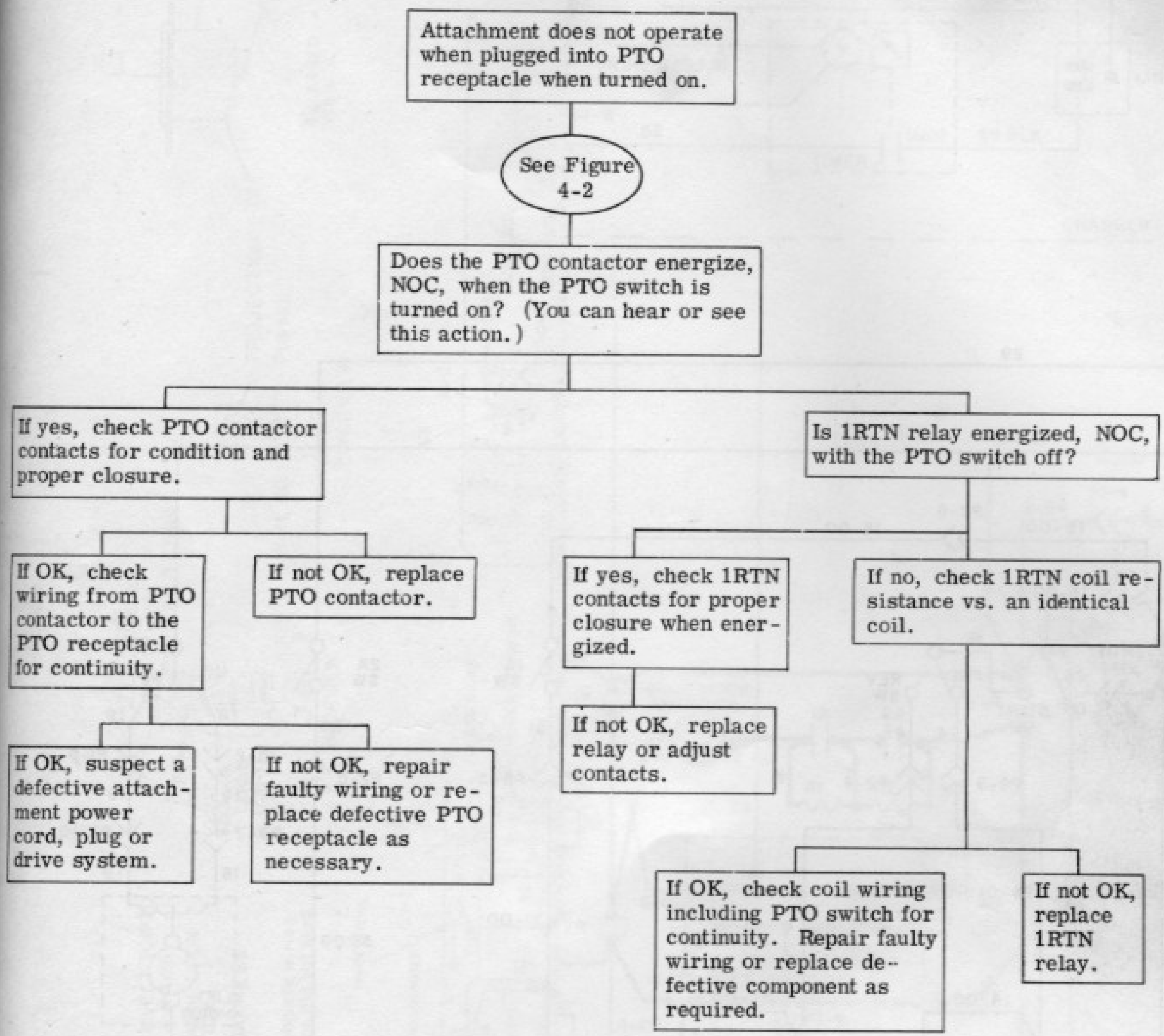
Refer to troubleshooting section entitled "Drive motor has poor torque in speed control positions 1, 2, and 3."

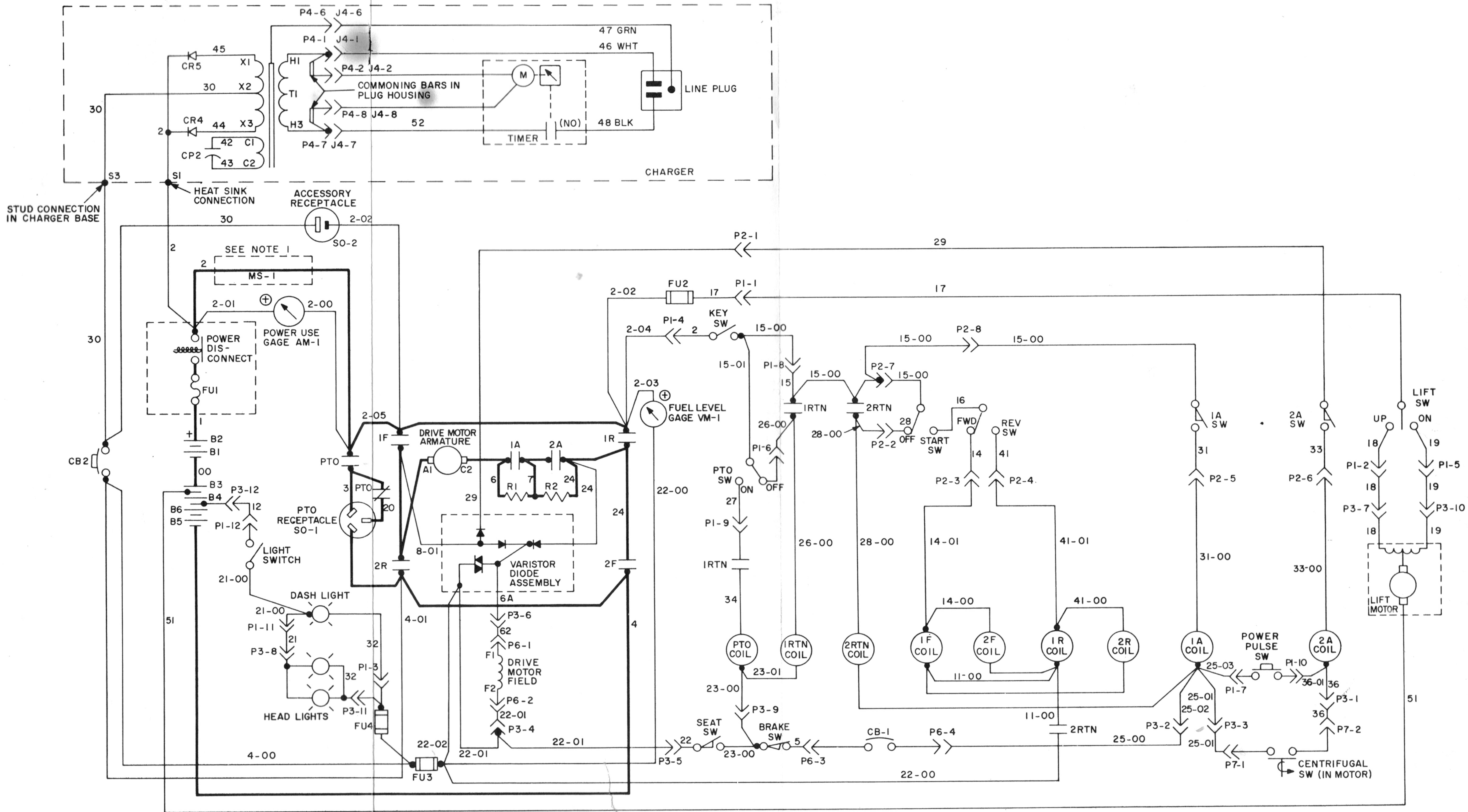


*Since both diodes are in parallel, one of the diode wires must be removed before either diode can be checked for an "open". Removing a wire is not necessary to check for a short.


Charger does not shut off.
See Figure 5-5
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 1 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 4-2
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.
Is 1RTN relay energized, NOC, with the PTO switch off?
If OK, check wiring from PTO contactor to the PTO receptacle for continuity.
If not OK, replace PTO contactor.
If yes, check 1RTN contacts for proper closure when energized.
If no, check 1RTN coil resistance vs. an identical coil.
If not OK, replace relay or adjust contacts.
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.
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.



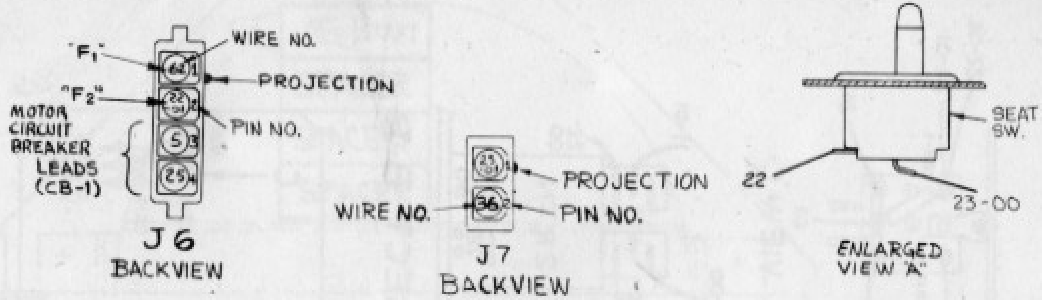
NOTES: SHUNT MS-1 IS A 20" LENGTH OF 6 AWG CABLE

Fig. 4-4 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.



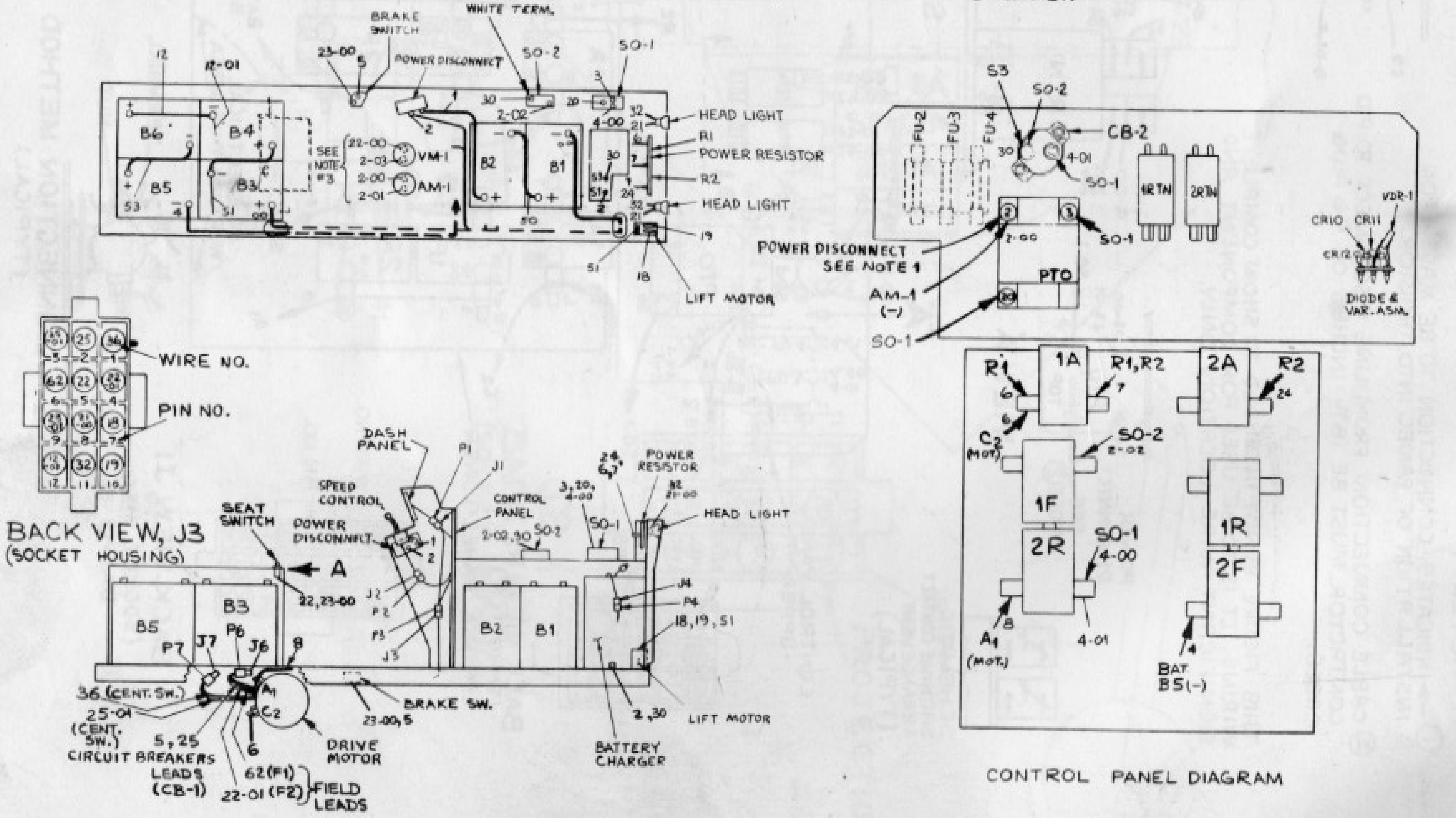


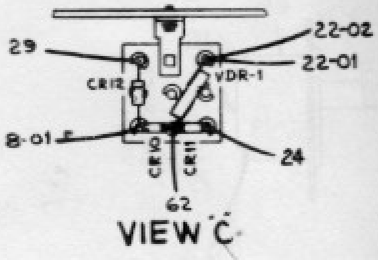
Fig. 4-5 E12 Tractor Wiring

NOTES:

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

② CABLE CONNECTION FROM LINE DISCONNECT TO PTO CONTACTOR MUST BE 18 1/4 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.



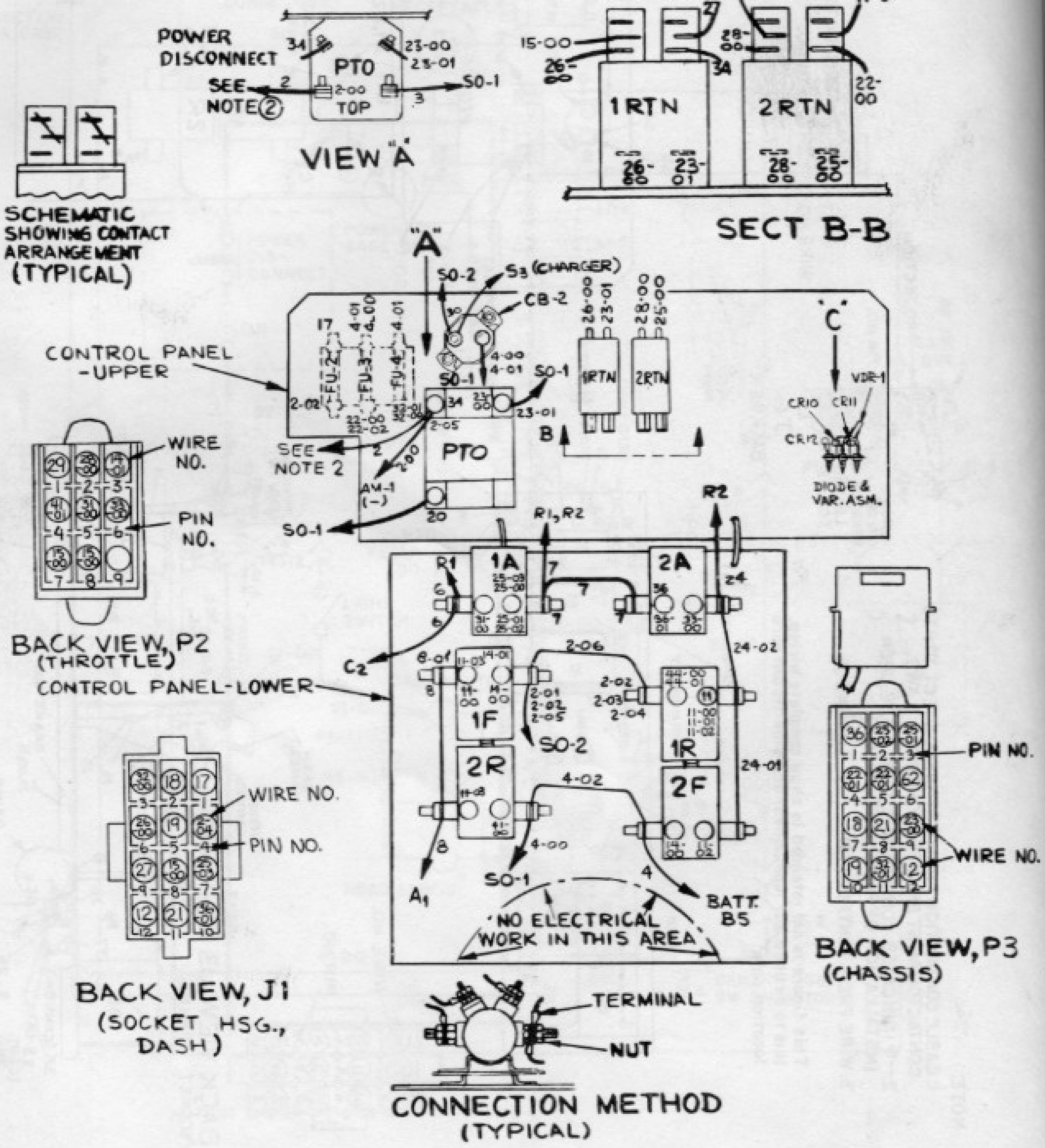


Fig. 4-6 E12 Control Panel Wiring

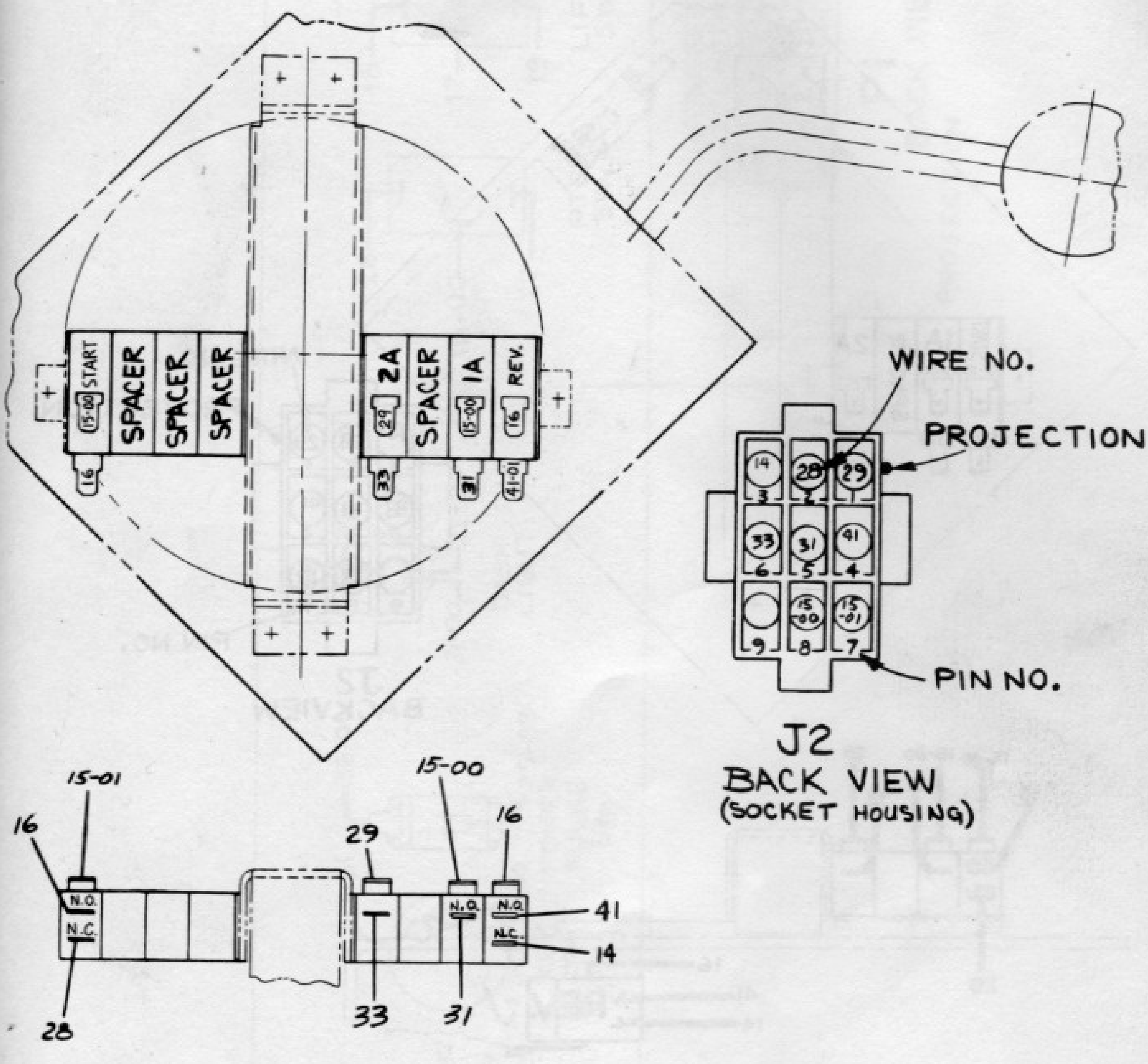


Fig. 4-7 26AE12C Speed Control Wiring

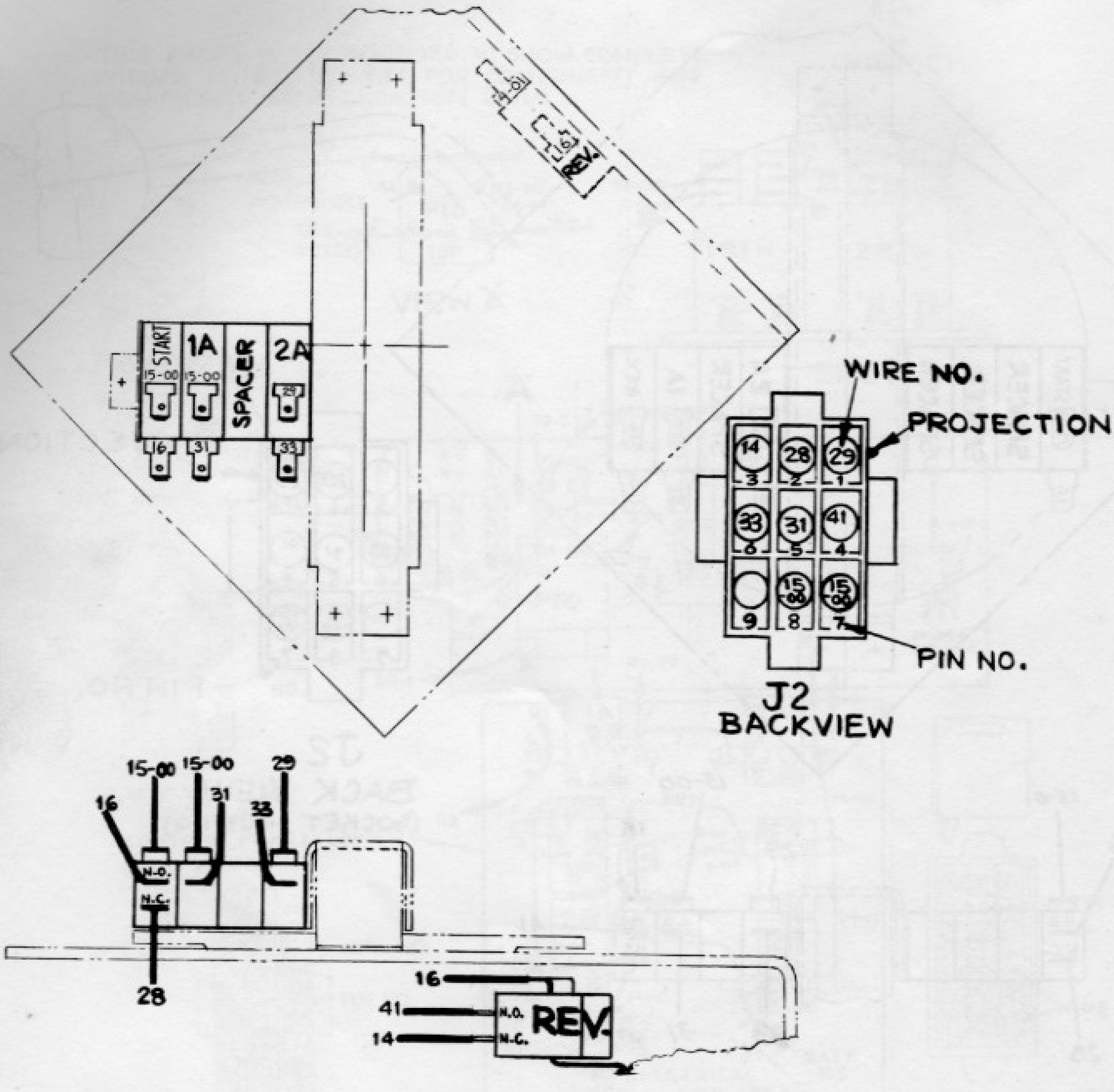


Fig. 4-8 26AE12D Speed Control Wiring

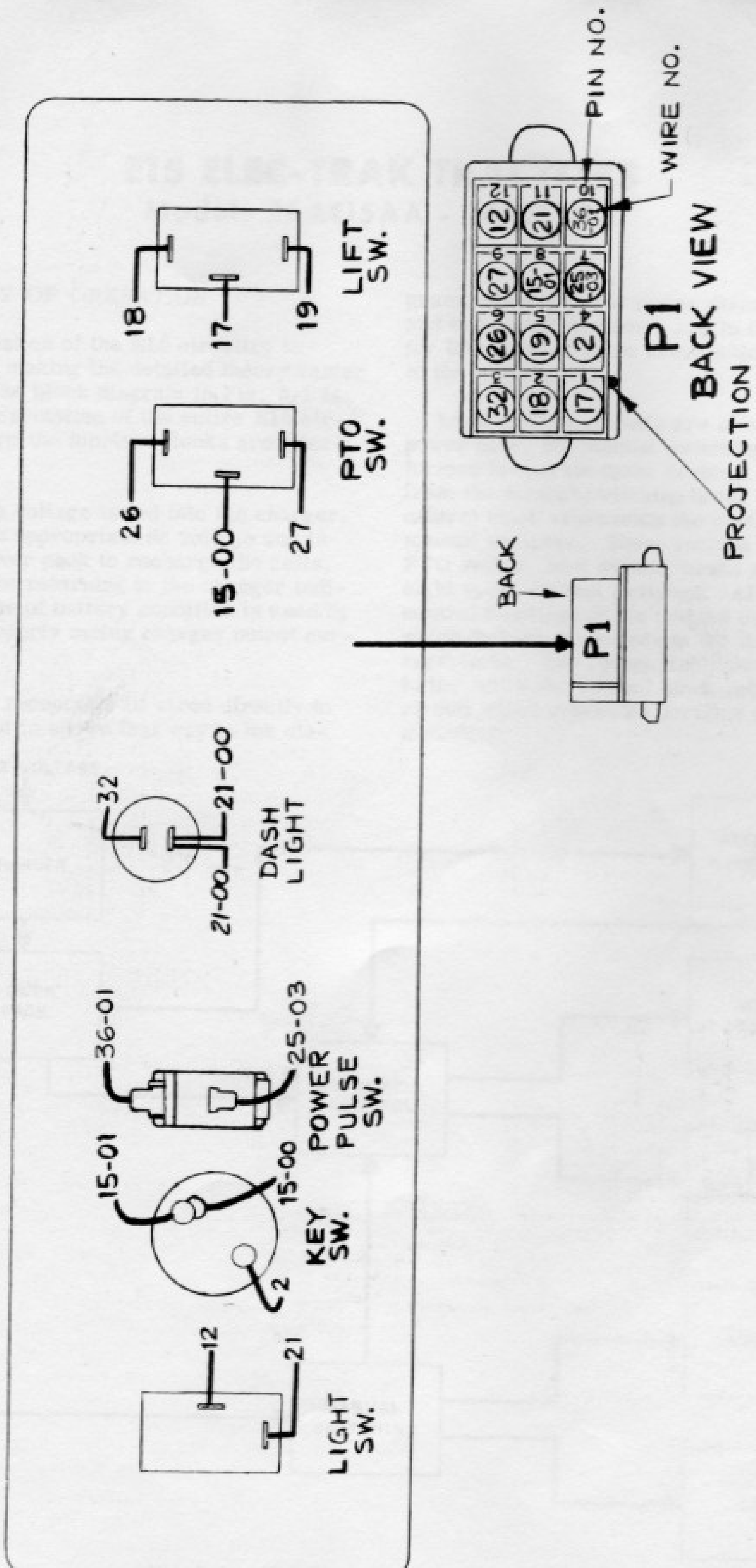


Fig. 4-9 E12 Dash Panel Wiring

E15 ELEC-TRAK TRACTORS
Models 26AE15AA - 26AE15GA

5.1 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 Fig. 5-1 is a simplified representation of the entire E15 circuitry. Notice how the function blocks are interconnected.

After the house voltage is fed into the charger, it is changed to an appropriate dc 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.

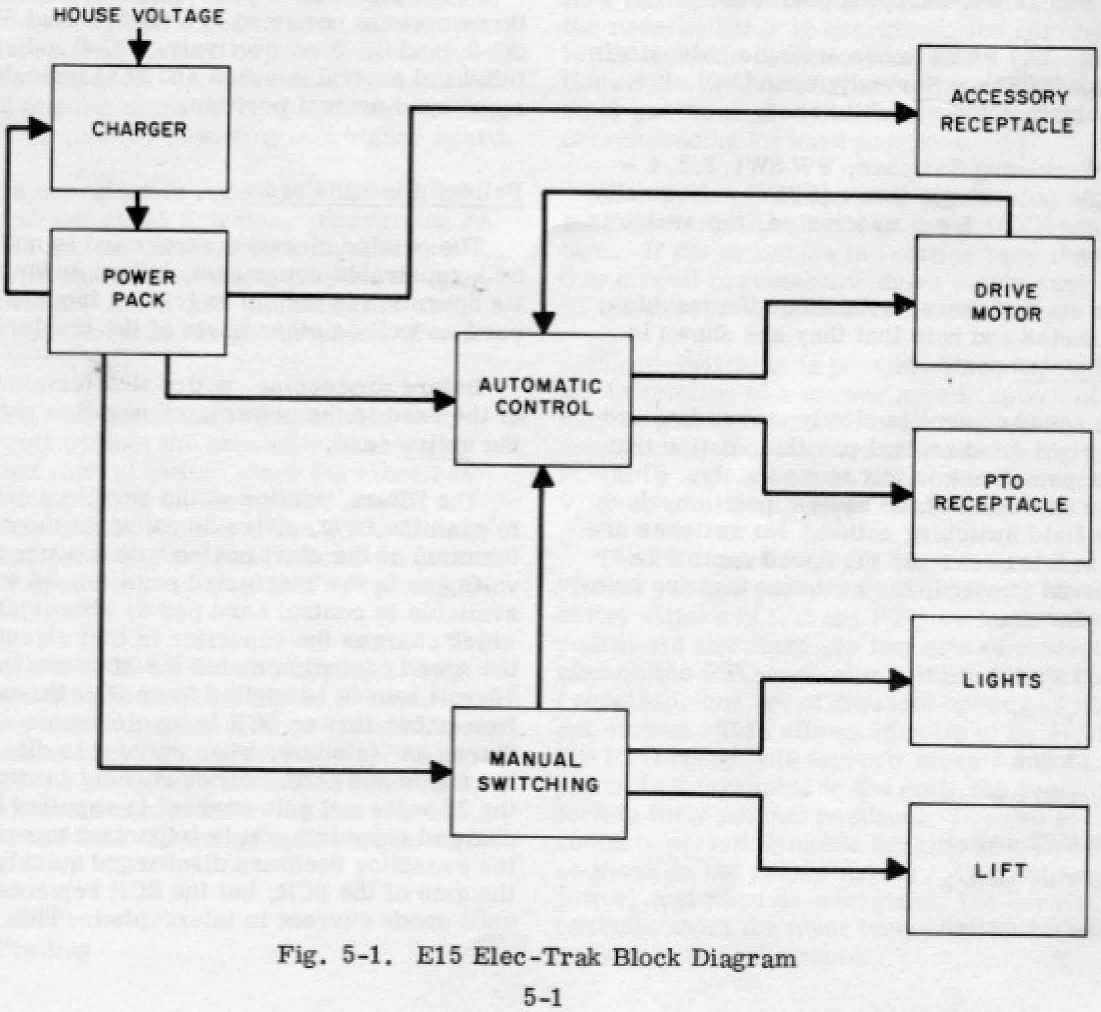


Fig. 5-1. E15 Elec-Trak Block Diagram

Successful troubleshooting of the E15 ELEC-TRAK tractor 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 overall 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 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 is supplied 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 bypassed 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 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.

(1) Patent Pending

> 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 overspeed which causes excessive armature current and severe motor heating.

The FW contacts bypass 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 obtained directly from the speed control without any time delays.

The reverse coil of the reverse relay, Rev, is energized immediately if 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 motor rotation 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. If unsuppressed, these spikes may be capable of closing SCR's by supplying gate current. The varistor, VDR-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 allows 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 creates more charging energy per cycle of ac power input.

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-Hertz 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 higher rate of charge for each cycle of ac power input.

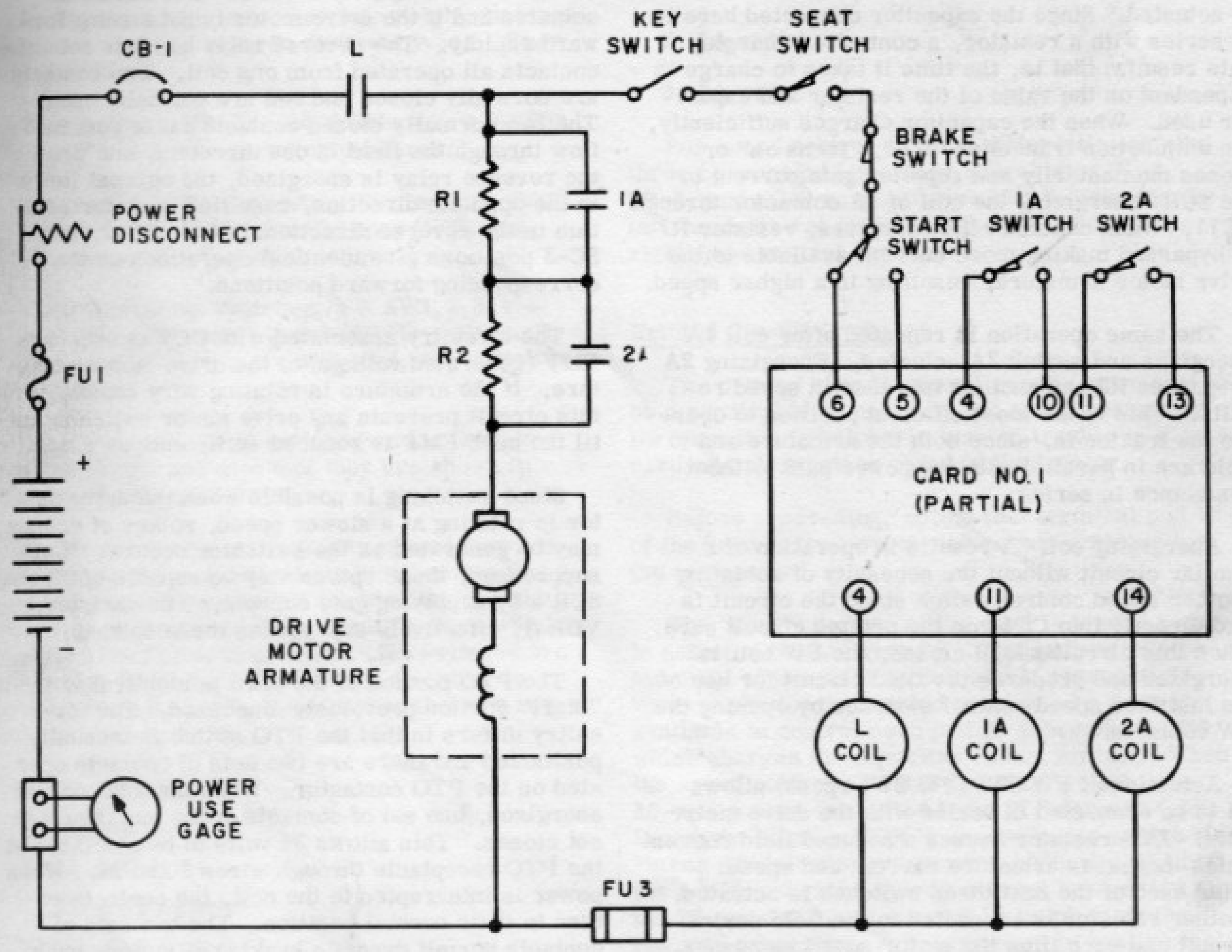


Fig. 5-2. E15 Drive Motor Armature Control

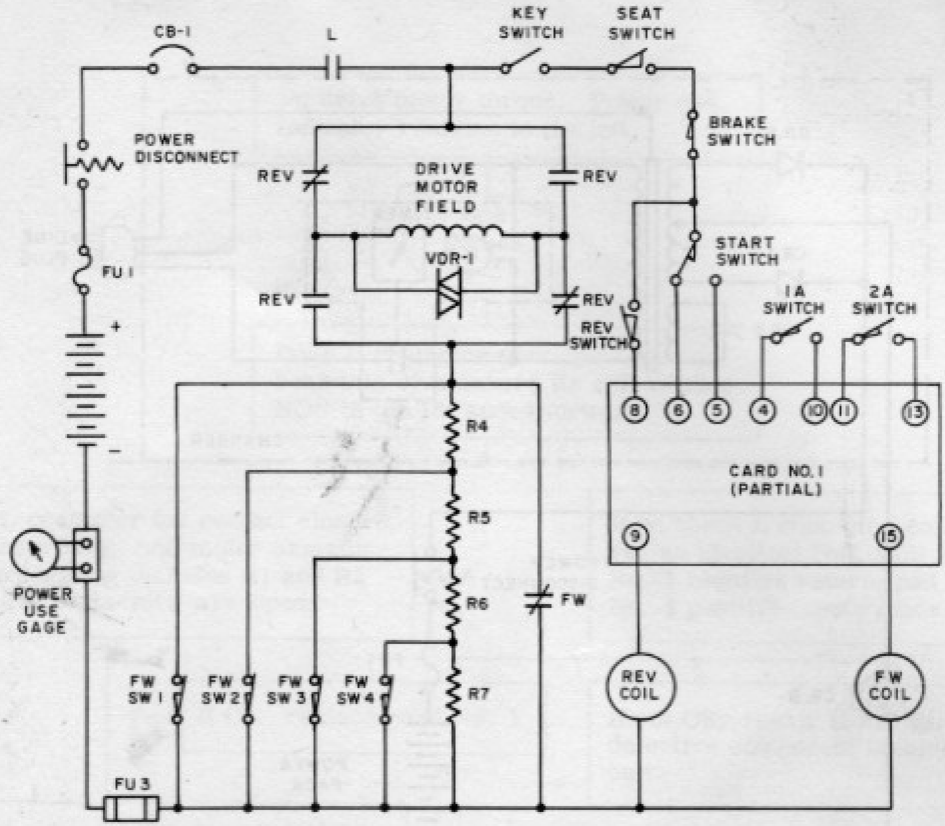


Fig. 5-3. E15 Drive Motor Field Control

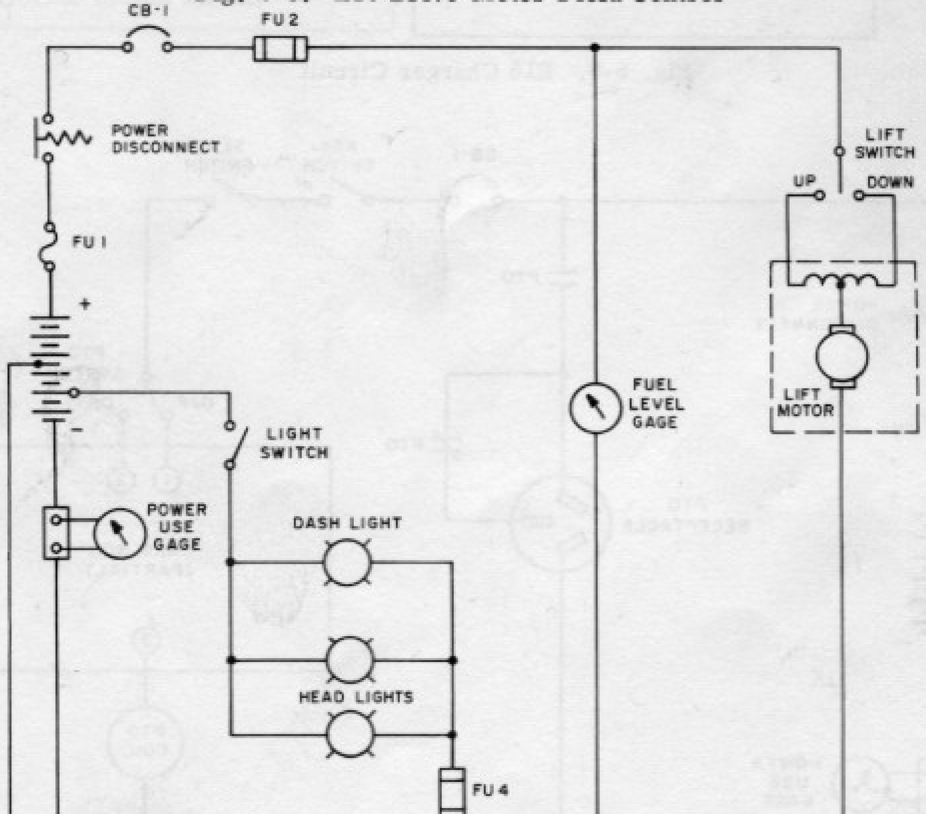


Fig. 5-4. E15 Lift and Light Circuit

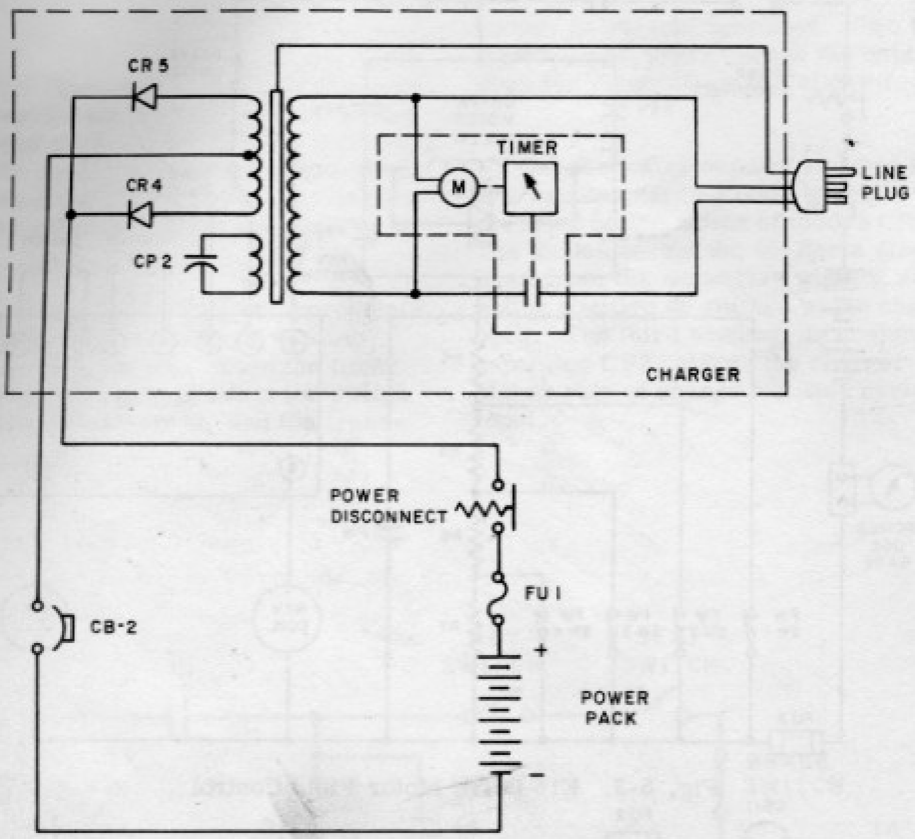


Fig. 5-5. E15 Charger Circuit

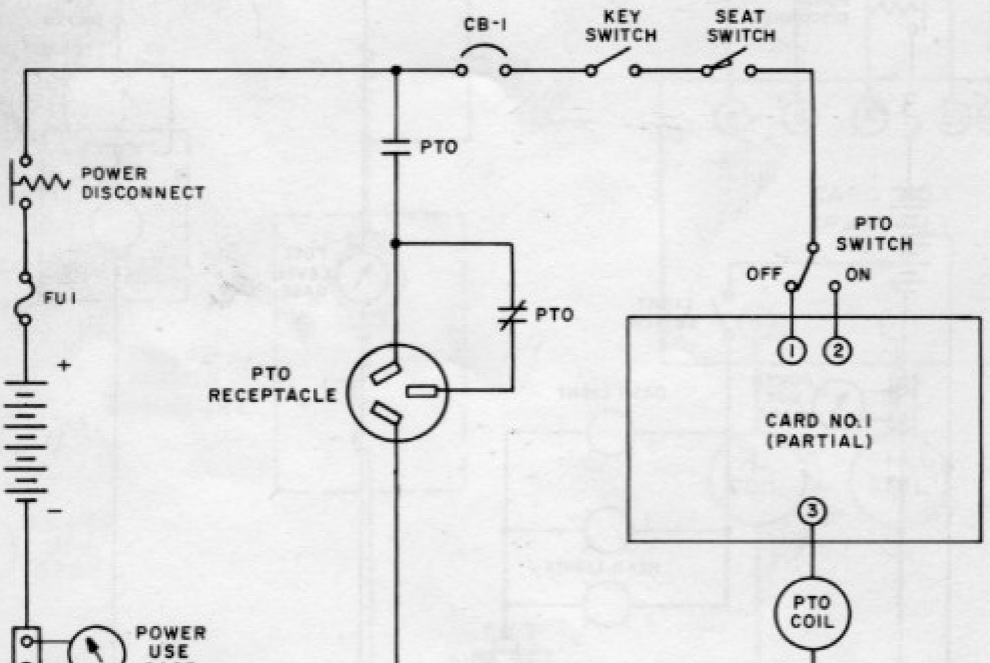


Fig. 5-6. E15 PTO Circuit

No drive motor torque. Power use indicator remains to the left.

See Figure 5-2

Does L contactor pick up? You can hear this or measure its coil voltage NOC in the 1st speed forward.

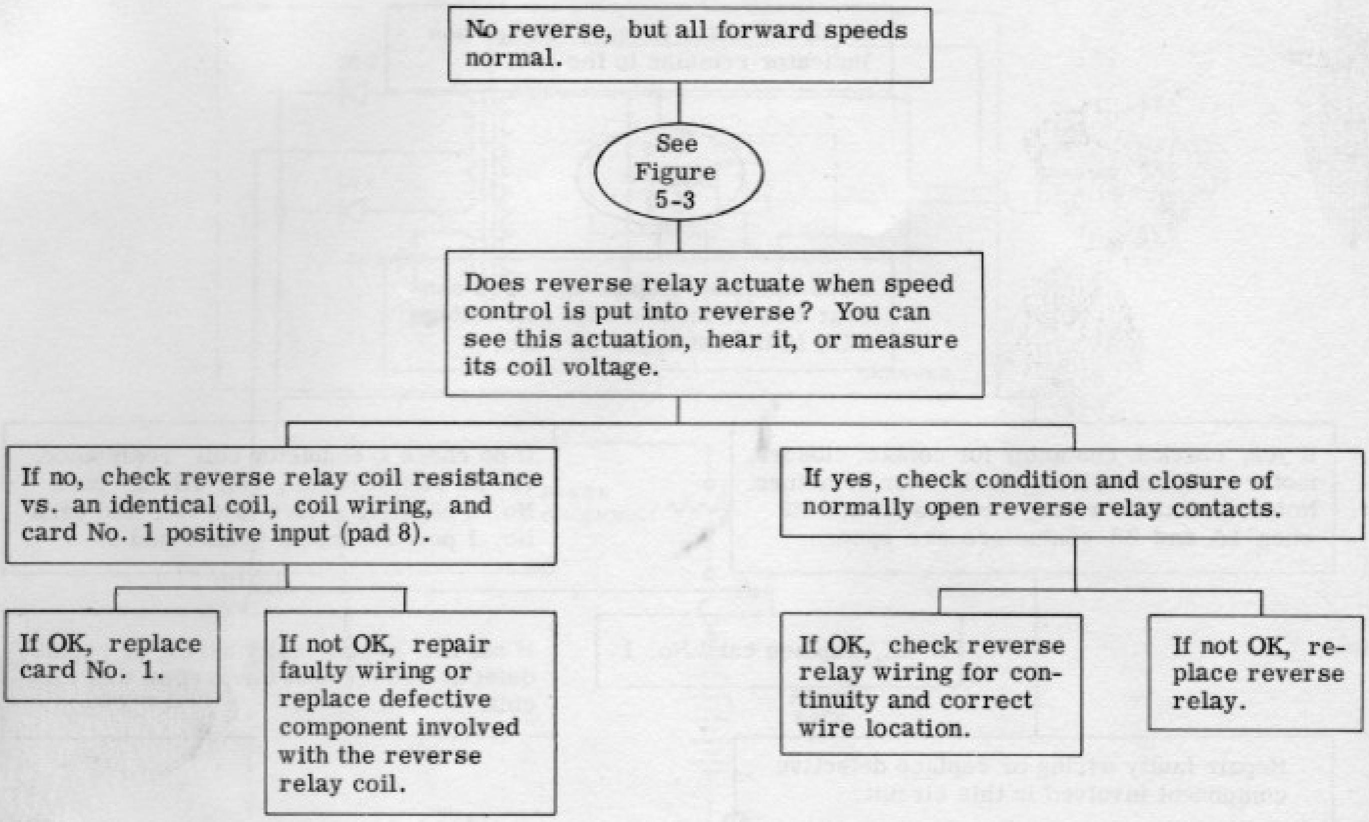
If yes, check L contactor for contact closure, motor armature wiring, and motor armature. Note: Armature wiring includes R1 and R2 when 1A and 2A contactors are open.

Repair faulty wiring or replace defective component involved in this circuit.

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.


No reverse, but all forward speeds normal.
See Figure 5-3
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 5-3

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 5-2

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 5-3

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 5-3

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 5-3

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 5-3

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 5-2

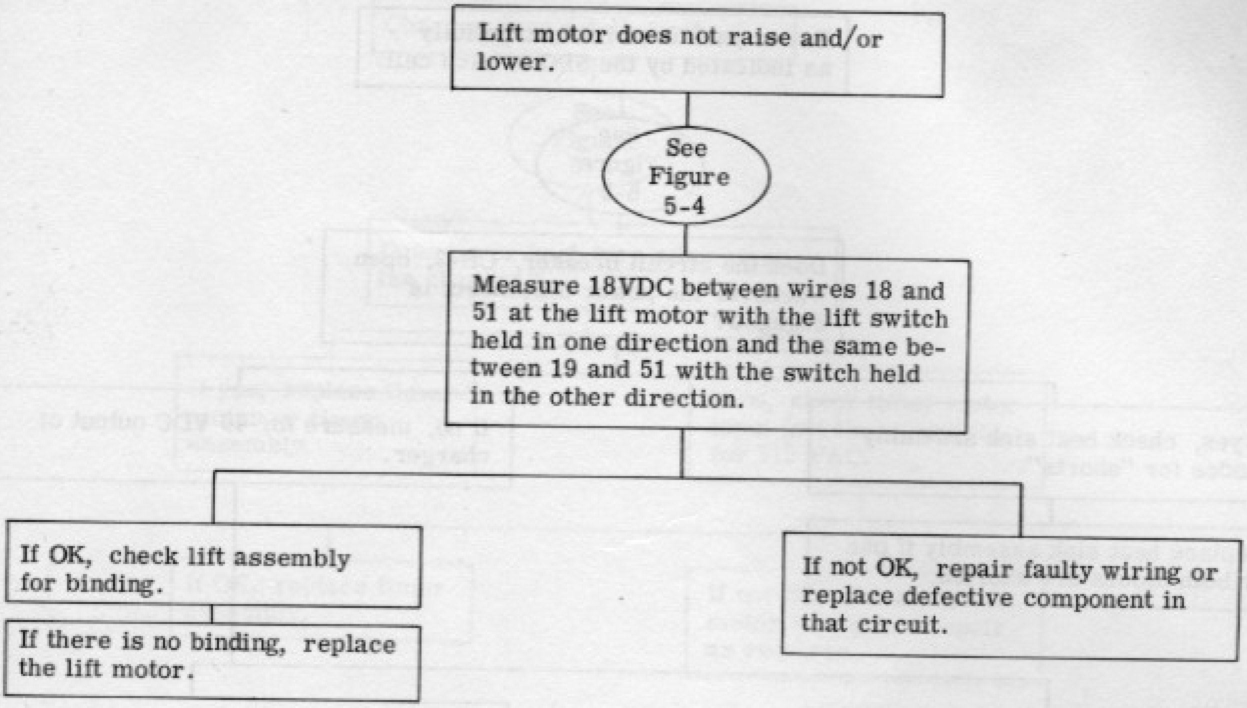
Does drive motor shut off if the speed control is moved slightly forward or slightly to the rear?

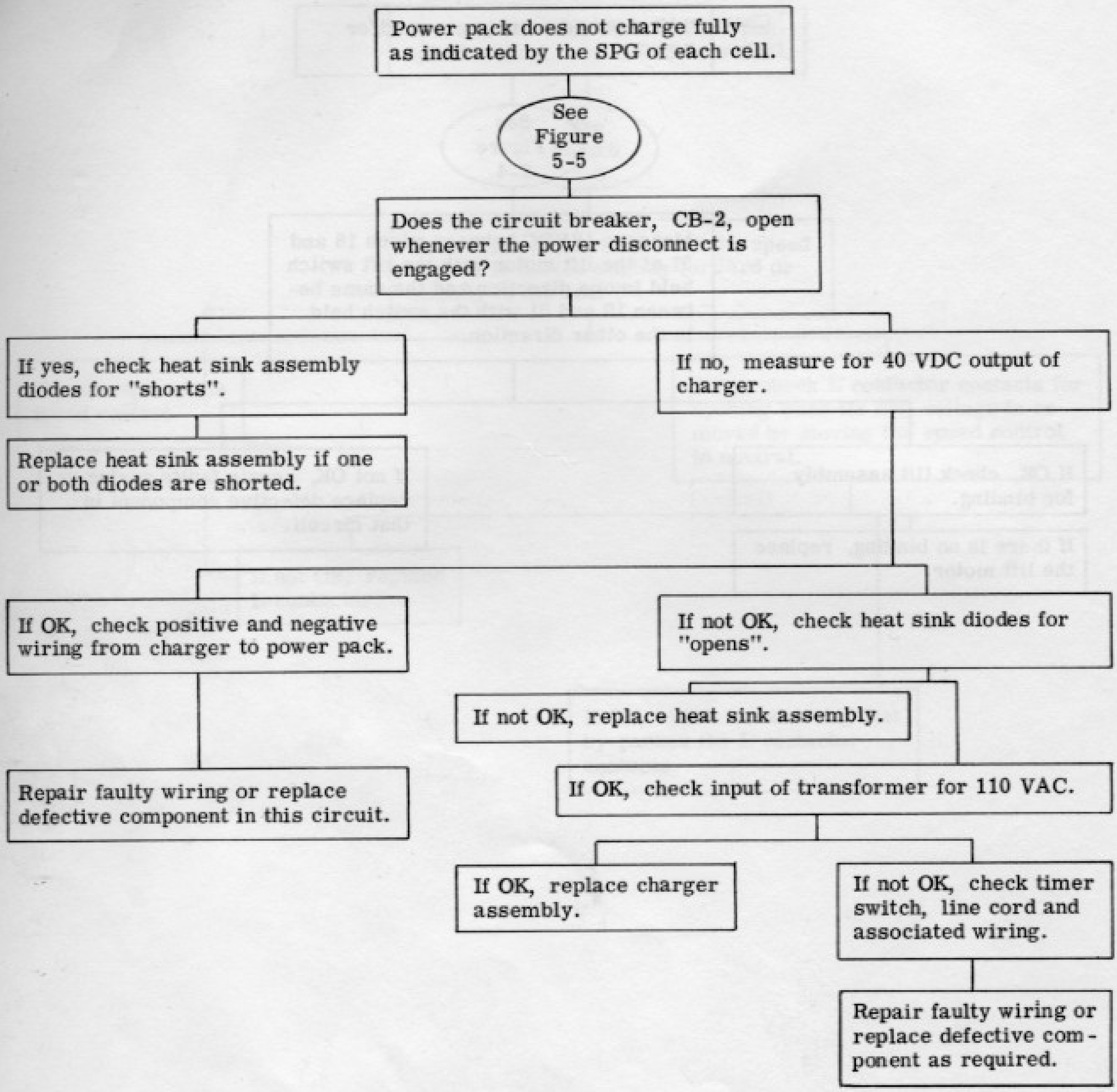
If yes, replace the speed control.

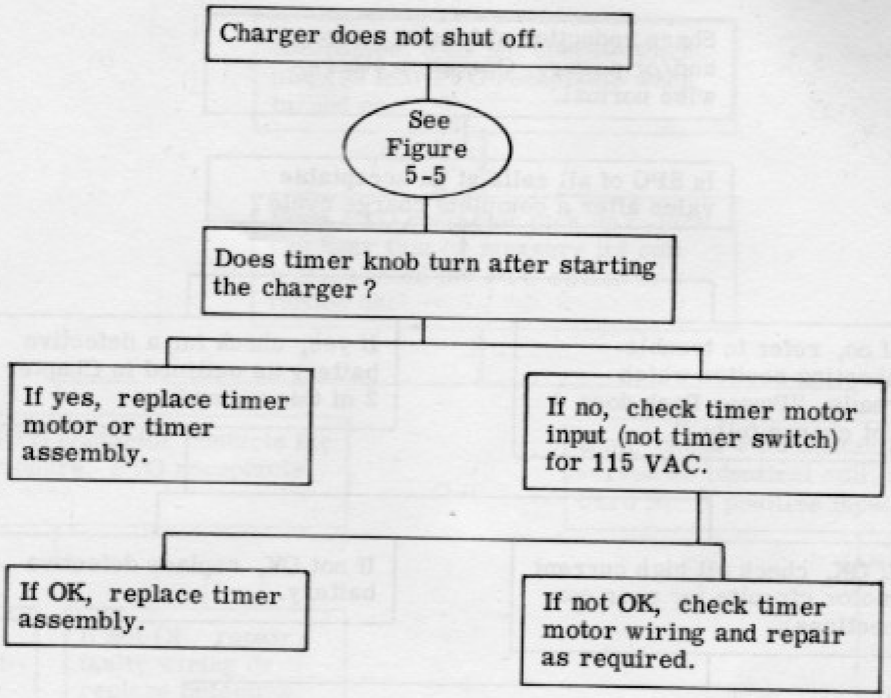
If no, check L contactor contacts for opening when its coil voltage is removed by moving the speed control to neutral.

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 5-4
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 5-5
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 5-5
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 troubleshooting 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 ok, suspect defective attachment wiring or its motor.

If not OK, repair faulty wiring or replace defective component.

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, replace card No. 1.

If not OK, repair faulty wiring or replace defective component.

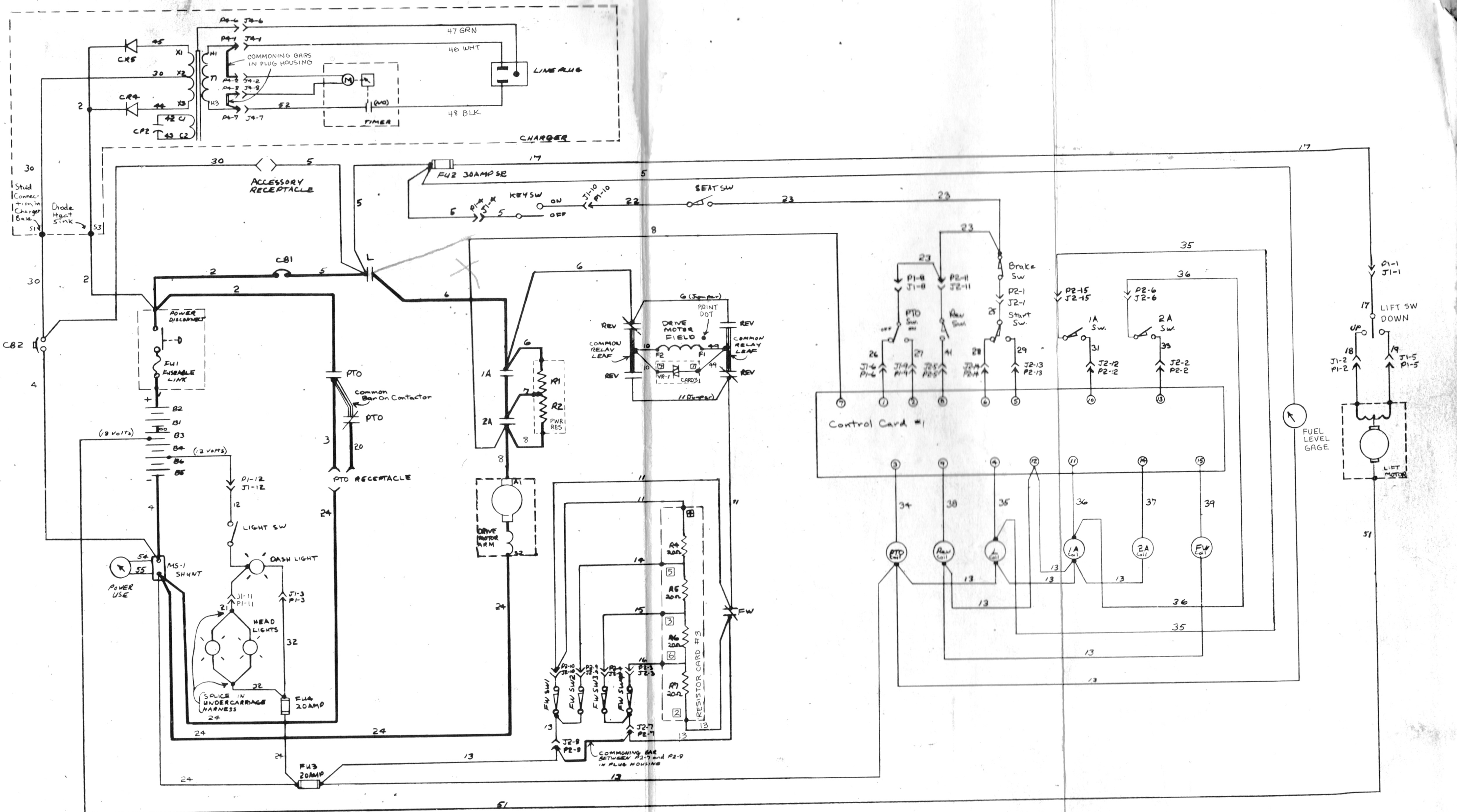


Fig. 5-7 E15 Troubleshooting Sketch

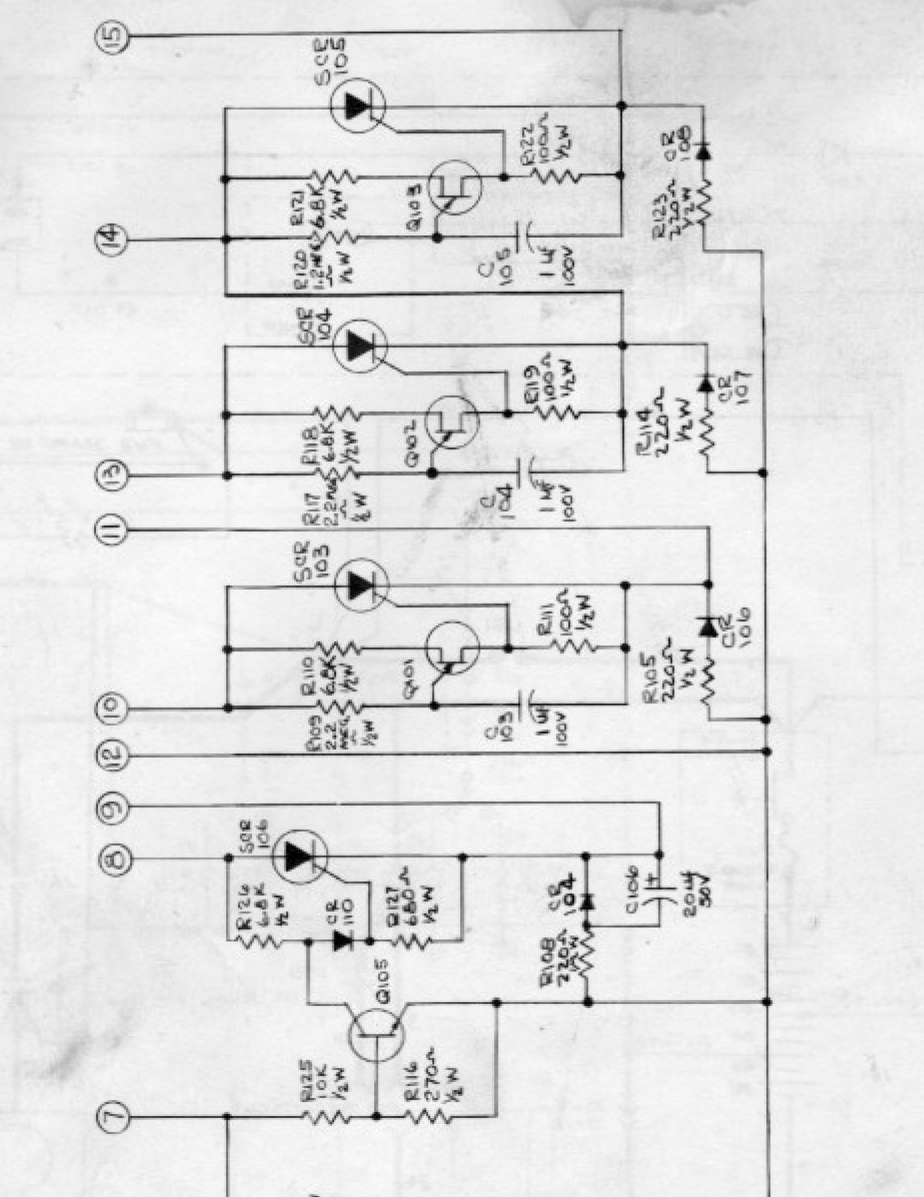


Fig. 5-8 26AE15 Card #1 (Control) Schematic

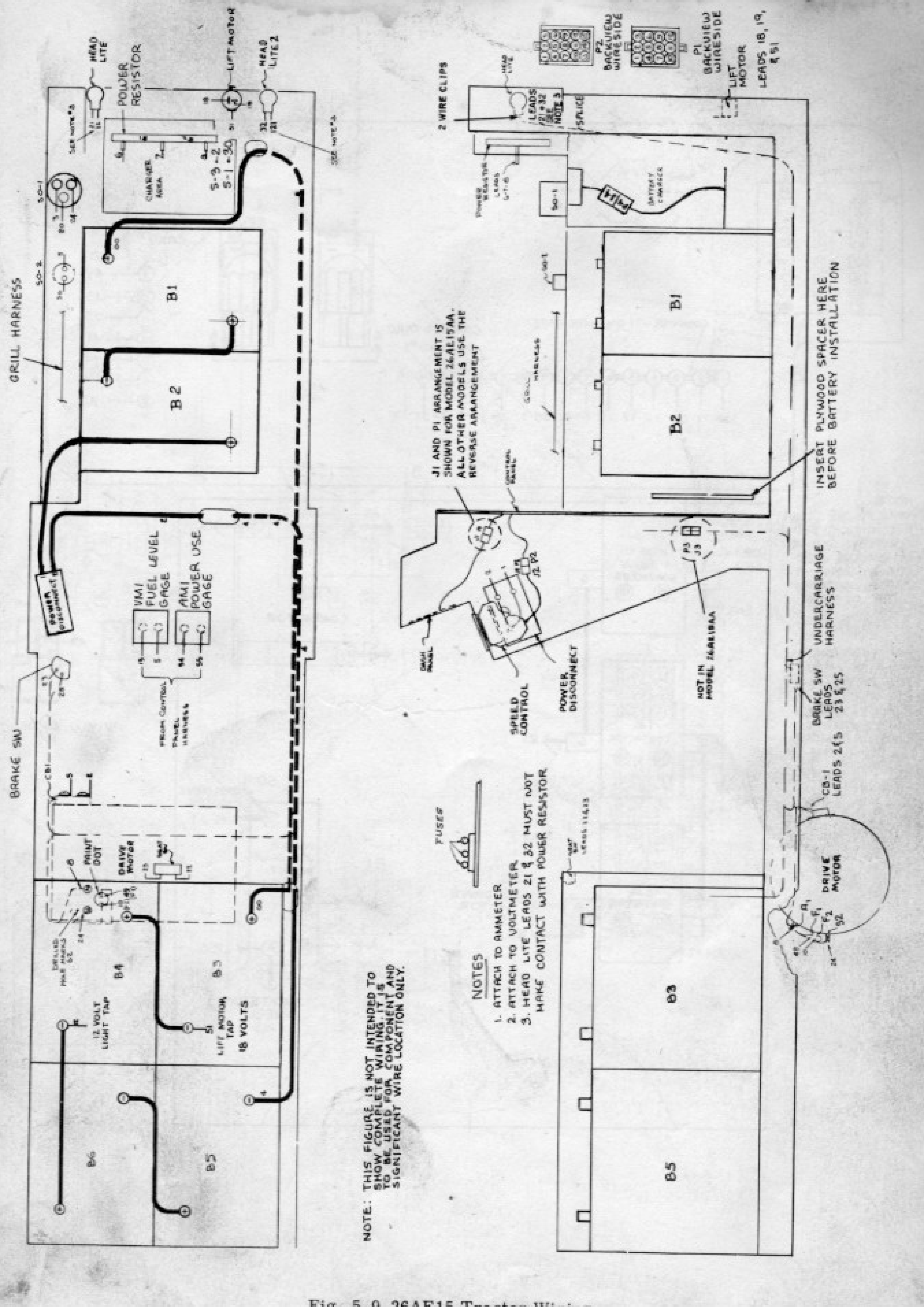


Fig. 5-9 26AE15 Tractor Wiring

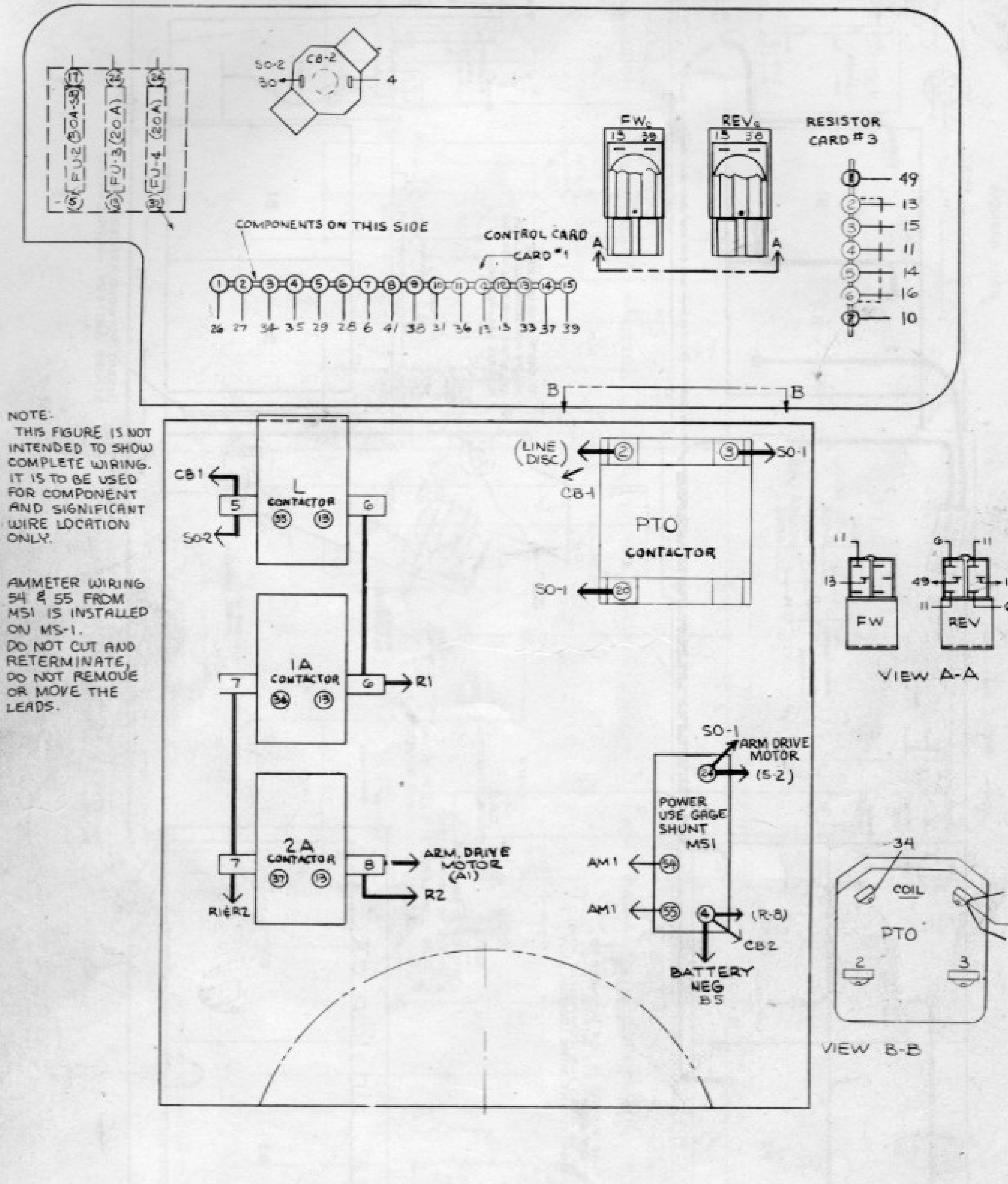
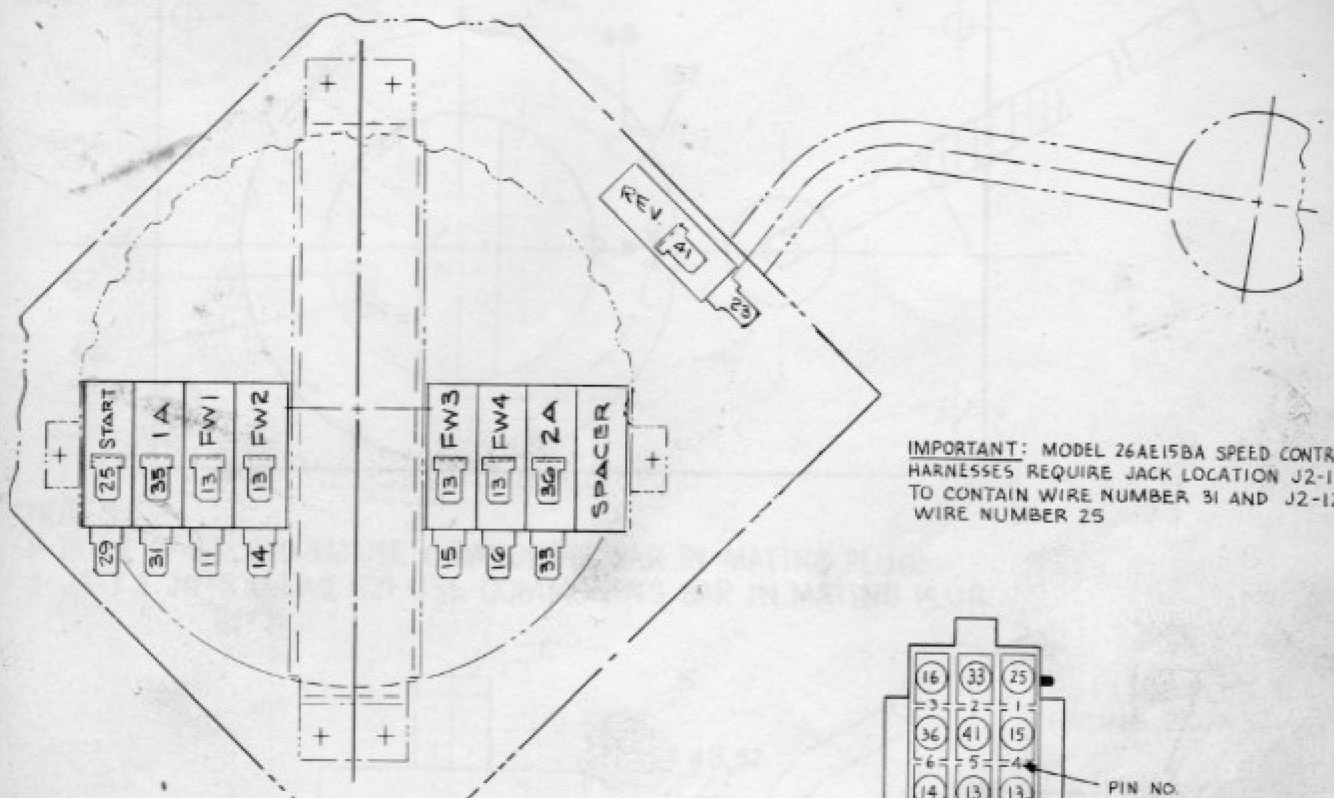
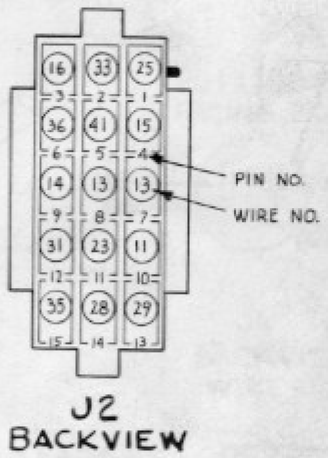


Fig. 5-10 26AE15 Control Panel Wiring



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



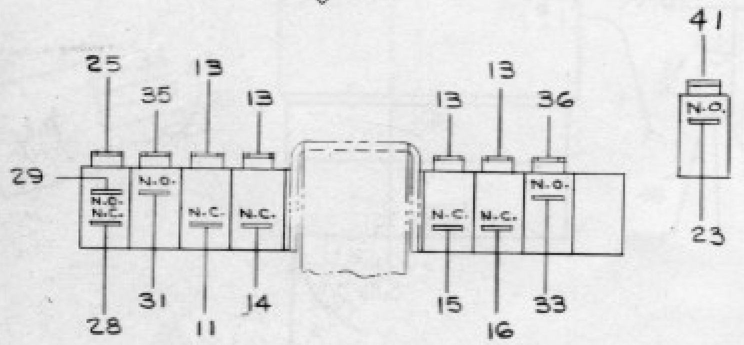
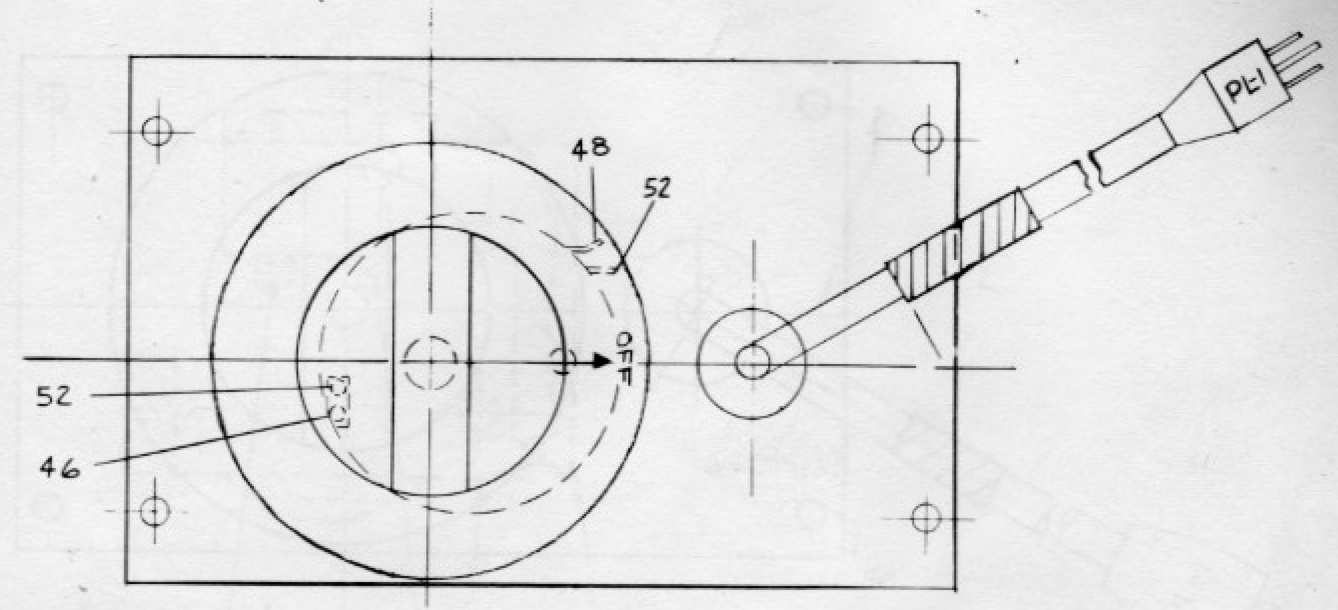


Fig. 5-11 26AE15 Speed Control Wiring



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.

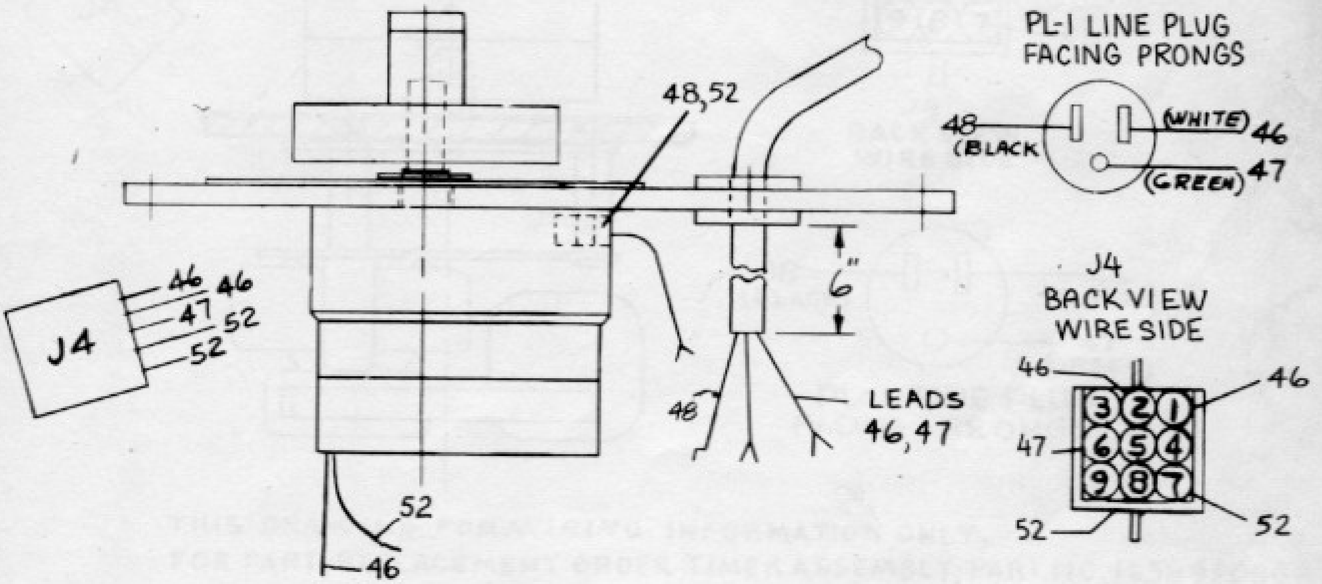
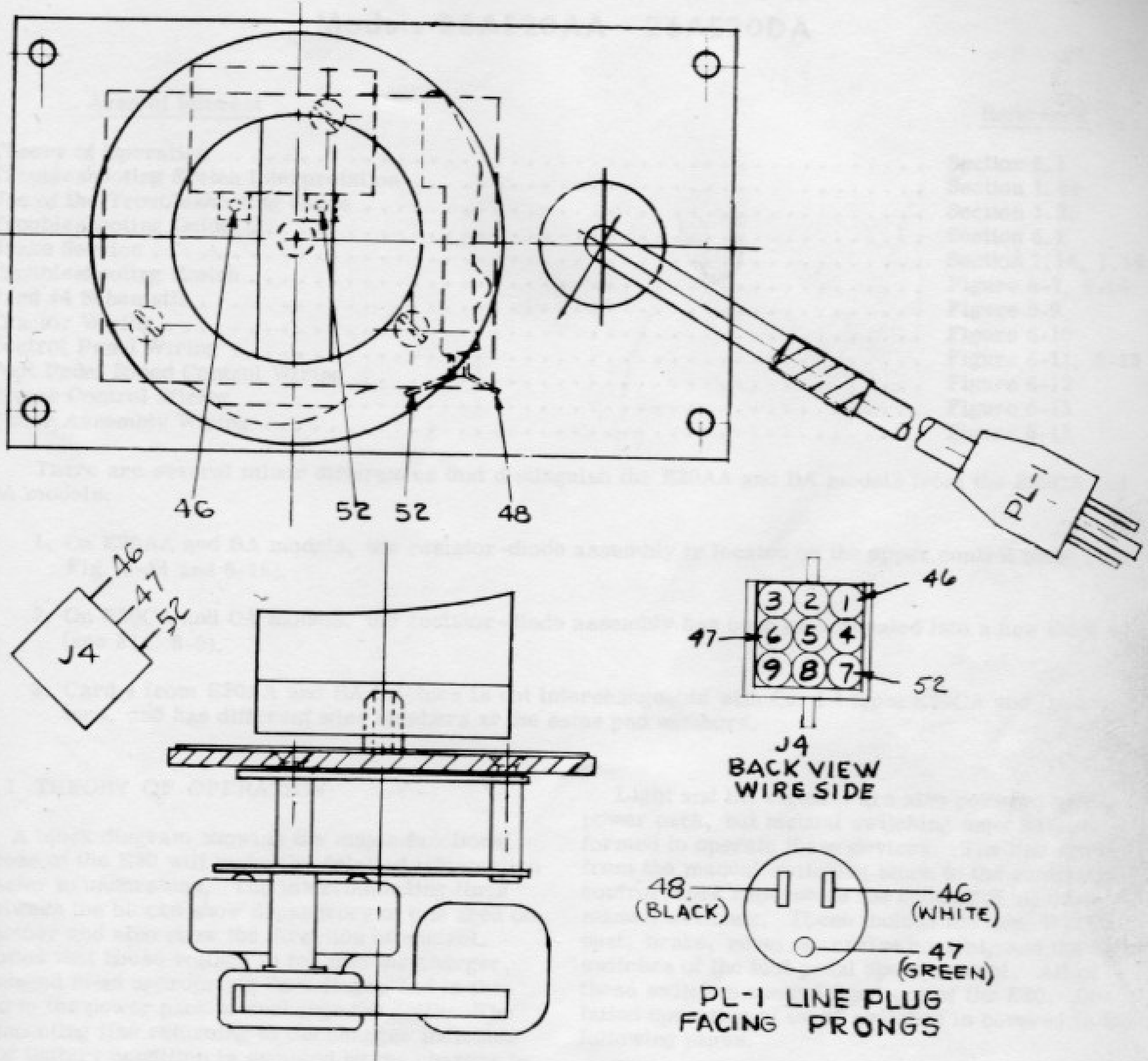


Fig. 5-12 26AE15 Timer Assembly Wiring (Model 26AE15A has alternate methods. See Fig. 5-13.)



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

Fig. 5-13 26AE15AA* Timer Assembly Wiring
*This is one alternate method. See Fig. 5-12

E20 ELEC-TRAK TRACTORS

Models 26AE20AA - 26AE20DA

There are several minor differences that distinguish the E20AA and BA models from the E20CA and DA models:

1. On E20AA and BA models, the resistor-diode assembly is located on the upper control panel (see Fig. 6-11 and 6-15).

2. On E20CA and DA models, the resistor-diode assembly has been incorporated into a new Card 4 (see Fig. 6-9).

3. Card 4 from E20AA and BA tractors is not interchangeable with Card 4 from E20CA and DA tractors, and has different wire numbers at the same pad numbers.

6

6.1 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 dc 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 Fig. 6-1. 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.

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

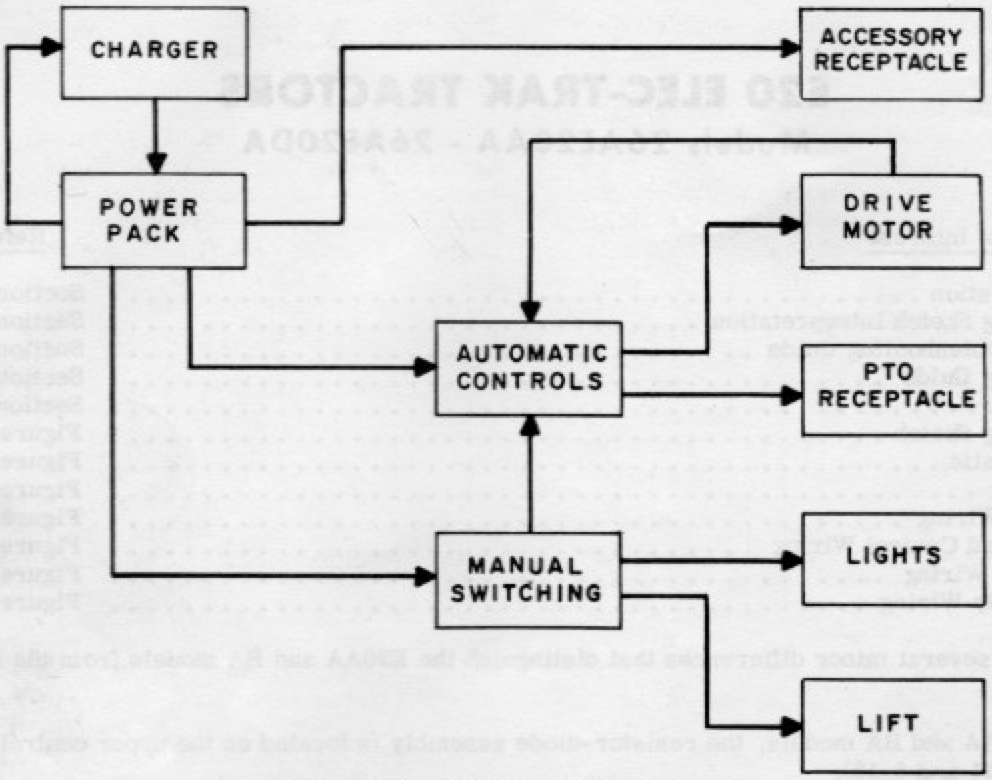


Fig. 6-1. E20 Block Diagram

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 Fig. 6-2.

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 the 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 that 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" closes. 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 Fig. 6-3 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

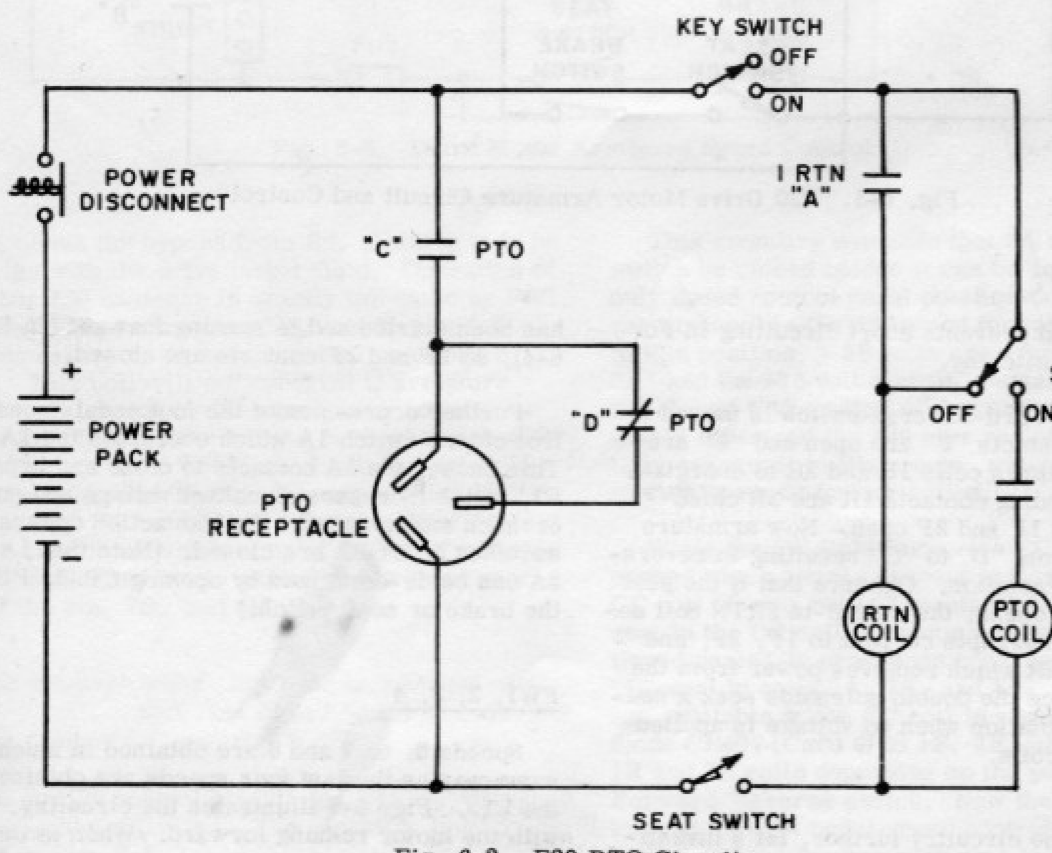


Fig. 6-2. E20 PTO Circuit

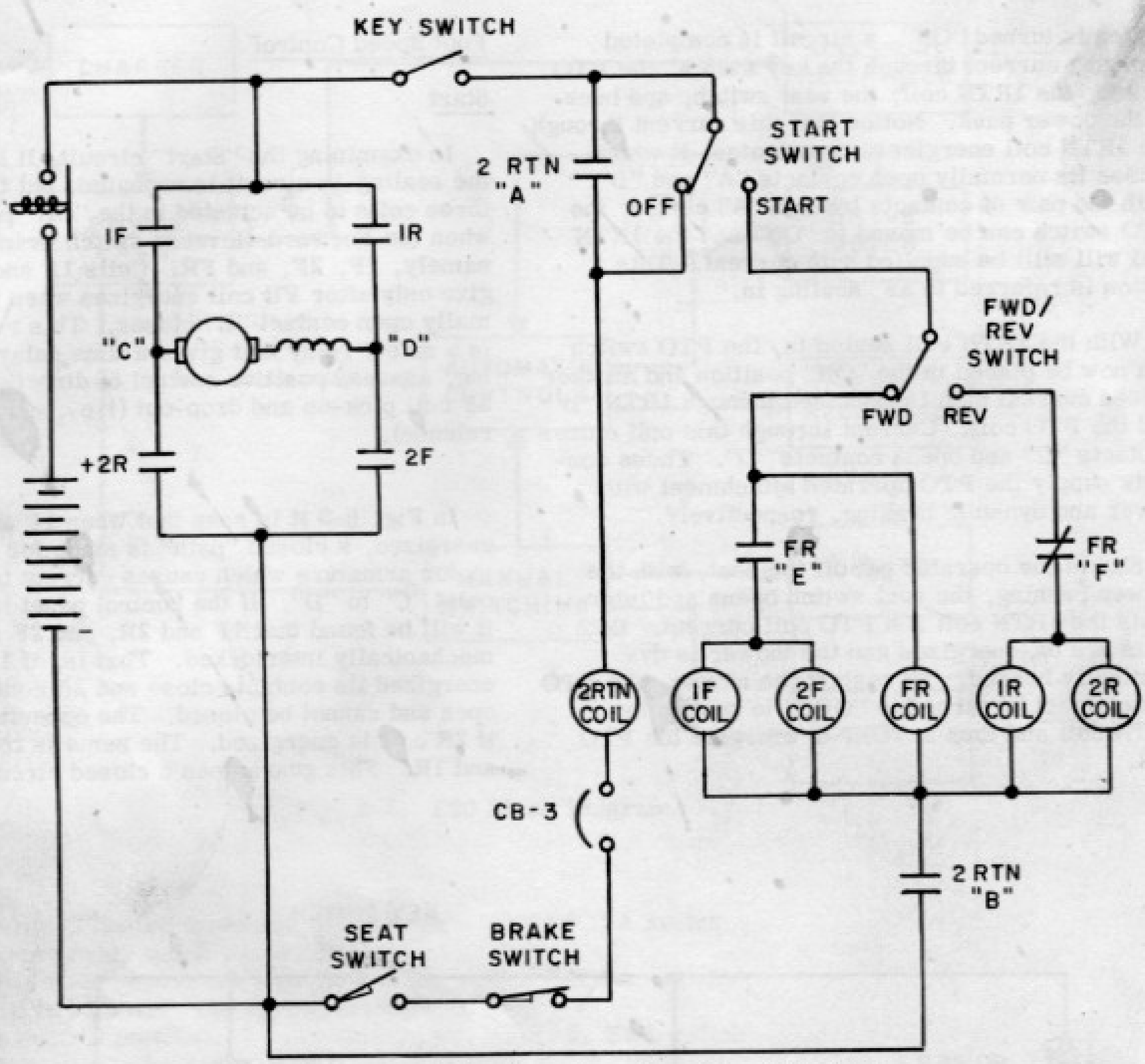


Fig. 6-3. E20 Drive Motor Armature Circuit and Control

the armature and prevents short circuiting in Forward-Reverse switching.

When the Forward-Reverse switch is moved to Reverse, FR contacts "E" are open and "F" are closed, which allows 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 Fig. 6-4), so 1F and 2F contacts are closed.

Further depression of the foot pedal speed control closes switch 1A which energizes the 1A coil. This causes the 1A contacts to close and bypass 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, or the 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. Fig. 6-5 illustrates the circuitry, again with the motor running forward. When switch FW1 is actuated with the speed control pedal, it opens

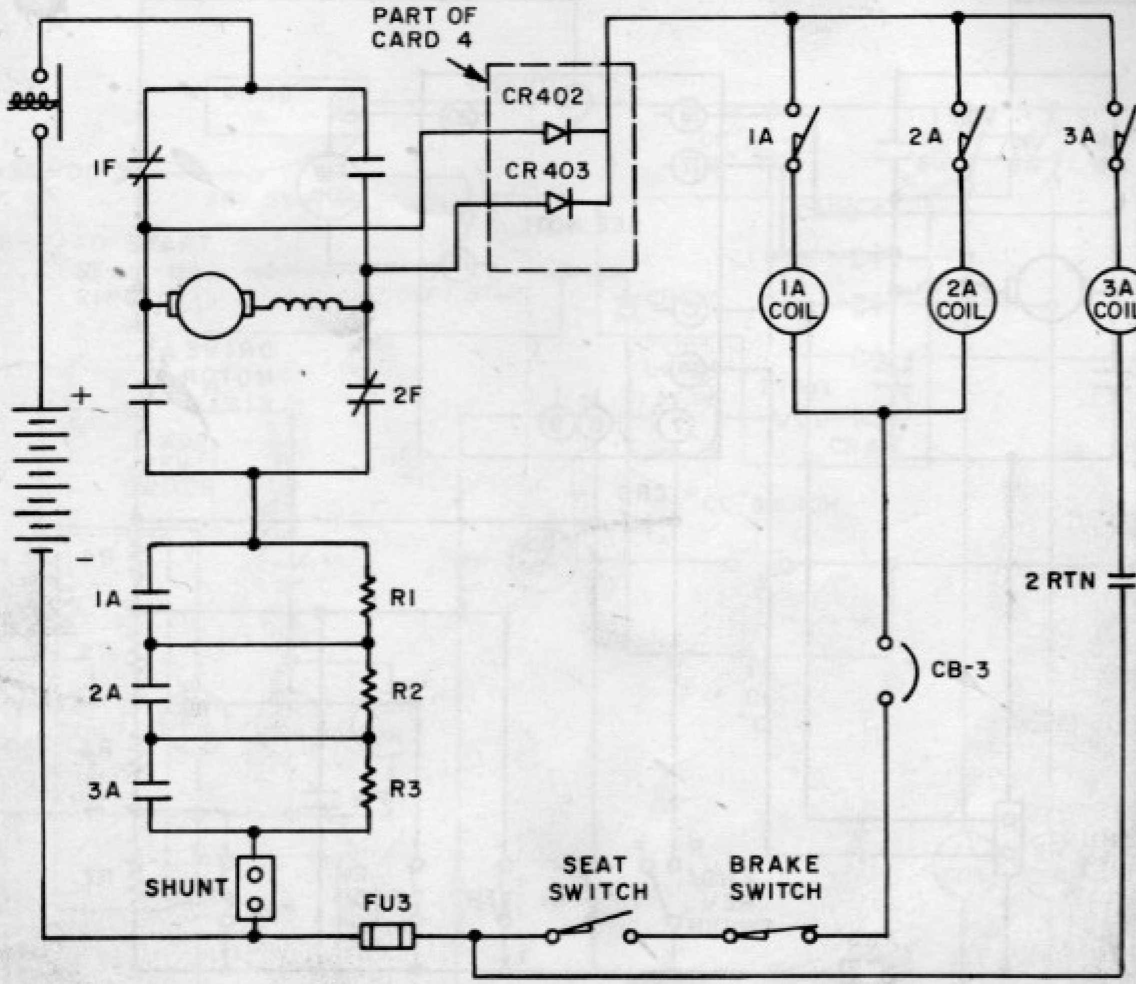


Fig. 6-4. Drive Motor Armature Speed Control

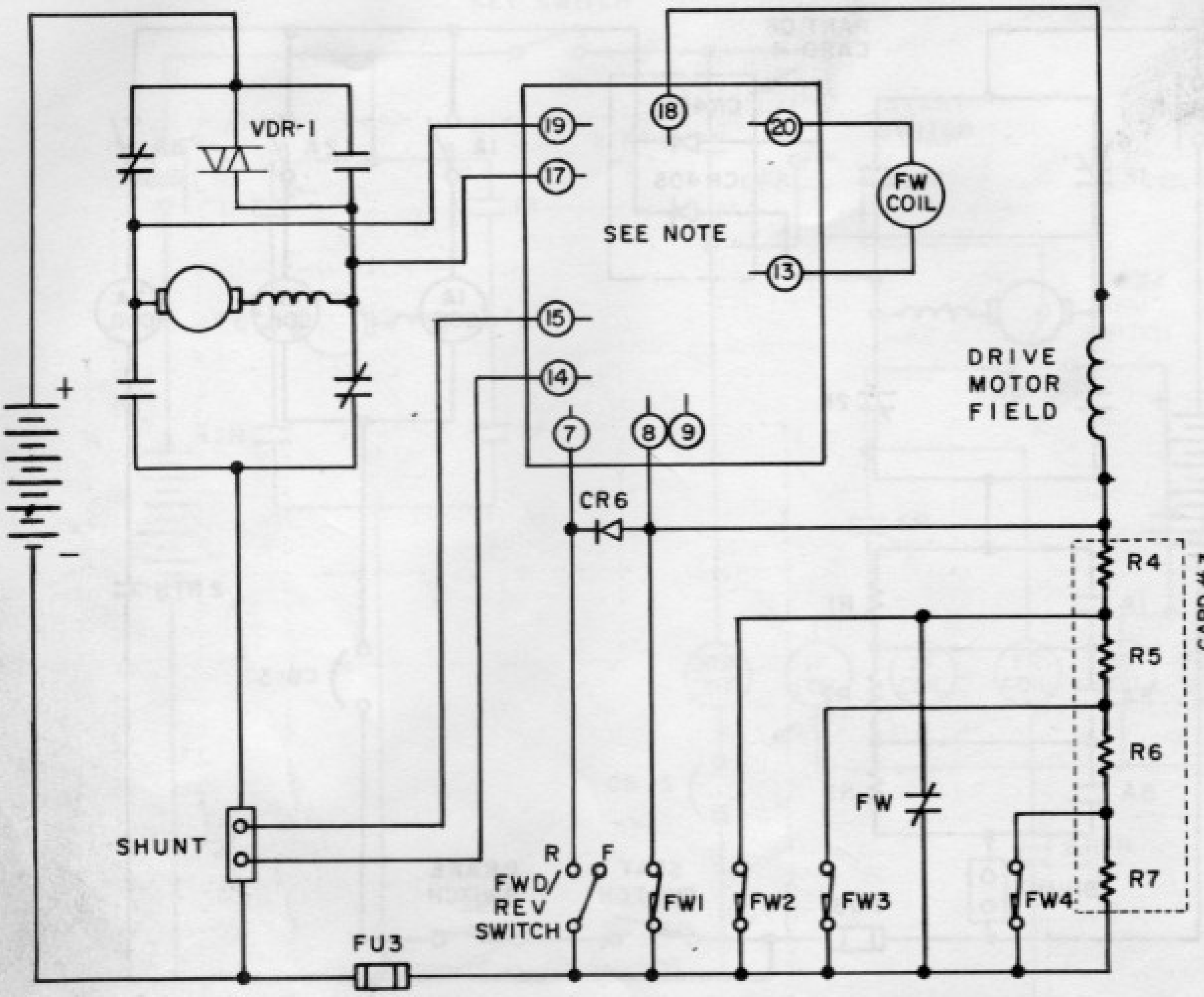
and removes the bypass from R4, allowing it to be in series with the drive motor field. Operation of the other FW switches is exactly the same as FW1, but relay FW contacts must open before speed changes can occur in speed control positions 6, 7, and 8. This coil will not energize if armature current, 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 Fig. 6-6.

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 pedal speed control can be released and the tractor continues to operate in the



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.

Fig. 6-5. Drive Motor Field Control

4th forward speed until the speed control is depressed past the 4th forward speed position, or the seat, brake, or key switch are opened.

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 Section 1.11 for operation and troubleshooting information.

Forward/Reverse

In addition to the operation of the Forward/Reverse switch already discussed, another function is illustrated in Fig. 6-5. This half of the 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 bypassed 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 bypass 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 Fig. 6-3 and 6-4).

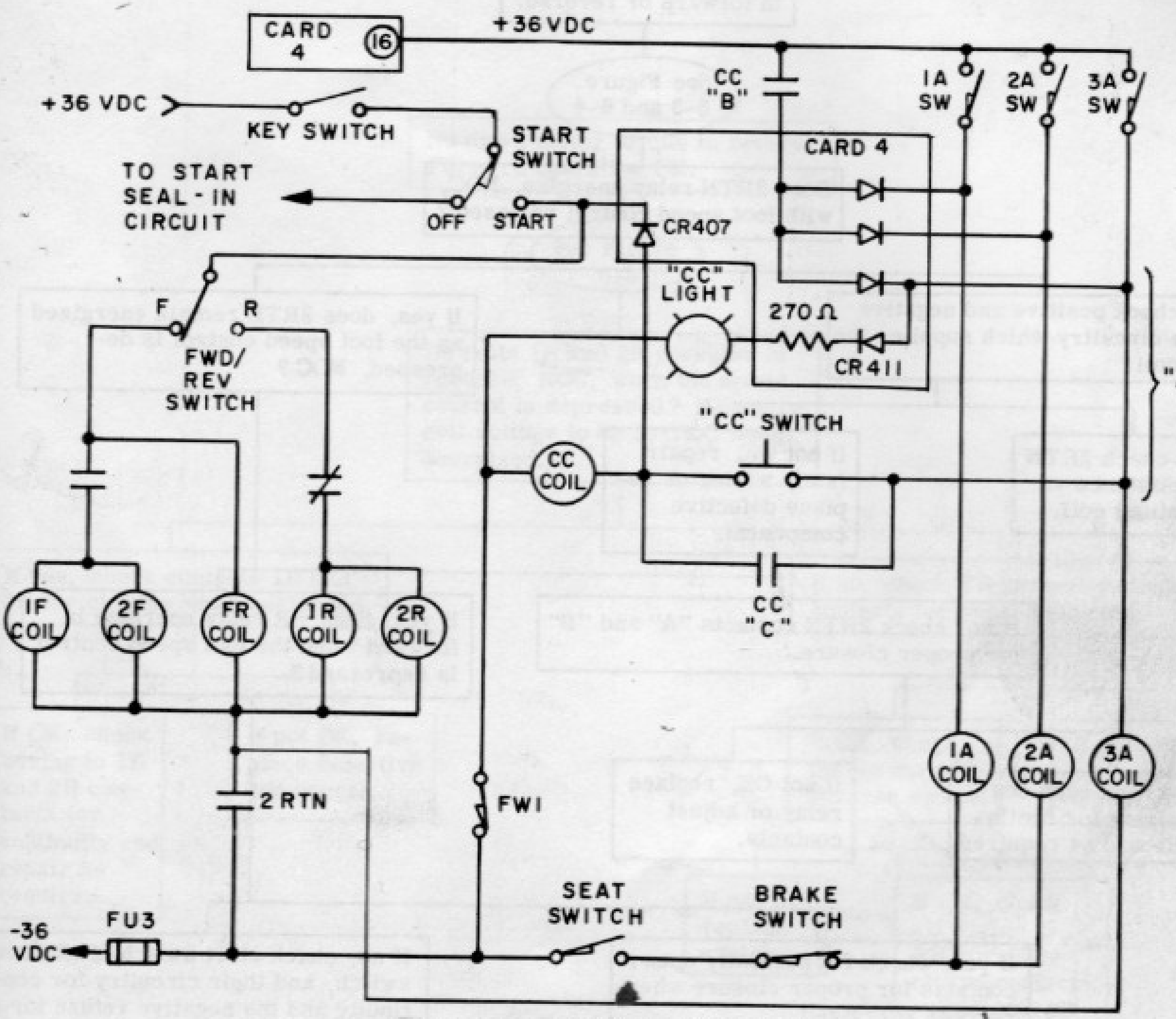
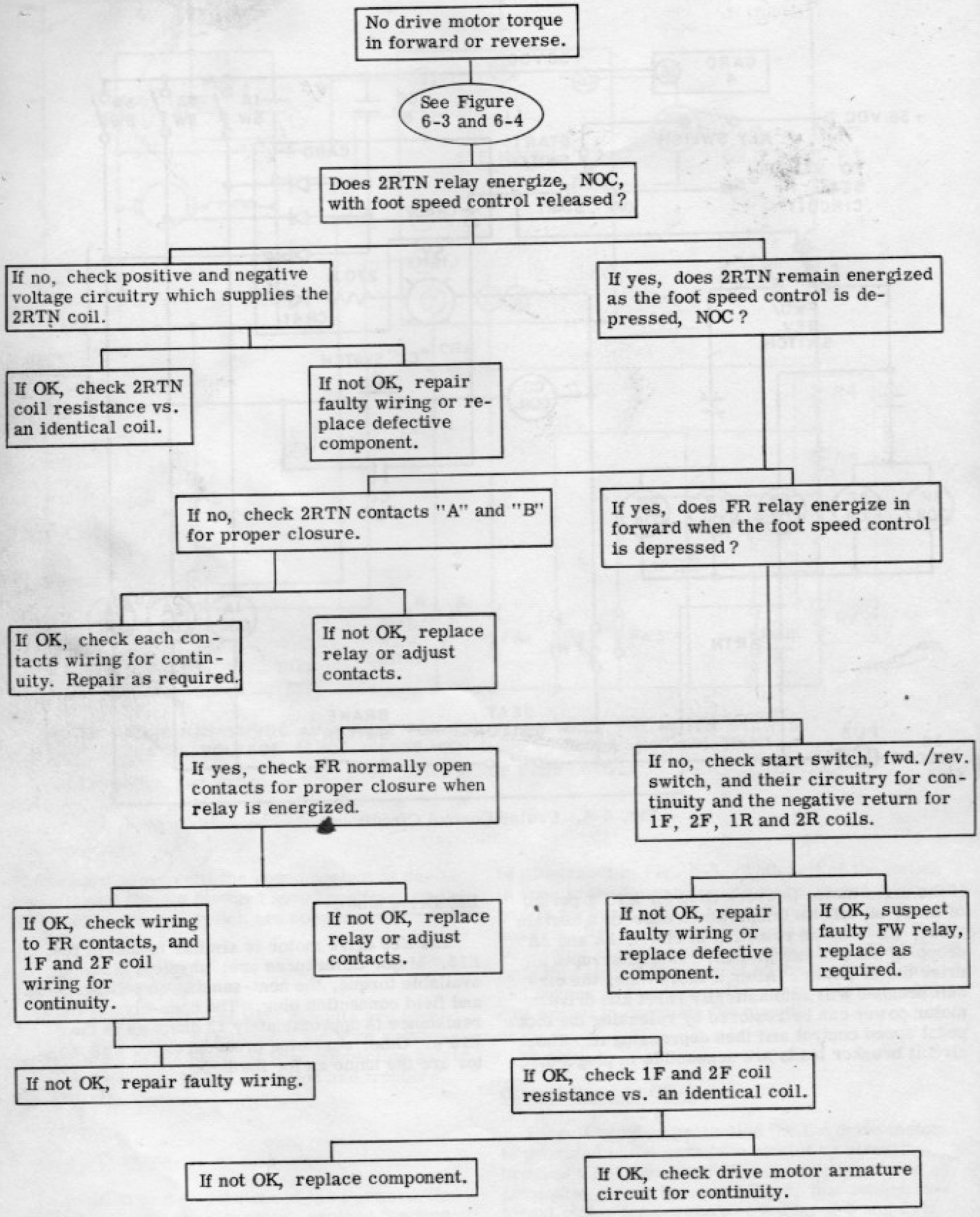


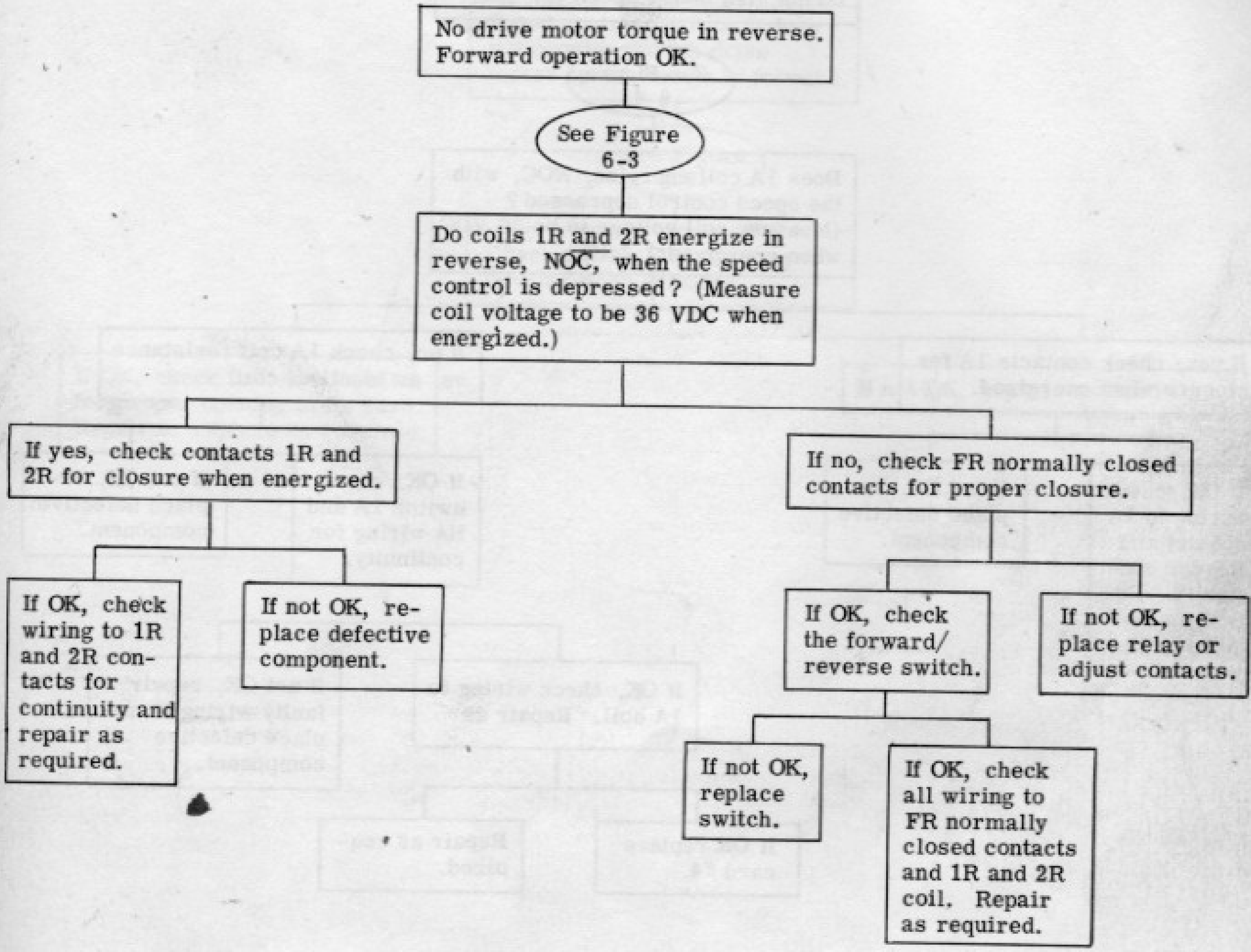
Fig. 6-6. Cruise Control Circuit

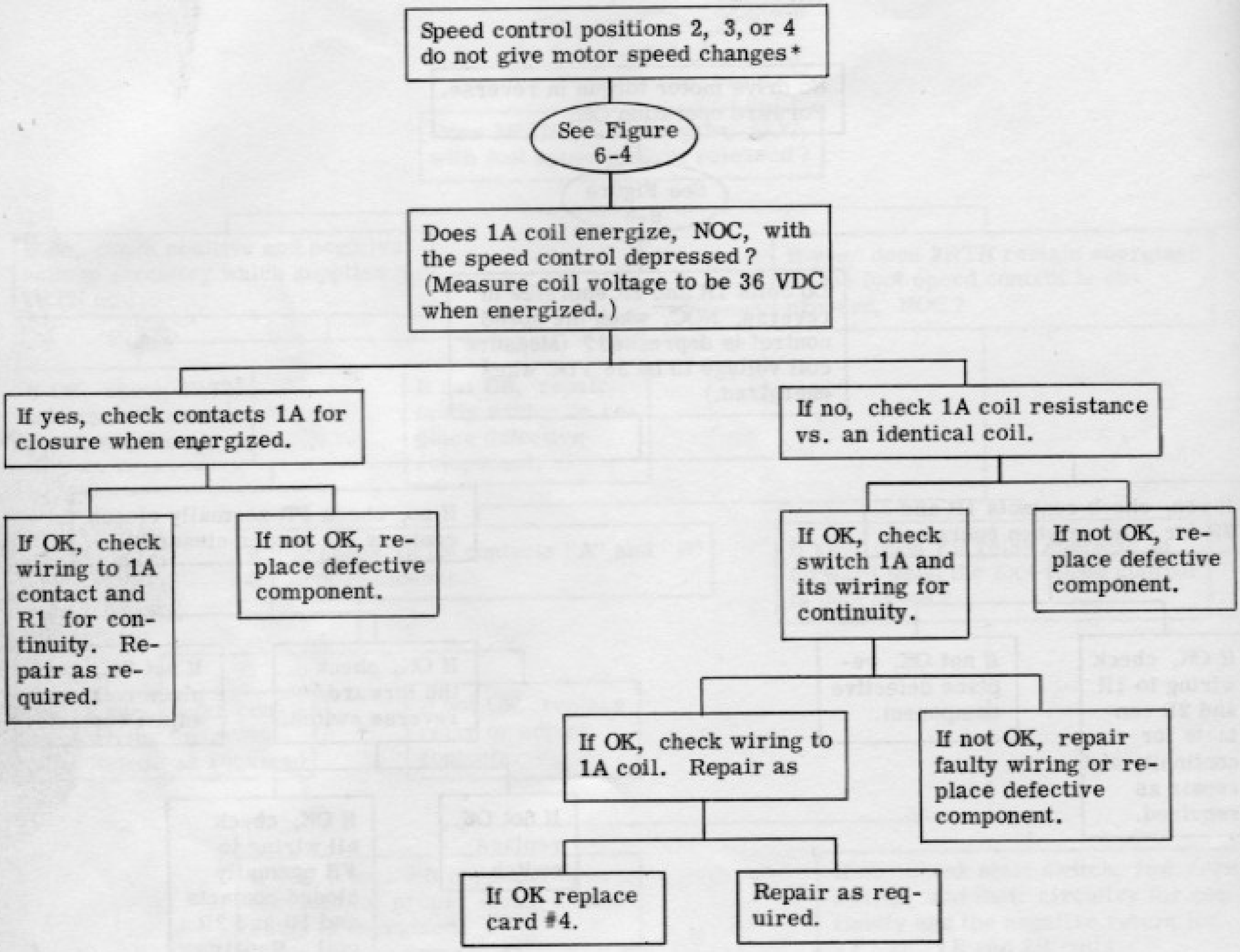
If the drive motor is overloaded for a long period of time, so that its temperature exceeds a certain value, CB-3 opens resulting in 2RTN, 1A and 2A dropping out (de-energizing). This interrupts all drive motor power. After a short time, the circuit breaker will automatically reset and drive motor power can be restored by releasing the foot pedal 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.


No drive motor torque in forward or reverse.
See Figure 6-3 and 6-4
Does 2RTN relay energize, NOC, with foot speed control released?
If no, check positive and negative voltage circuitry which supplies the 2RTN coil.
If OK, check 2RTN coil resistance vs. an identical coil.
If not OK, repair faulty wiring or replace defective component.
If yes, does 2RTN remain energized as the foot speed control is depressed, NOC?
If no, check 2RTN contacts "A" and "B" for proper closure.
If OK, check each contacts wiring for continuity. Repair as required.
If not OK, replace relay or adjust contacts.
If yes, does FR relay energize in forward when the foot speed control is depressed?
If yes, check FR normally open contacts for proper closure when relay is energized.
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.
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.
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 not OK, repair faulty wiring or replace defective component.
If OK, suspect faulty FW relay, replace as required.


No drive motor torque in reverse. Forward operation OK.
See Figure 6-3
Do coils 1R and 2R energize in reverse, $\overline{NOC}$, 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.

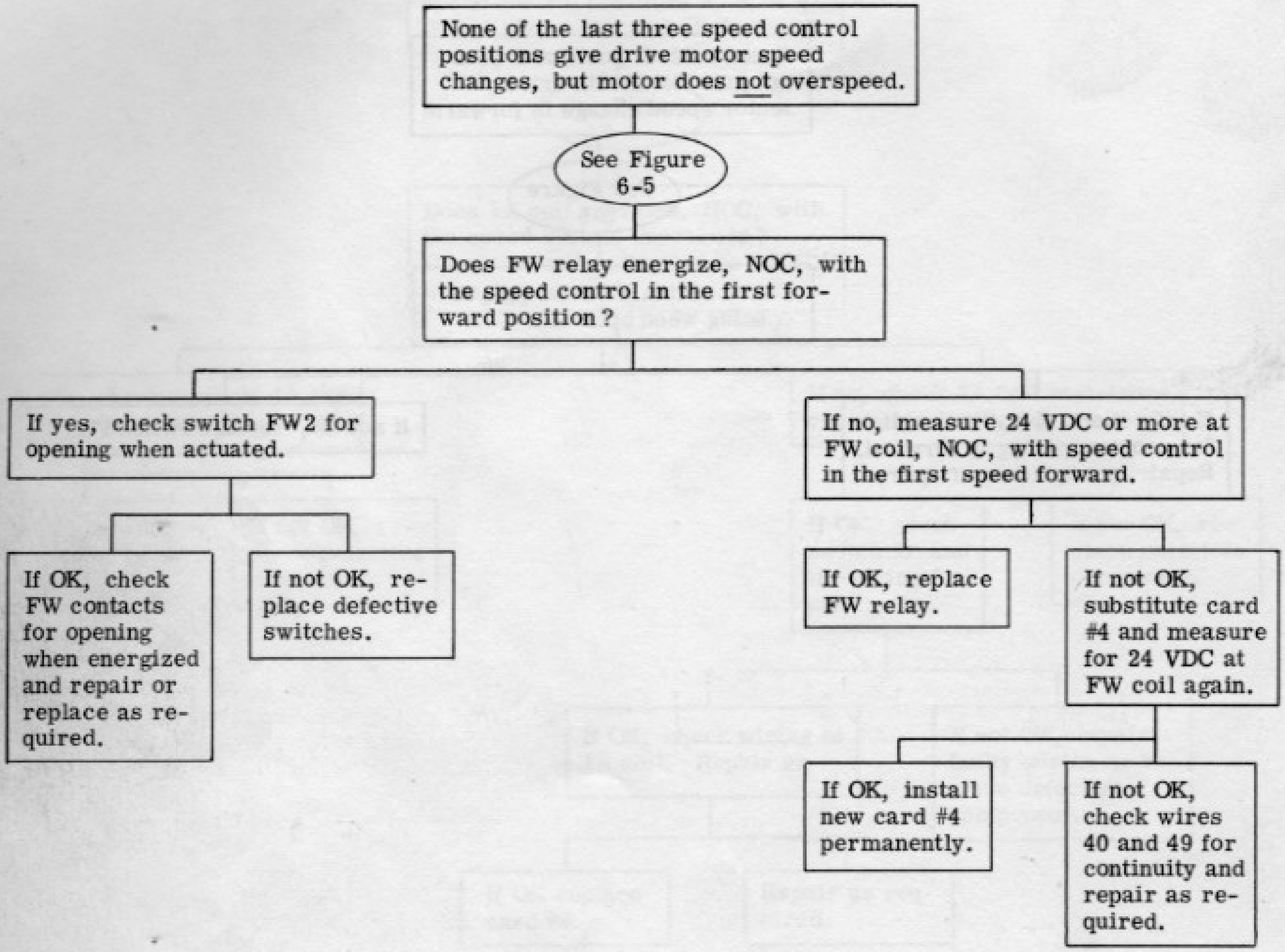
Speed control position 5 does not provide the 5th drive motor speed change in forward.

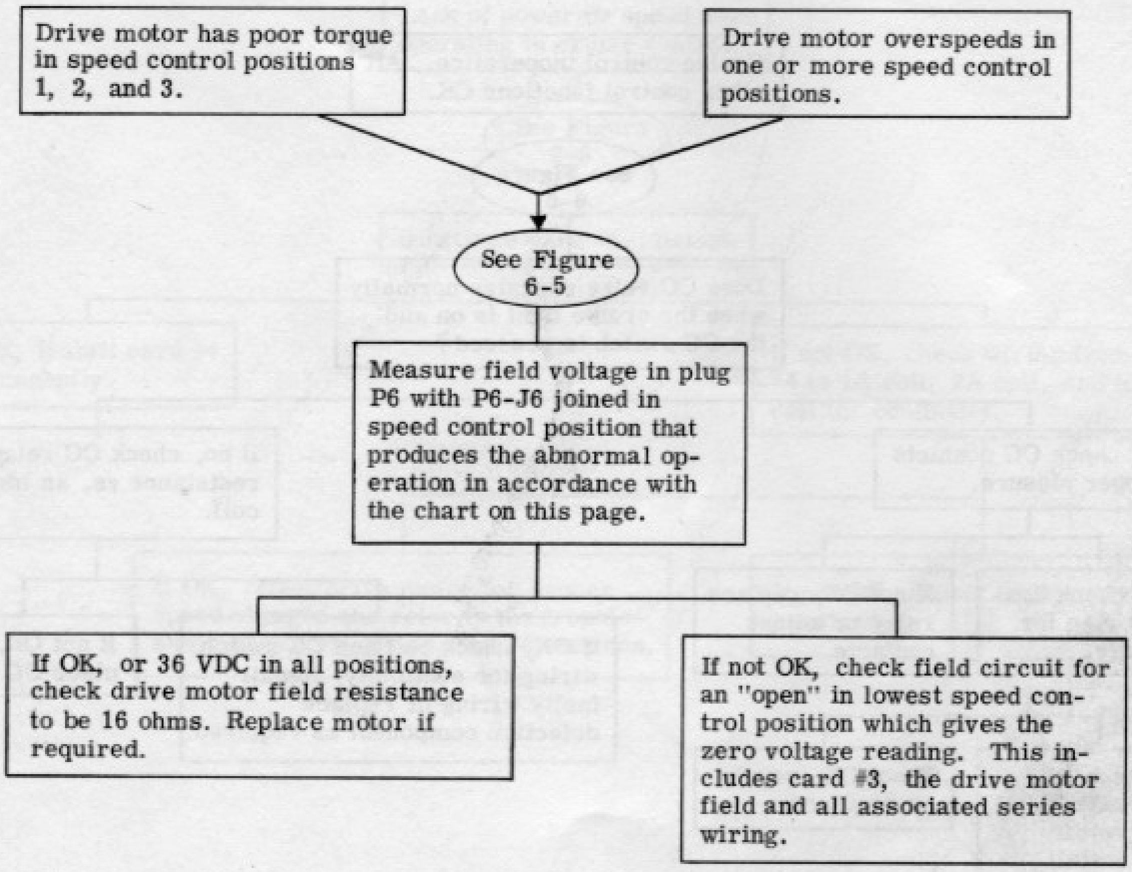
See Figure 6-5

Check switch FW1 for proper opening when actuated.

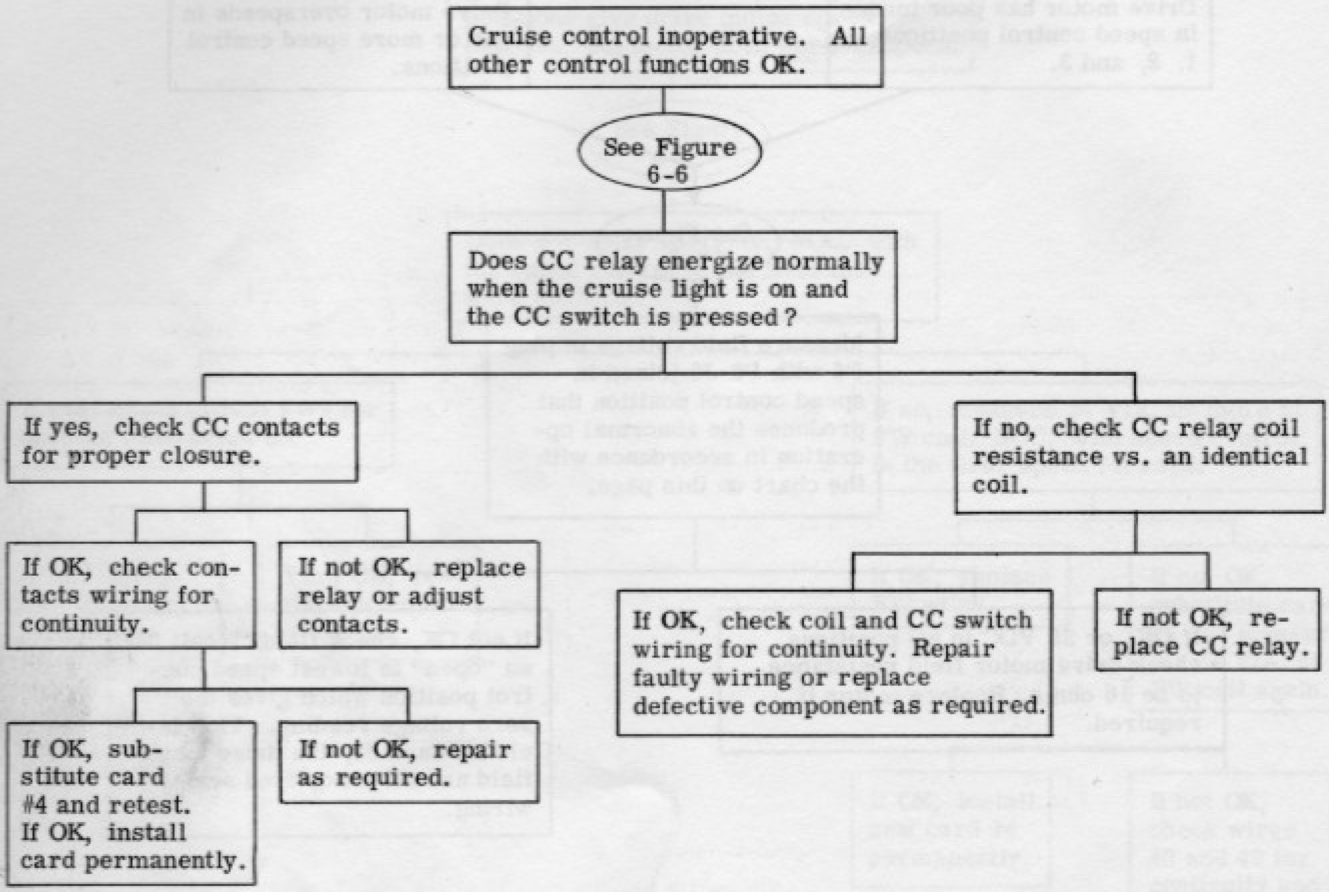
If OK, check fwd./rev. switch for proper opening in forward. Repair or replace as required.

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 6-5
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 6-6
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 OK, check contacts wiring for continuity.
If not OK, replace relay or adjust contacts.
If OK, substitute card #4 and retest. If OK, install card permanently.
If not OK, repair as required.
If no, check CC relay coil resistance vs. an identical coil.
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.

Lack of power or speed when operating in cruise control.

See Figure 6-6

Substitute card #4. Retest.

If OK, install card #4 permanently.

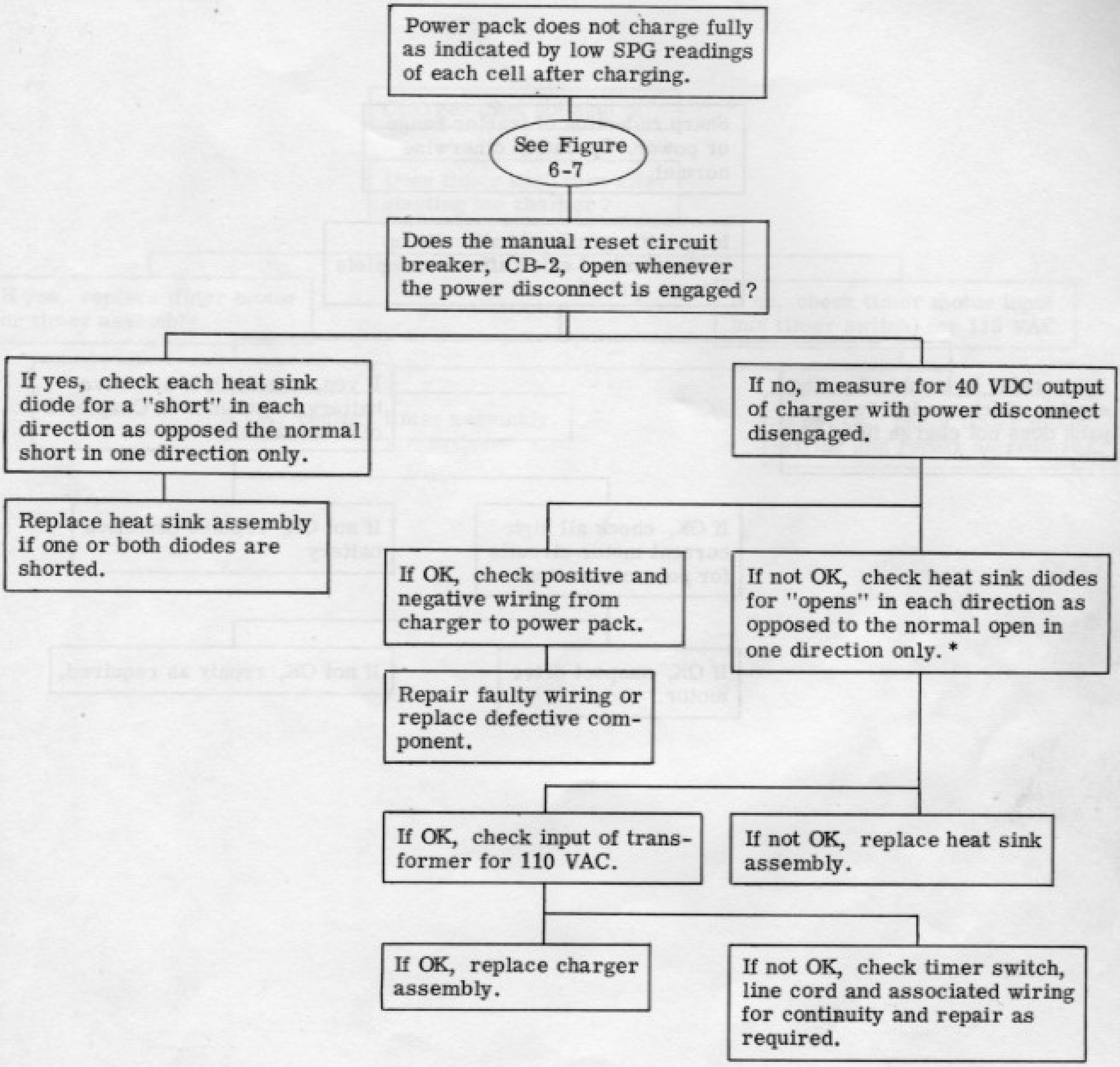
If not OK, check wiring from card #4 to 1A coil, 2A coil, and to 3A coil for continuity.

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.

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.

Charger does not shut off.

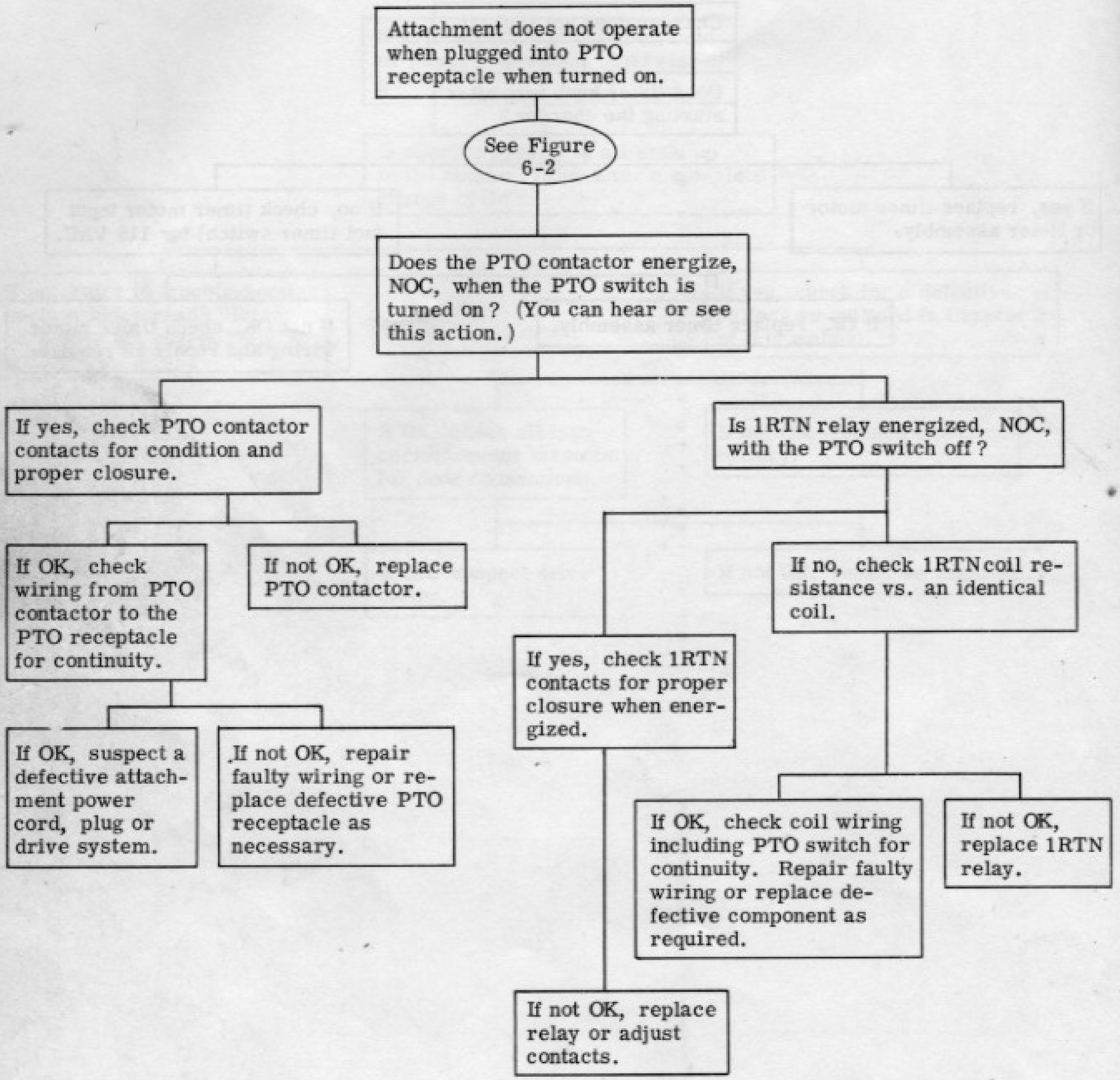
Does timer knob turn after starting the charger ?

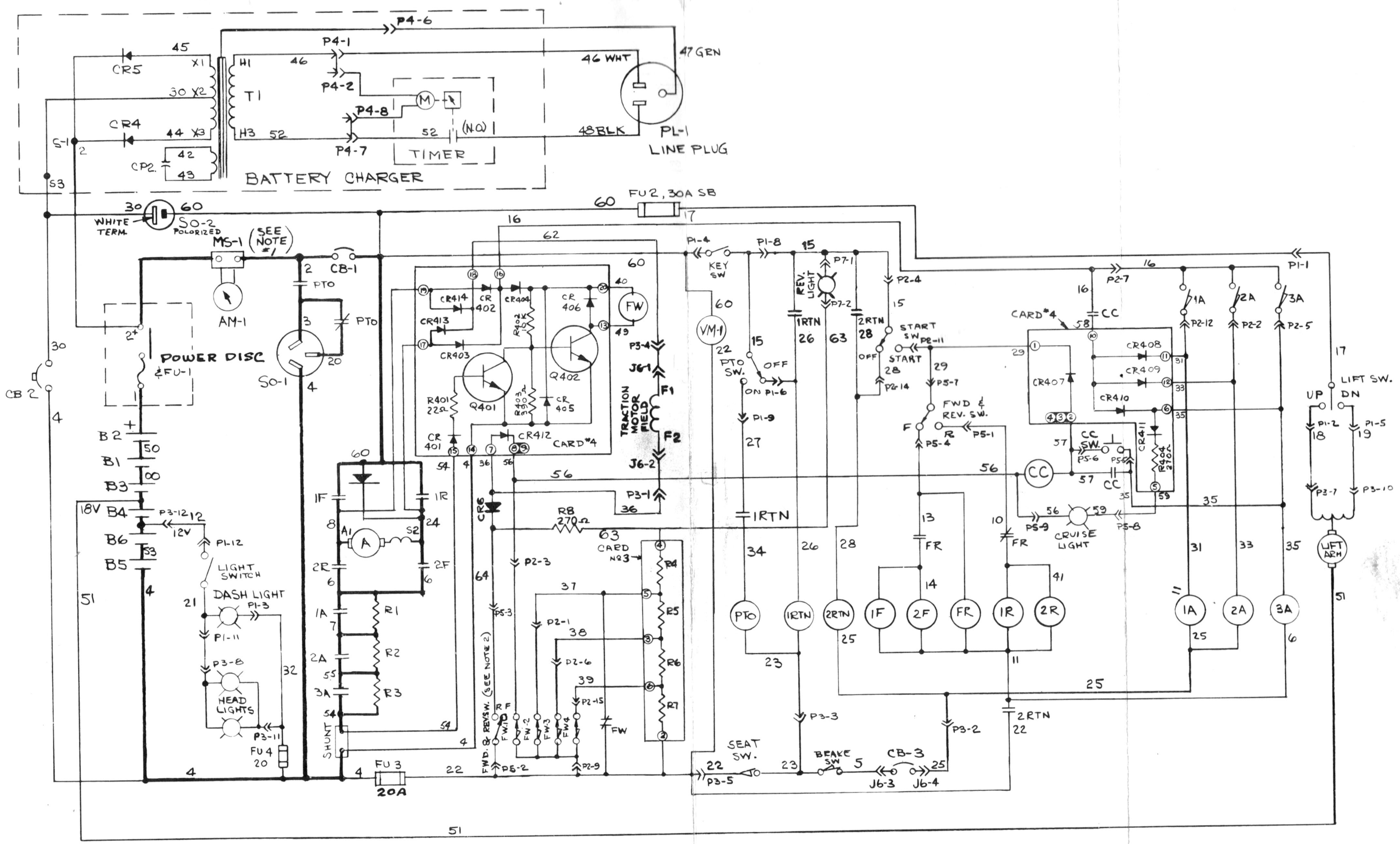
If yes, replace timer motor or timer assembly.

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.


Attachment does not operate when plugged into PTO receptacle when turned on.
See Figure 6-2
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.

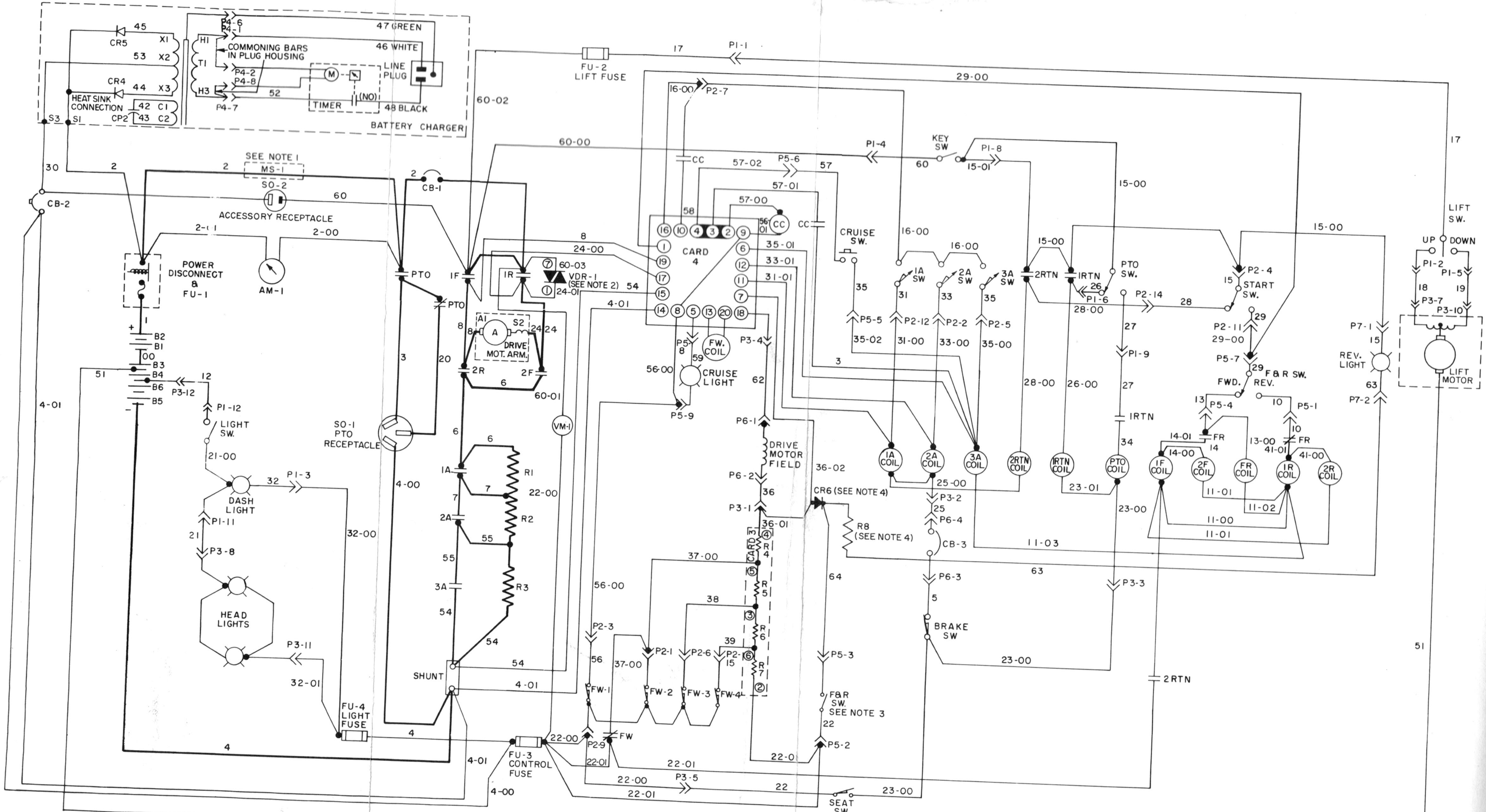


NOTE

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

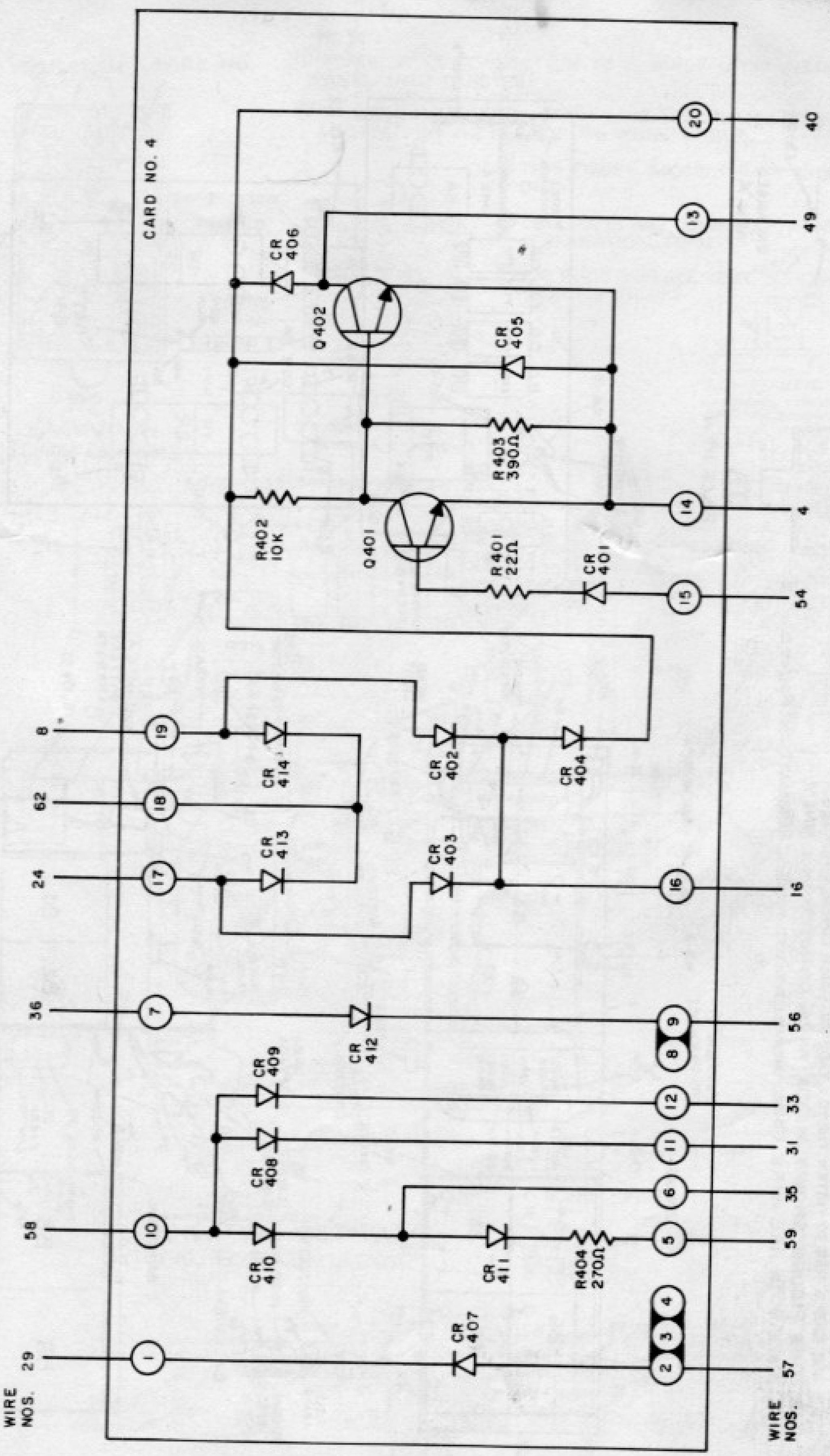
2- F&R SWITCH CLOSED IN REVERSE POSITION ONLY

Fig. 6-7 Troubleshooting Sketch (Models E20AA and BA only)



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. 6-8 Connection Diagram (Models E20AA and BA only)

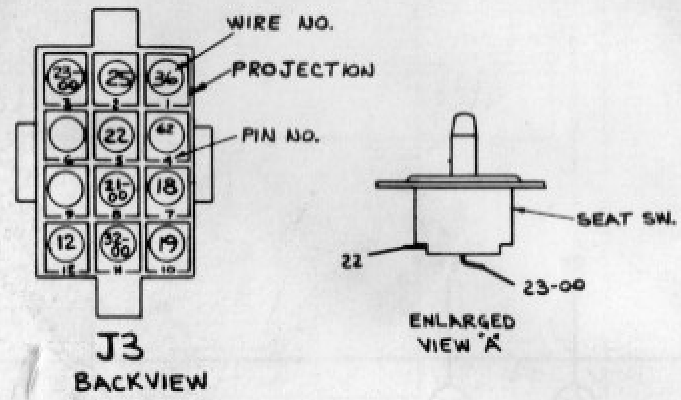


Circled numbers correspond to pad numbers on printed circuit card.

Fig. 6-9 E20 Card #4 (Models E20AA and BA only)

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



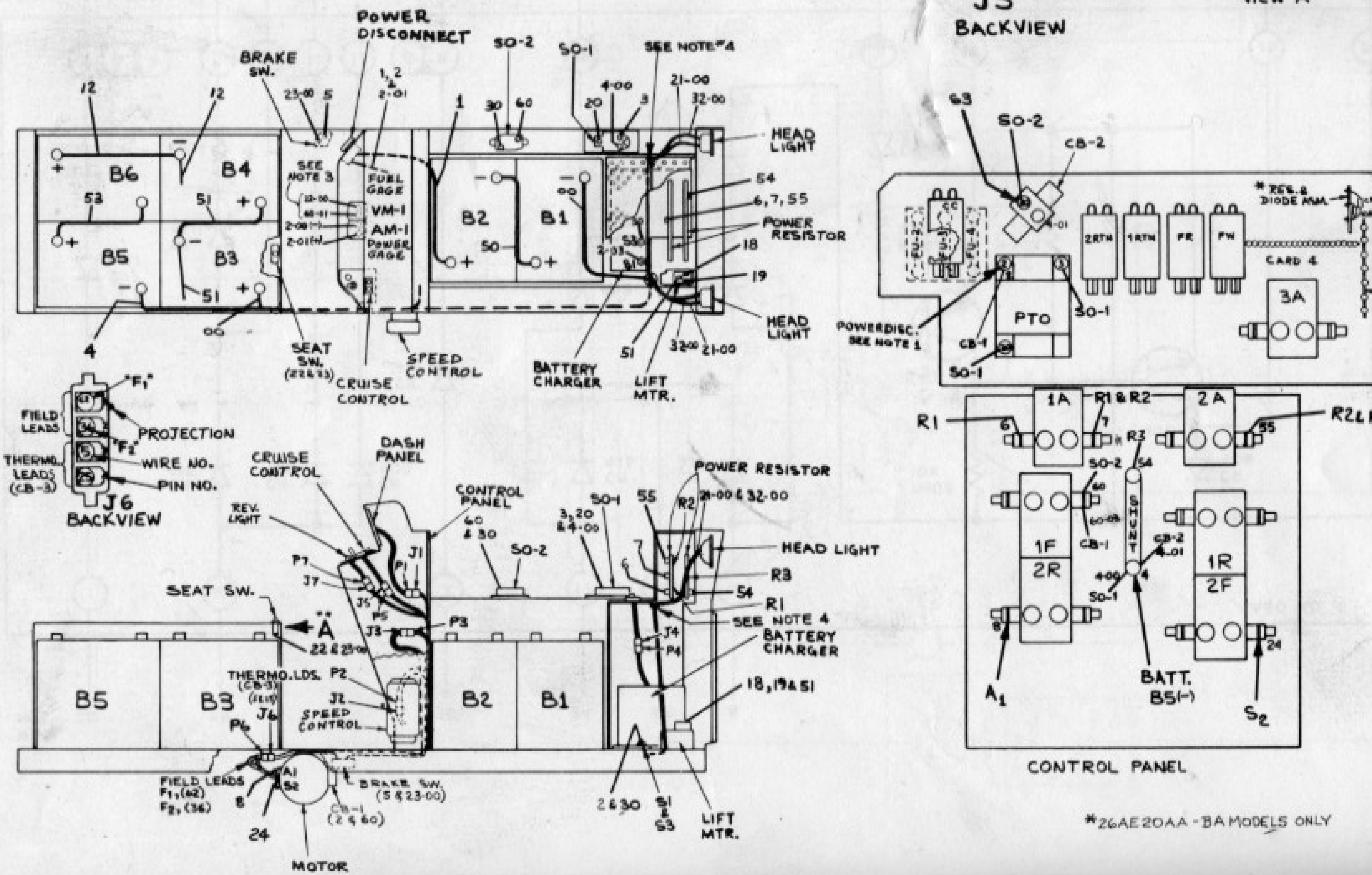


Fig. 6-10 E20 Tractor Wiring

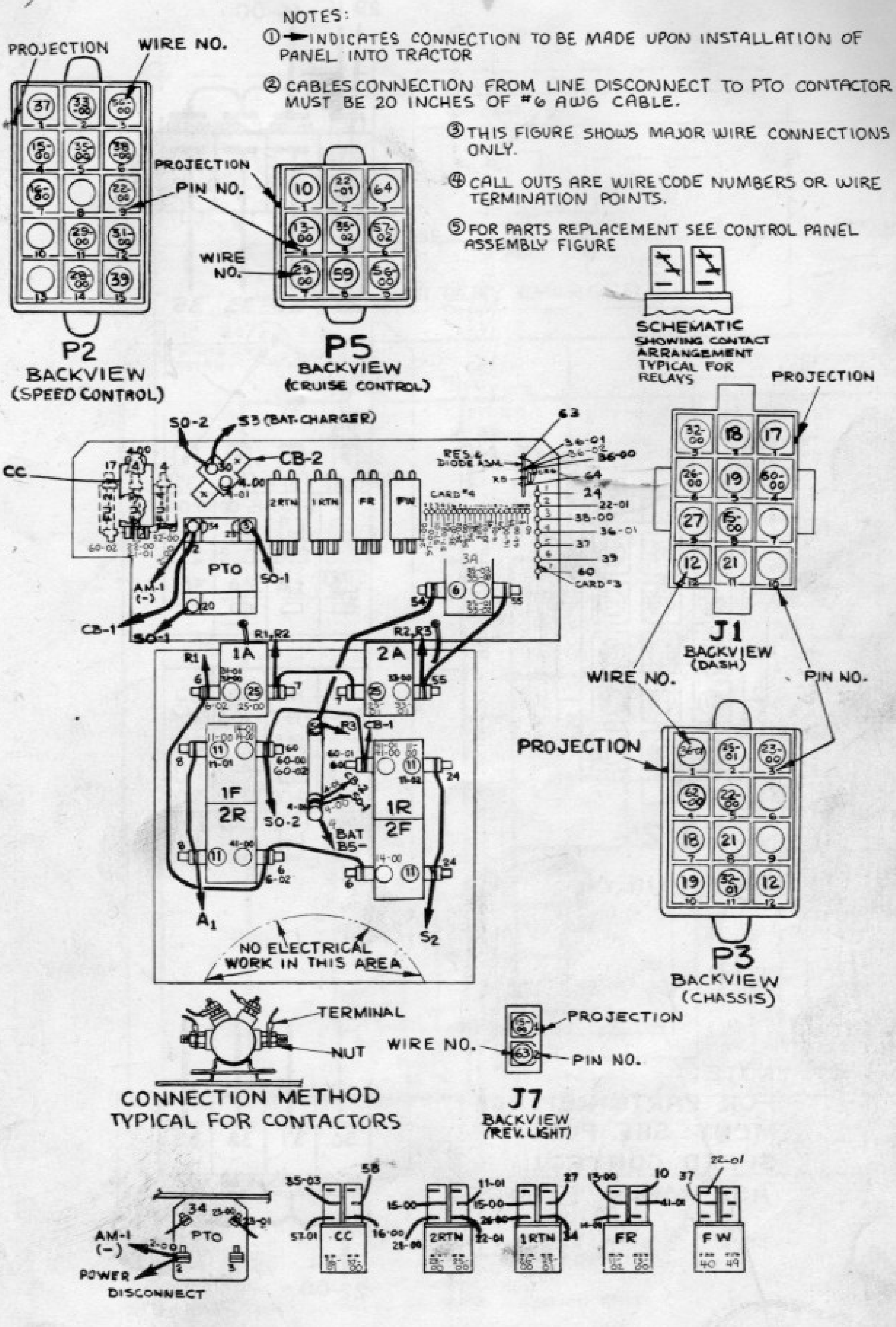
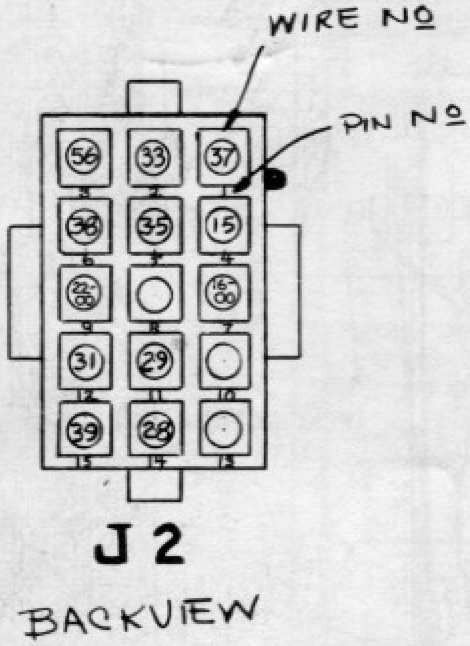
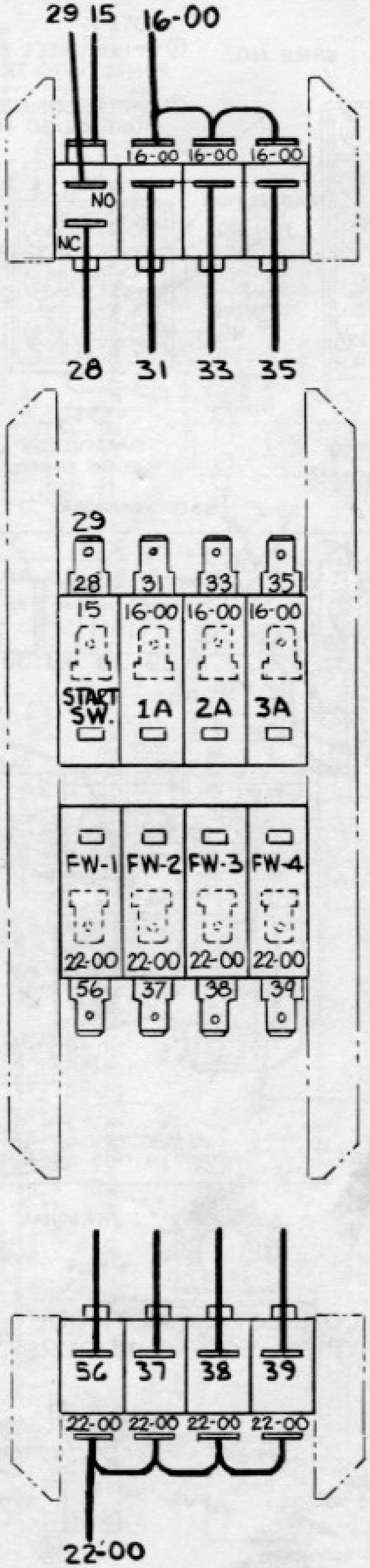


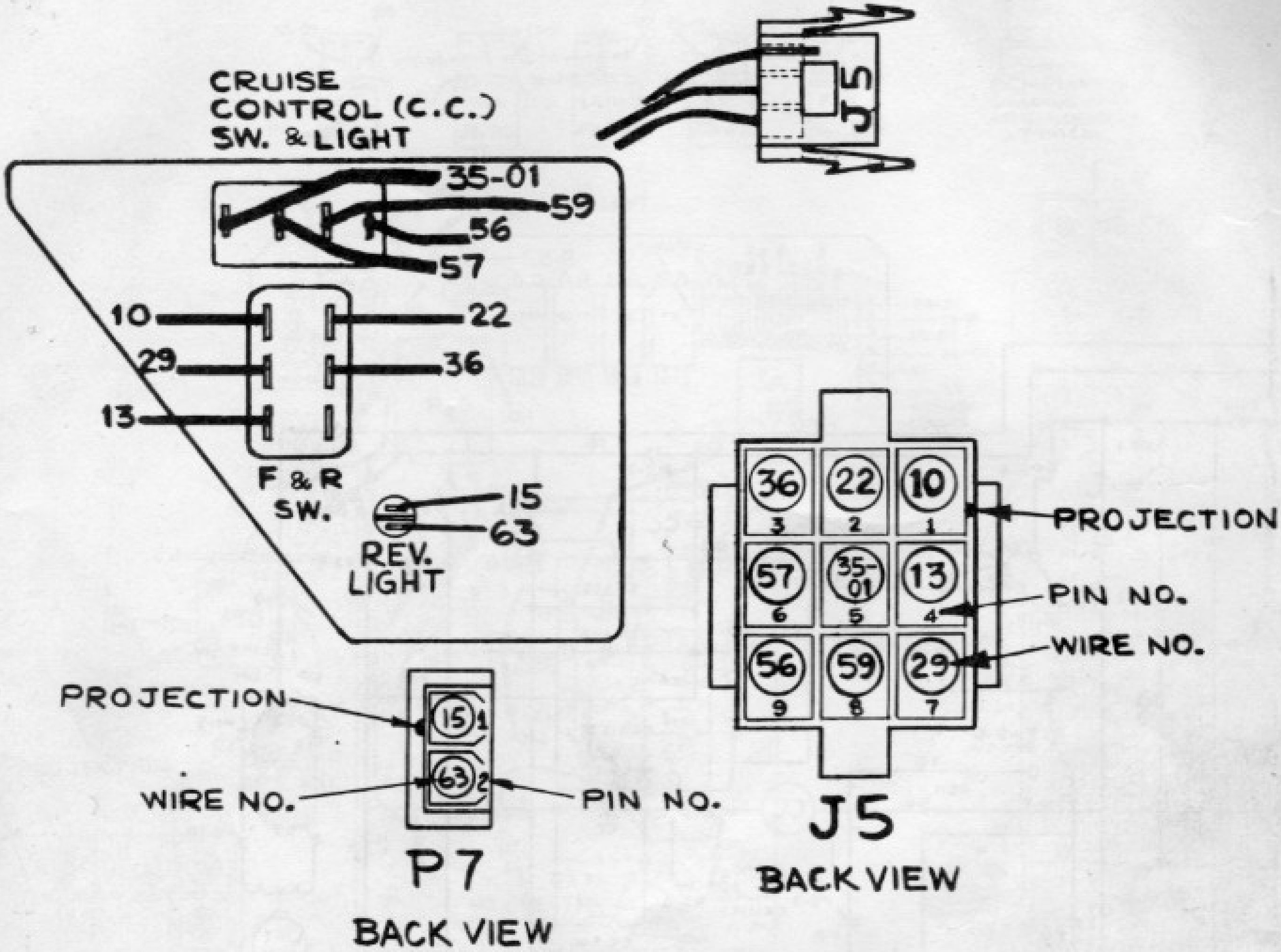
Fig. 6-11 E20 Control Panel Wiring





NOTE:
FOR PARTS REPLACEMENT SEE FOOT SPEED CONTROL ASSEMBLY FIGURE.

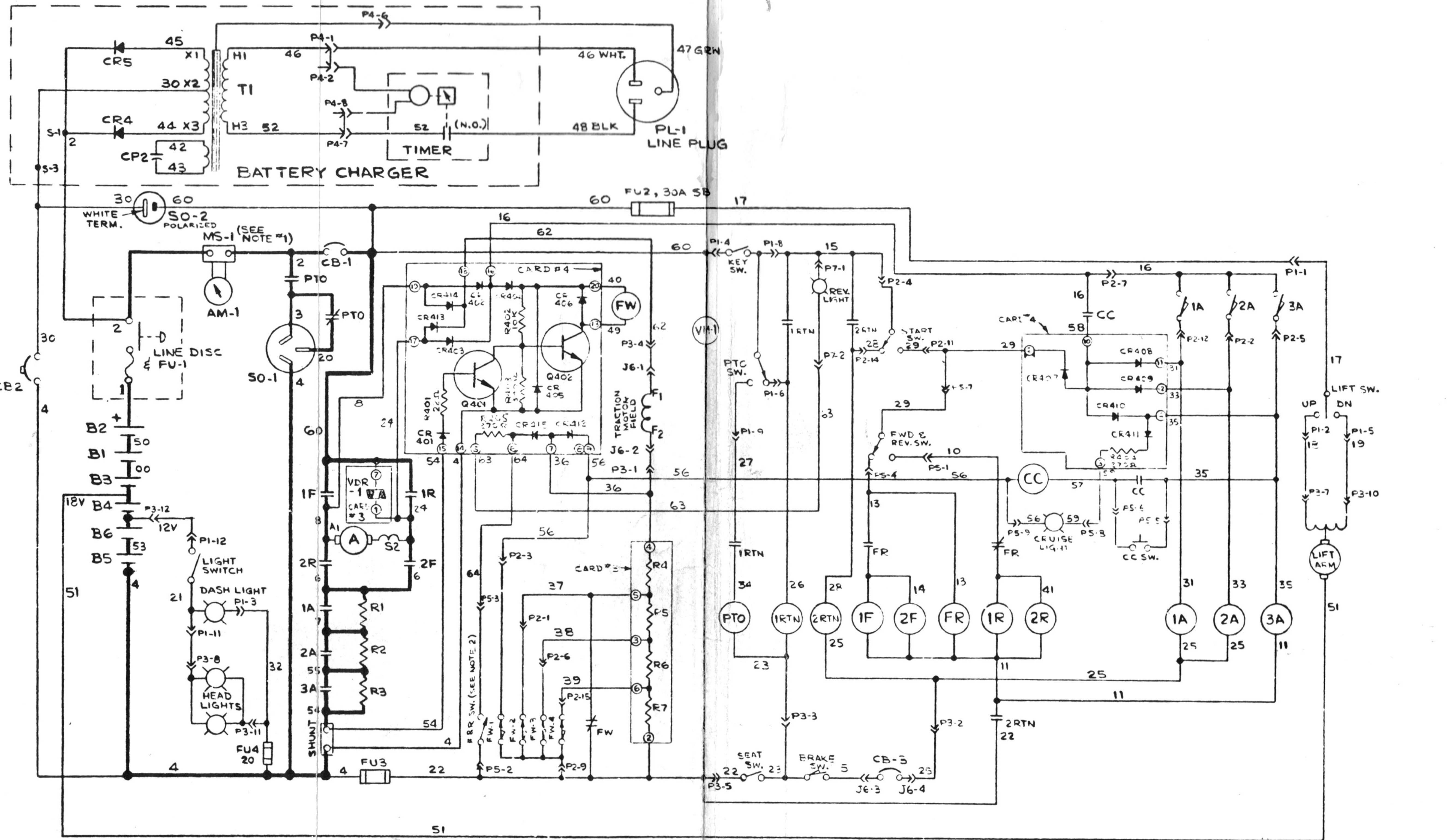
Fig. 6-12 E20 Foot Pedal Speed Control Wiring



NOTES:
① CALL OUTS ARE WIRE CODE NUMBERS OR WIRE TERMINATION POINTS

② FOR PARTS REPLACEMENT SEE CRUISE CONTROL ASSEMBLY FIGURE

Fig. 6-13 E20 Cruise Control Wiring

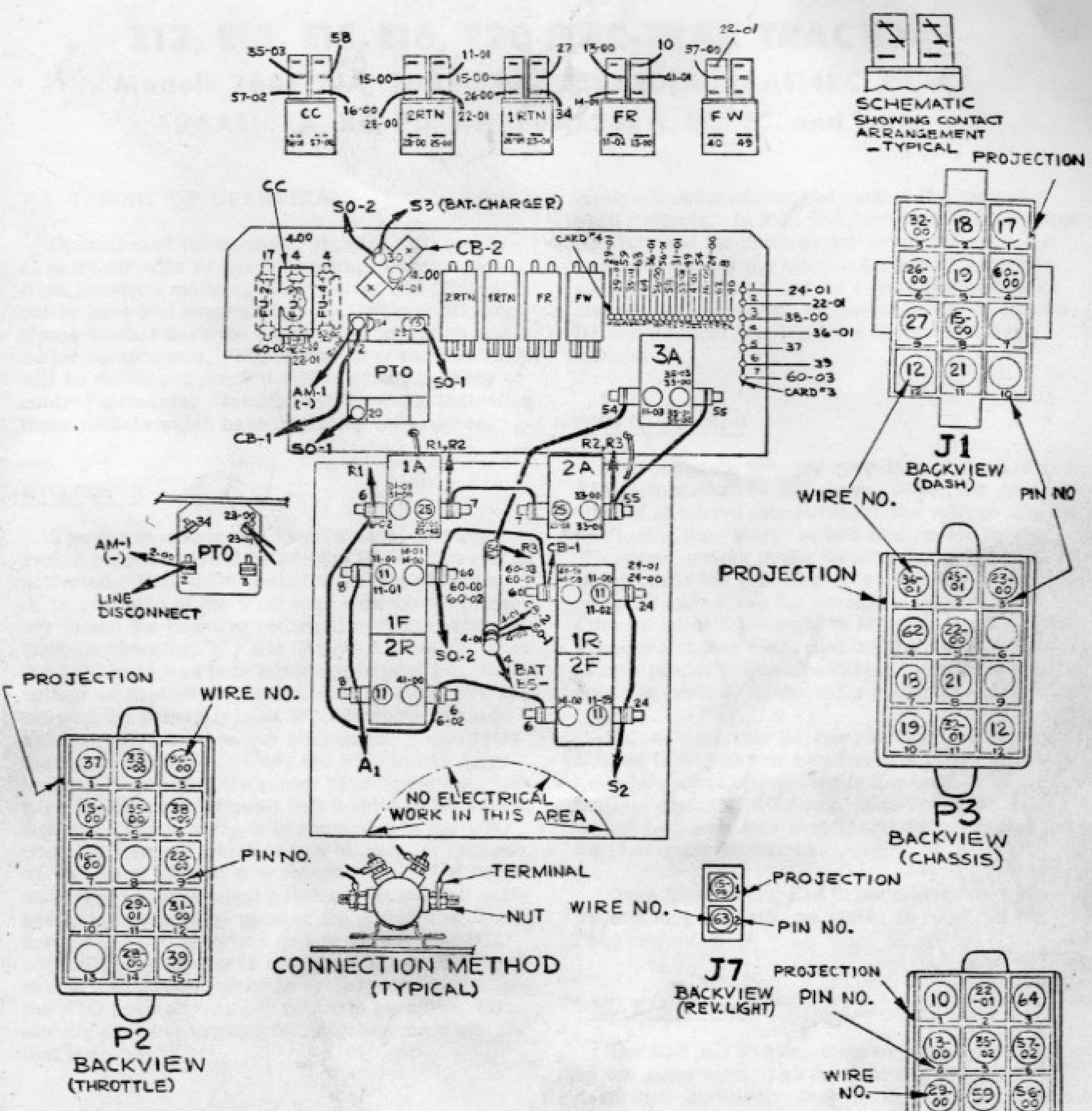


NOTES:

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

2- F&R SWITCH CLOSED IN REVERSE POSITION ONLY.

Fig. 6-14 Troubleshooting Sketch, Models 26AE20CA and DA



FACTORY NOTES:

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

② CABLE CONNECTION FROM LINE DISCONNECT TO PTO CONTACTOR MUST BE 18.25 INCHES OF #6AWG CABLE.

Fig. 6-15 Control Panel Wiring, Models 26AE20CA and DA

E12, E14, E15, E16, E20 ELEC-TRAK TRACTORS

Models 26AE12JA, 26AE15HA, 26AE20EA, 26AE14RC, RJ, AA, 26AE16RA, RB, RD, AA, 26AE20RA, ED, EC, and Later

7.1 THEORY OF OPERATION

Operation of the charger, lighting, lift and accessory circuits remains essentially unchanged from previous models. The control and PTO circuitry have had several changes, but now all large-frame models have the same basic operation and major components. The operation of the E20 model will be developed since it utilizes the full array of control elements. Notation will be made indicating those models which have operating differences.

PTO Circuit

The power disconnect, seat switch, and key switch must be closed before the PTO outlet can be activated. With these conditions met, +36 volts dc is available at the PTO switch on wire 5 (number 5) and the negative return circuit is complete through wires 24, 23, and 13 (see Fig. 6-1). When the PTO switch is held in the upper position, this voltage is applied to the PTO coil through wire 26, causing the normally open PTO contacts to close and applying power to any attachment plugged into the PTO receptacle. When the PTO switch is released, it moves to its center "Run" position, and wire 27, which previously had 0 volts dc available, now has +36 vdc since it is connected to the PTO contactor contact which is now closed. It is these wires (3 and 27) that now supply PTO coil voltage and keep the attachment powered. If the coil voltage is interrupted by opening the power disconnect, seat switch, PTO switch or key switch, the PTO normally-open contacts re-open and the PTO operated attachment power is removed. At this time, the PTO normally-closed contacts re-close, furnishing dynamic braking for attachments wired for that purpose.

Start Circuit

Assume that the tractor is prepared for forward operation. When the key switch is turned to "On", the RTN relay is energized through the speed control start switch. Both RTN contacts close, sealing the coil voltage in, so that when the speed control is moved out of neutral, the relay coil voltage will remain, and the negative path for the F coil is completed through the other pair of RTN relay contacts. When the speed control is advanced to actuate the start switch, voltage is applied to the F coil (R coil in reverse), opening this contactor's normally-closed contacts and closing its normally-open contacts. In Fig. 7-1, current flows through R1, R2, and the drive motor armature from left to right, driving the tractor forward. As speed control switches 1A and 2A close, contactors 1A and 2A are energized, bypassing power resistors R1 and R2, and providing the second and third speeds.

E12, E14 Control

The complete forward operation of the E12 and E14 is described by the above. When the speed control is moved into reverse, the voltage applied by closing the "Start" switch is directed by the "Reverse" switch in the throttle to the R coil, which opens the R contactor's normally-closed contacts and closes the normally-open contacts. Current flows from right to left through the motor armature at that time, and the tractor is driven in reverse. Closing of switch 1A gives the second speed in reverse in the same fashion as in forward.

Before contactor 2A can be energized in normal fashion in forward or reverse, the drive motor armature must be rotating fast enough to close its built-in centrifugal switch. The Power Pulse switch bypasses this centrifugal switch during unusual starting situations.

Since the E12 and E14 drive motor has a permanent magnet field, no wiring is required for field control.

E15, E16 Control

The E15 and E16 drive motors are reversed by the same method as those of the E12 and E14 described previously; that is, when the start switch is closed in reverse, voltage is directed by the F-R switch to the R contactor coil.

The additional four forward speeds are available by opening switches FWS-1, 2, 3 and 4 which allow resistors to become in series with the drive motor field (Fig. 7-4). The opening of any combination of these four switches is voided if the normally-closed contacts 2AH are closed, or if the Power Pulse button is held depressed. Both pairs of 2AH contacts are actuated when the 2AH coil (in parallel with the drive motor armature) has adequate pick-up voltage applied to it. This voltage may be

7

inadequate when high armature current through power resistor R2 causes a reduced voltage across the armature and 2AH coil. When switch 2A is closed, coil 2A would not be energized in this case, because contacts 2AH in series with it are open. This results in an undesirable condition if forward motion cannot be obtained during this heavy loading. By pressing the Power Pulse button, the 2AH contacts are bypassed momentarily, forcing contactor 2A to energize. In this way, resistor R2 is bypassed and the armature (and coil 2AH) receive full battery voltage. Since the 2AH relay is now energized, the Power Pulse button can be released, 2A remains energized, and the drive motor armature should continue to rotate.

The Power Pulse button serves an additional function when it is depressed while operating in speeds 4, 5, 6 or 7. The depressed switch bypasses all of the field weakening resistors, and forces the tractor to operate in its most efficient (3rd) speed until the button is released.

E20 Control

The operation of the E20 is the same as that of the other models discussed so far with two minor exceptions: 1) The Power Pulse button is now referred to as a Cruise Control button, and 2) there are two RTN relays to control direction, which is selected before the start switch is actuated (Fig. 7-7). The Cruise Control button serves the additional function of locking the tractor operation into Cruise Control. One of the RTN relays is energized, depending on whether the direction switch is in forward or reverse before the speed control pedal is depressed. The relay so determined "seals in" its own voltage, and, with its other pair of contacts, completes the negative return circuit for its associated direction contactor coil; either F or R. When the reverse relay, RTN R, is selected, the reverse light glows since it is wired in parallel with the RTN R relay coil.

When the Cruise Control button is depressed, the four field weakening switches FWS-1, 2, 3 and 4 are bypassed, and the 2AH contacts in series with the 2A coil are bypassed as was the case with the E15 and E16. On the E20, depressing the Cruise Control button energizes the CC relay, provided the tractor is operating in the third forward speed. Energizing the CC relay locks the drive motor operation in the third or fourth speed forward.

During operation in Cruise Control, the Cruise Control switch can be in the "Fast" or "Slow" position. In the "Slow" position, the armature and field voltages are at full battery voltages of about 36-vdc, corresponding to 3rd speed forward. In the "Fast" position, the 4th forward speed results because this has the same effect as opening switch FWS 1 since the Cruise Control switch is in series with FWS 1. During operation other than in Cruise Control, the Cruise Control switch has no effect in either position, since it is bypassed by the normally-closed Cruise Control relay contacts. Release from the Cruise Control mode of operation can be obtained by interrupting power to the RTN or CC relay coils, including depressing the speed control pedal beyond the third-speed position.

7.2 TROUBLESHOOTING MODELS E12JA, E14RC, RJ AND AA ONLY

Problem	Test	Probable Cause
A. Tractor has 2 speeds forward 2 speeds reverse motor under no heavy load	Push Power Pulse Button & get third speed	1. Repair or replace Centrifugal switch on motor
B. Tractor has 3 speeds forward & two speeds reverse	Normal operation	Nothing to repair
C. Tractor has less power in reverse.	True	
D. Power pulse will only work under heavy load.	True	
E. E12 Motor has no field wiring	True, permanent magnet motor.	

7.3 REPAIRING MODELS E12JA, E15HA, E20EA, E14 AND E16

Problem	Test	Probable Cause
A. 1. No speeds forward 2. No speeds reverse 3. RTN Relay does not pull down 4. Tractor is in normal operating condition.	1. 36 volts across fuse holder 2. 36 volts across key switch 3. 36 volts across seat switch 4. 36 volts across brake switch 5. 36 volts across drive motor CB 6. 36 volts RTN relay 7. 36 volts across start switch wire 5 & 34	Replace control fuse Replace key switch Replace seat switch Replace brake switch Replace circuit breaker Replace relay coil Replace start switch
B. 1. No speeds forward	1. Burnt or open middle & lower RTN contacts on right side of relay	Replace RTN Relay
2. No speeds reverse	2. 36 volts across drive motor armature.	Replace drive motor
C. 1. No speeds forward 2. No speeds reverse 3. RTN relay pulls down in neutral but releases when speed throttle is moved forward	1. Burnt or open middle & lower RTN contacts on left side of relay	Replace RTN Relay
D. 1. Tractor lacks power	1. 36 volts across CB-2 2. Check charger, see P/S bulletin 3. Run battery discharge test 4. Check continuity of motor field on E16 & E20	Reset circuit breaker
E. 1. Tractor has no speeds forward 2. a) 2 in reverse for E12/E14 b) 3 in reverse for E16/E20	1. With speed throttle forward in normal operating conditions 36 volts across middle big studs of F contactor 36 volts across small studs of F contactor	1. Replace F Contactor
	2. With speed throttle forward in normal operating conditions 36 volts across bottom big studs of R. Contactor	1. Replace R Contactor
	3. With speed throttle forward in normal operating condition no voltage to F Coil	1. Replace F/R switch

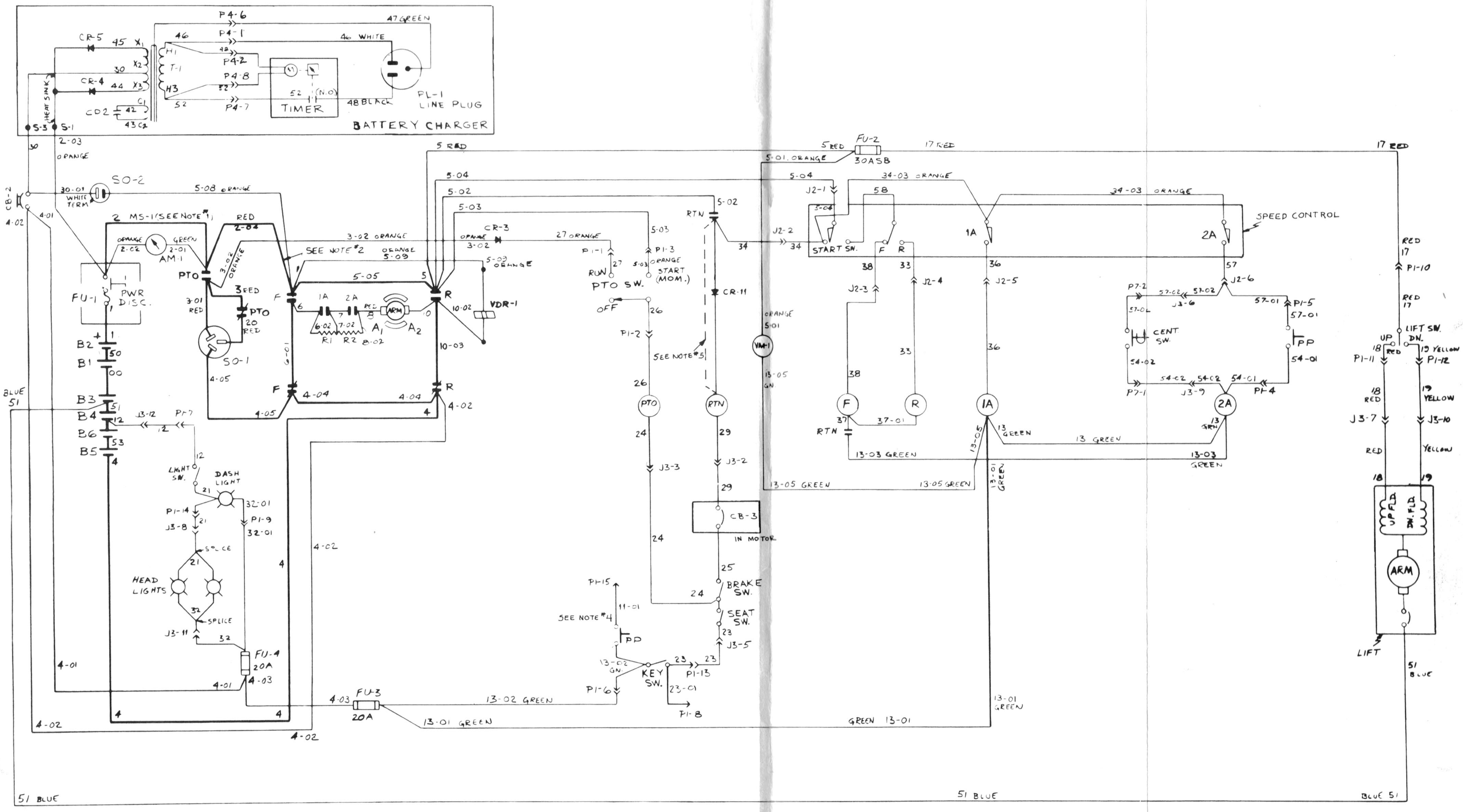
Problem	Test	Probable Cause
F. 1. Tractor has no speeds reverse	1. With speed throttle forward in normal operation conditions 36 volts across middle big studs of R contactor 36 volts across small studs	1. Replace R Contactor
	2. With speed throttle forward 36 volts across bottom big studs of F contactor	2. Replace F Contactor
	3. With speed throttle in normal operating condition no voltage to R coil	3. Replace F/R Switch
G. 1. Tractor skips the second speed forward and reverse	1. With speed throttle forward measure 4 volts across big terminals & 36 volts across the small terminals of the 1A contactor	1. Replace 1A contactor
	2. With the speed throttle forward 0 volts across small studs of 1A contactor	2. Replace 1A switch
H. 1. Tractor skips the third speed forward and reverse	1. With speed throttle forward measure 4 volts across big terminals & 36 volts across the small terminals of the 2A contactor	1. Replace 2A contactor

7.4 TROUBLESHOOTING MODELS E15HA, E16 AND E20EA

Problem	Test	Probable Cause
A. 1. Tractor has two speeds forward, two speeds reverse	1. Push power pulse to get third speed	1. Replace 2AH relay to press contacts together
	2. 2AH relay doesn't pull down	2. Replace 2AH relay
B. 1. Tractor has three speeds forward, three speeds reverse	1. Press upper & middle contacts to get last four speeds	1. Replace 2AH relay or press contacts together
C. 1. Tractor is missing one or more top four speeds	1. Check on replacer FW switches in speed throttle	

7.5 TROUBLESHOOTING MODEL E20EA ONLY

A. 1. Tractor has seven speeds forward and no speeds reverse	1. Replace RTN R. Relay	
B. 1. Tractor has no speeds forward and three speeds reverse	1. Replace RTN Relay	
C. 1. Tractor has no cruise control	1. Replace cruise control Relay	
D. 1. Tractor drops to first or second speed in cruise control	1. Replace diodes	



NOTES:

1. MS-1 IS 18¼" OF #6AWG CABLE EXTENDING FROM POWER DISCONNECT TO PTO CONTACTOR.
2. WIRE #2-04 CONNECTS TO CIRCUIT #5 AT F CONTACT.
3. NUMBER AND COLOR DESIGNATIONS CORRESPOND TO WIRE MARKINGS AND COLOR OF INSULATION.
4. NOT USED IN THIS MODEL.
5. MAY 30, 1973 LETTER INSTRUCTED REPLACEMENT OF WIRE 34-01 IN MODEL 26AE12JA WITH DIODE ASSEMBLY CR11.

Fig. 7-1 Schematic and Connection Diagram, Model 26AE12JA and Later

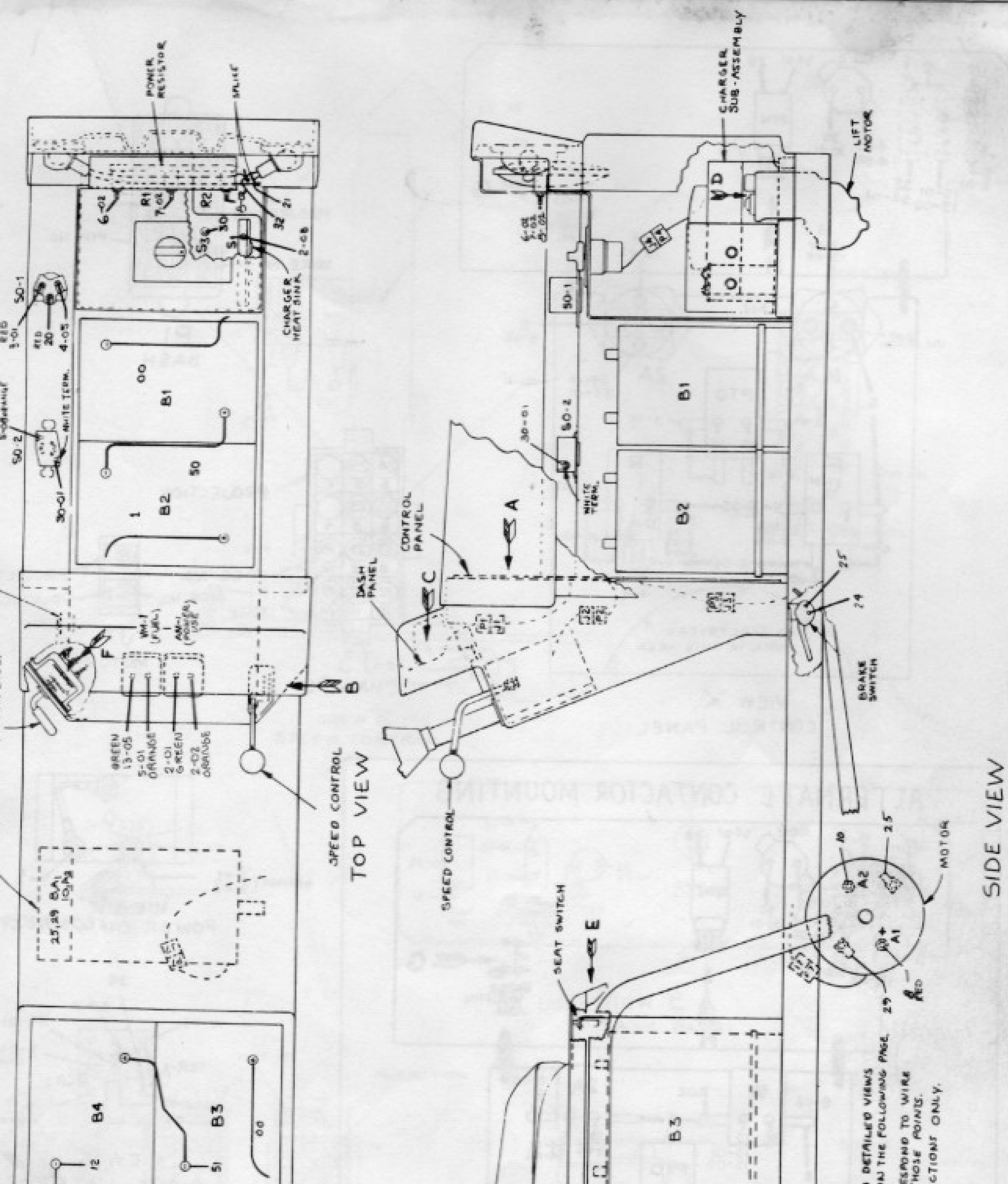
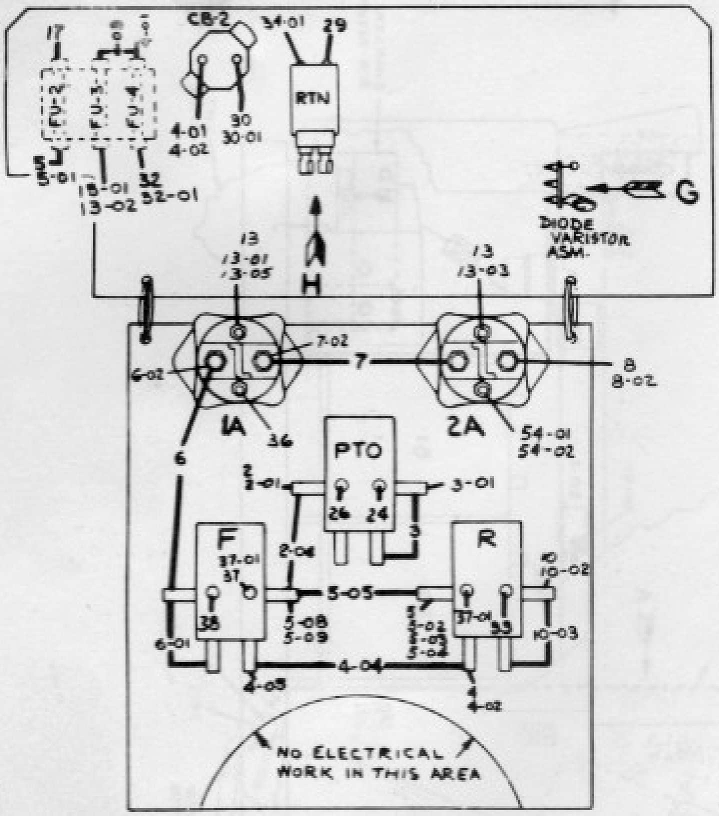
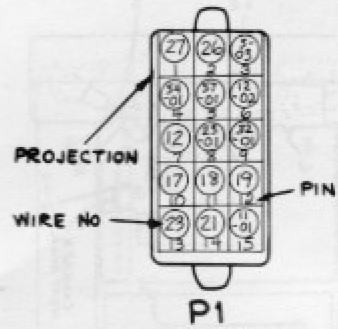


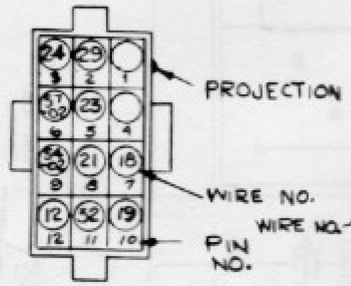
Fig. 7-2 Tractor Wiring, Models 26AE12JA and Later
Models 26AE14AA and Later



VIEW "A"
CONTROL PANEL

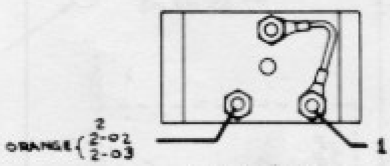


P1
DASH

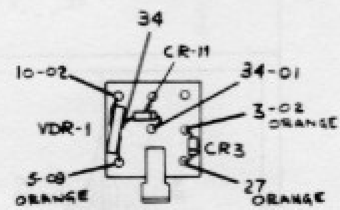


J3
CHASSIS

J7
MOTOR

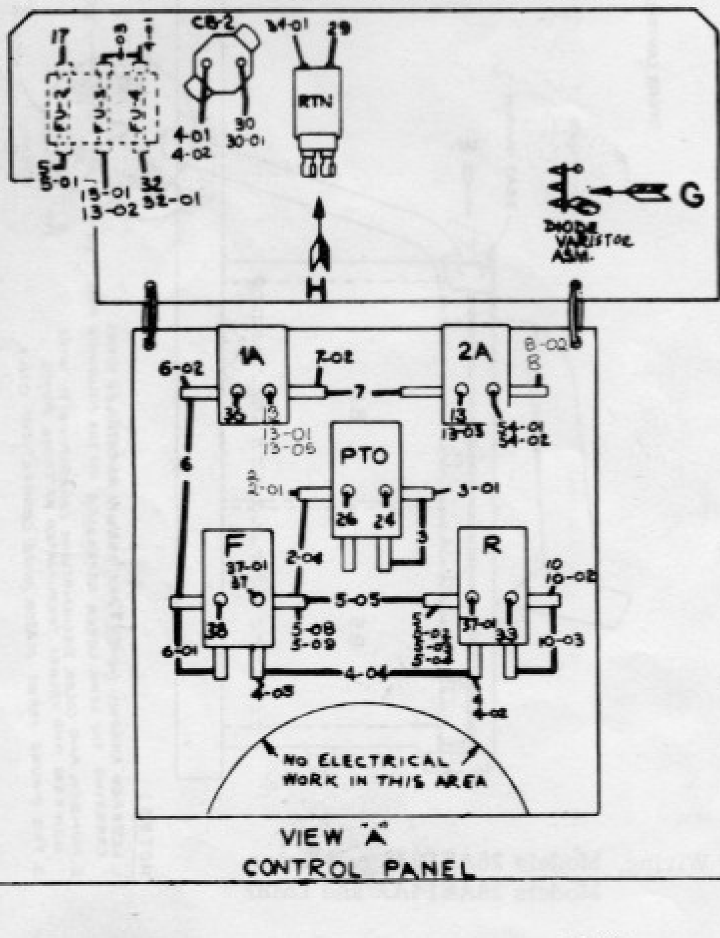


VIEW "F"
POWER DISCONNECT



VIEW "G"
DIODE - VARISTOR

ALTERNATE CONTACTOR MOUNTING



VIEW "A"
CONTROL PANEL

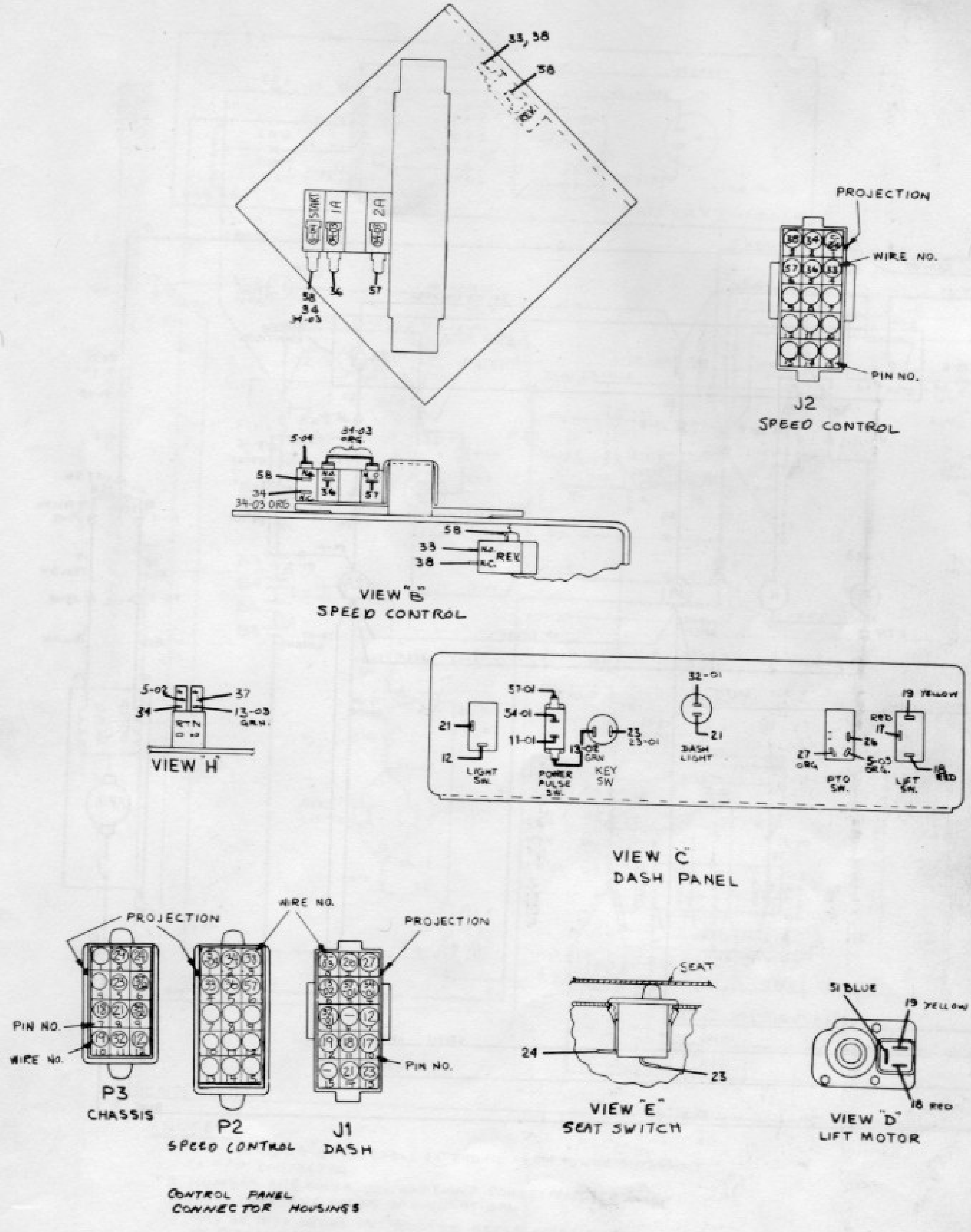
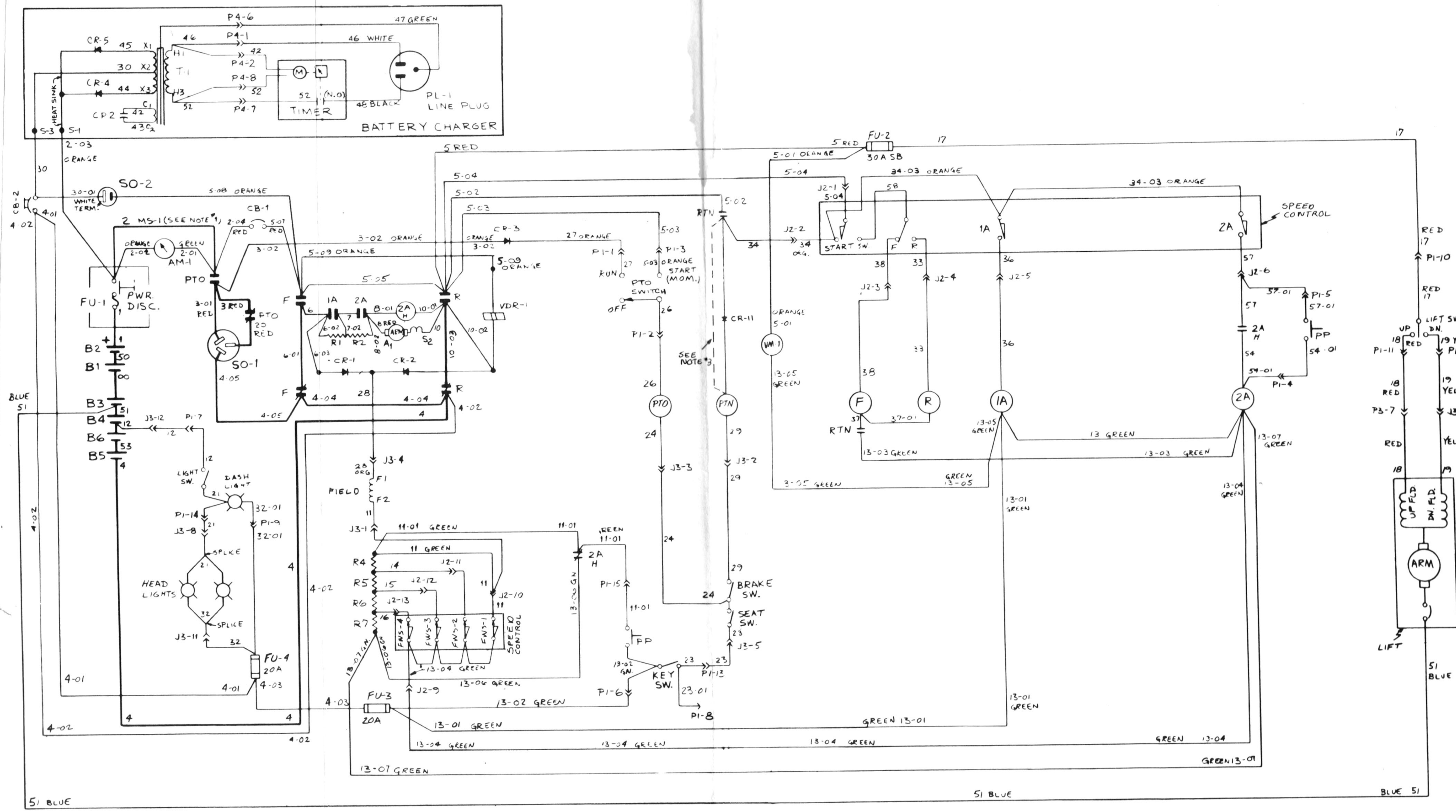


Fig. 7-3 Detailed Wiring Views, Models 26AE12JA and Later
Models 26AE14AA and Later



NOTES:

1. MS-1 IS $18\frac{1}{4}$" OF #6 AWG CABLE EXTENDING FROM POWER DISCONNECT TO PTO CONTACTOR.
2. NUMBER AND COLOR DESIGNATIONS CORRESPOND TO WIRE MARKINGS AND COLOR OF INSULATION.
3. MAY 30, 1973 LETTER INSTRUCTED REPLACEMENT OF WIRE 34-01 IN MODEL 26AE15HA WITH DIODE ASSEMBLY CR11.

Fig. 7-4 Schematic and Connection Diagram, Models 26AE15HA and Later

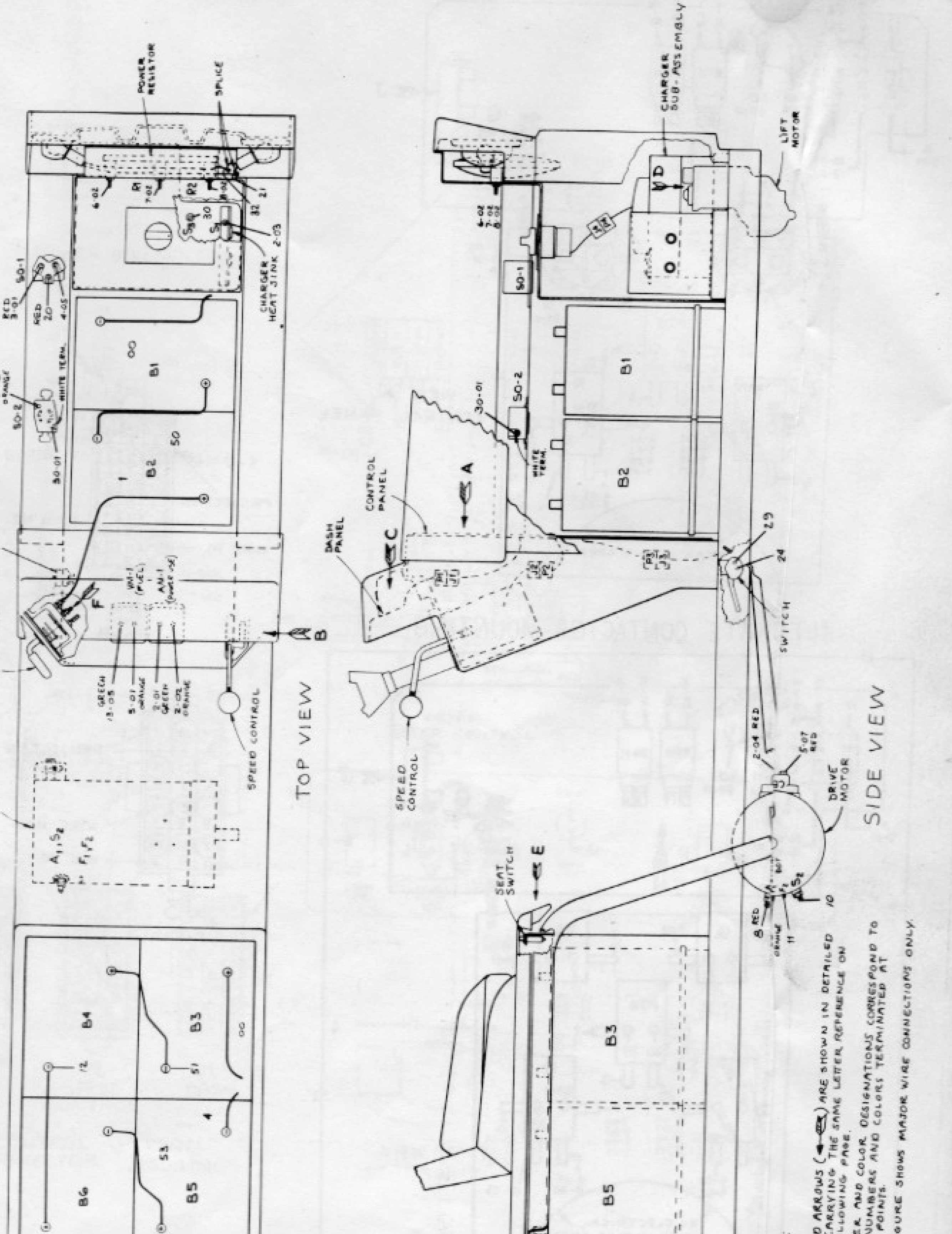
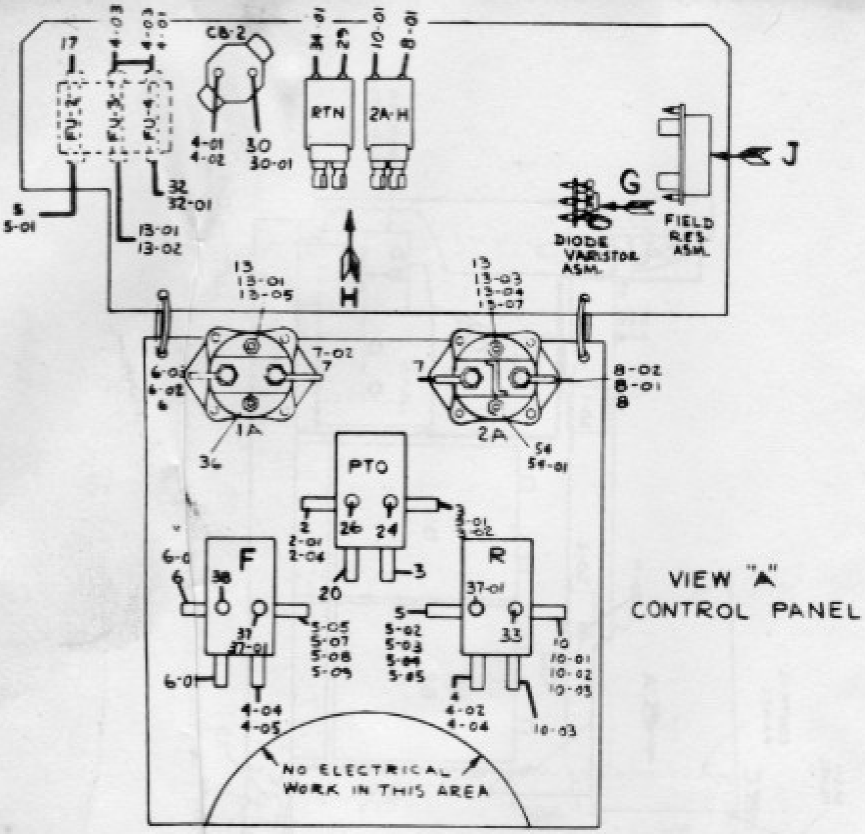
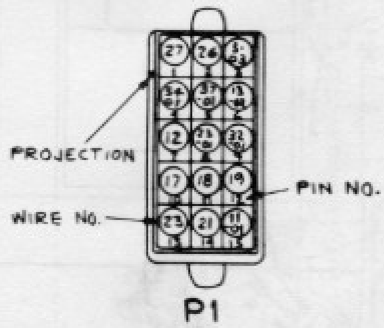


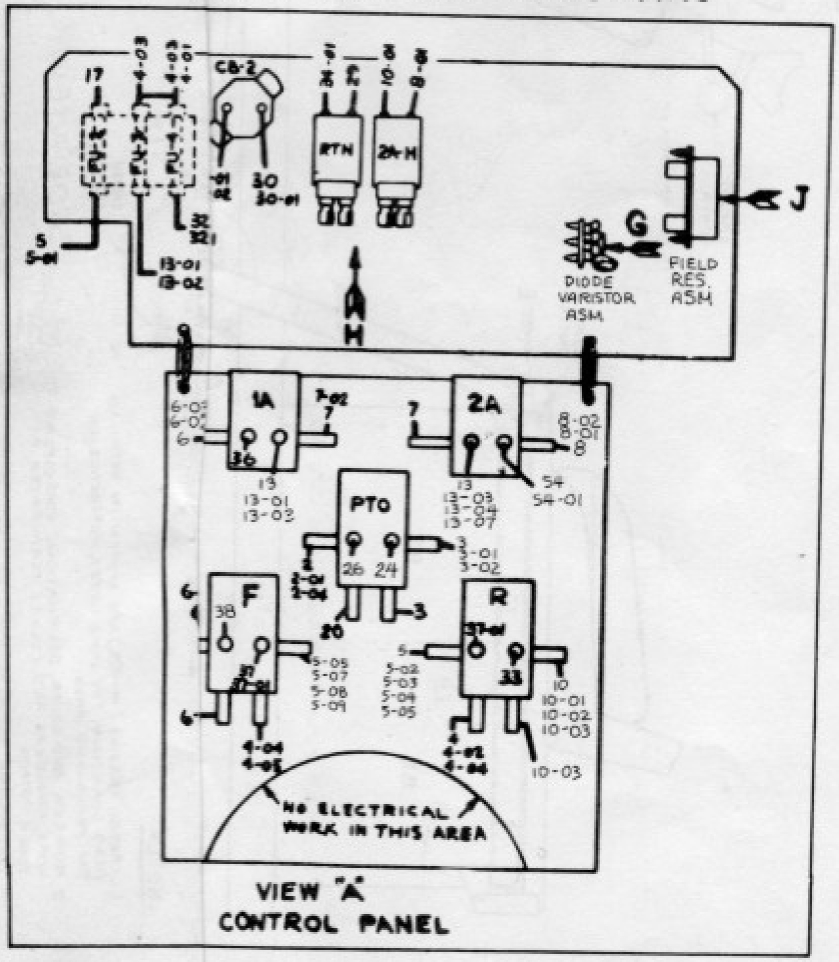
Fig. 7-5 Tractor Wiring, Models 26AE15HA and Later
Models 26AE16AA and Later

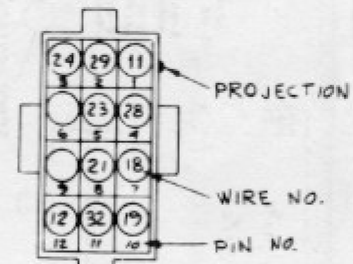




P1
DASH

ALTERNATE CONTACTOR MOUNTING





J3
CHASSIS

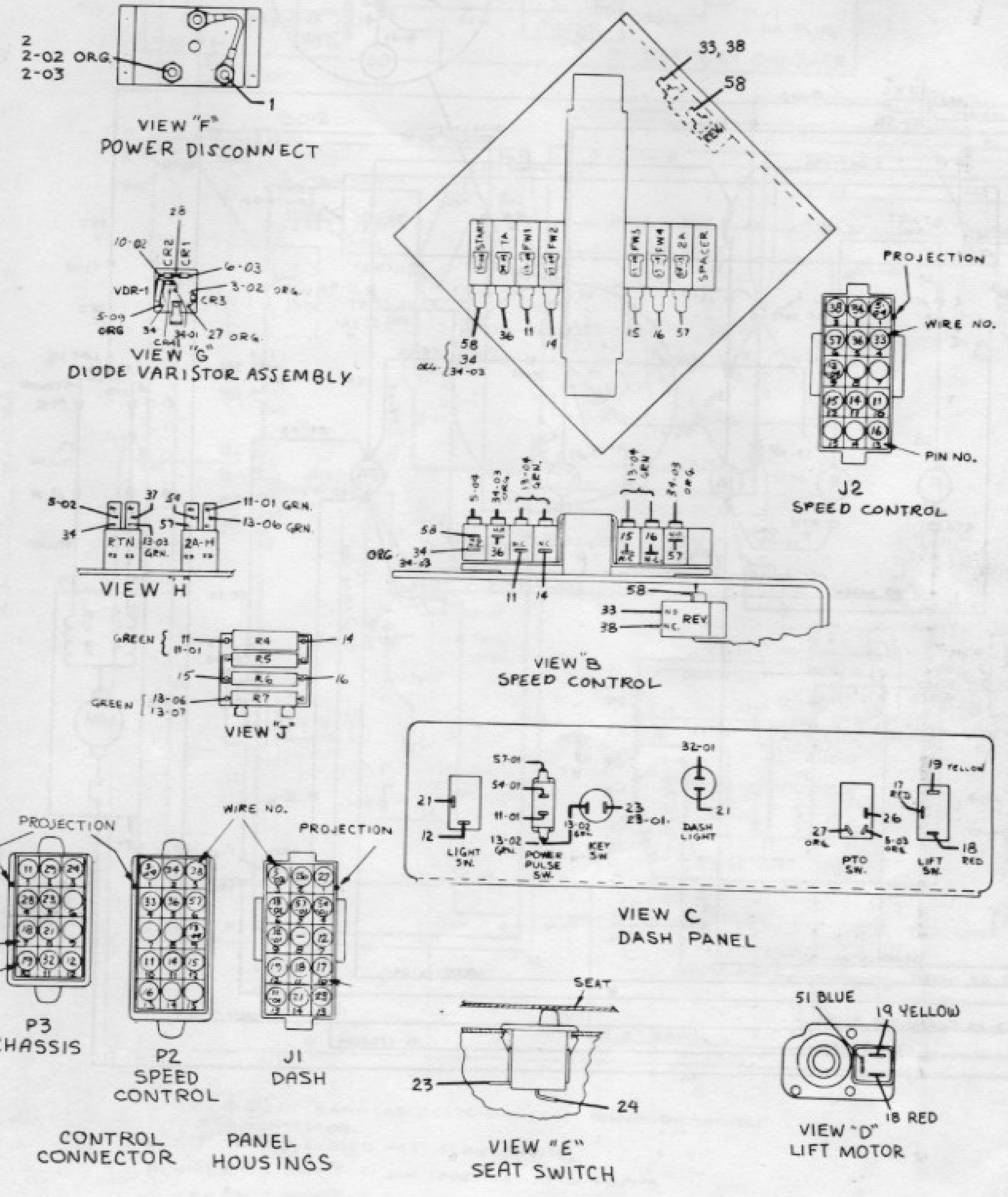
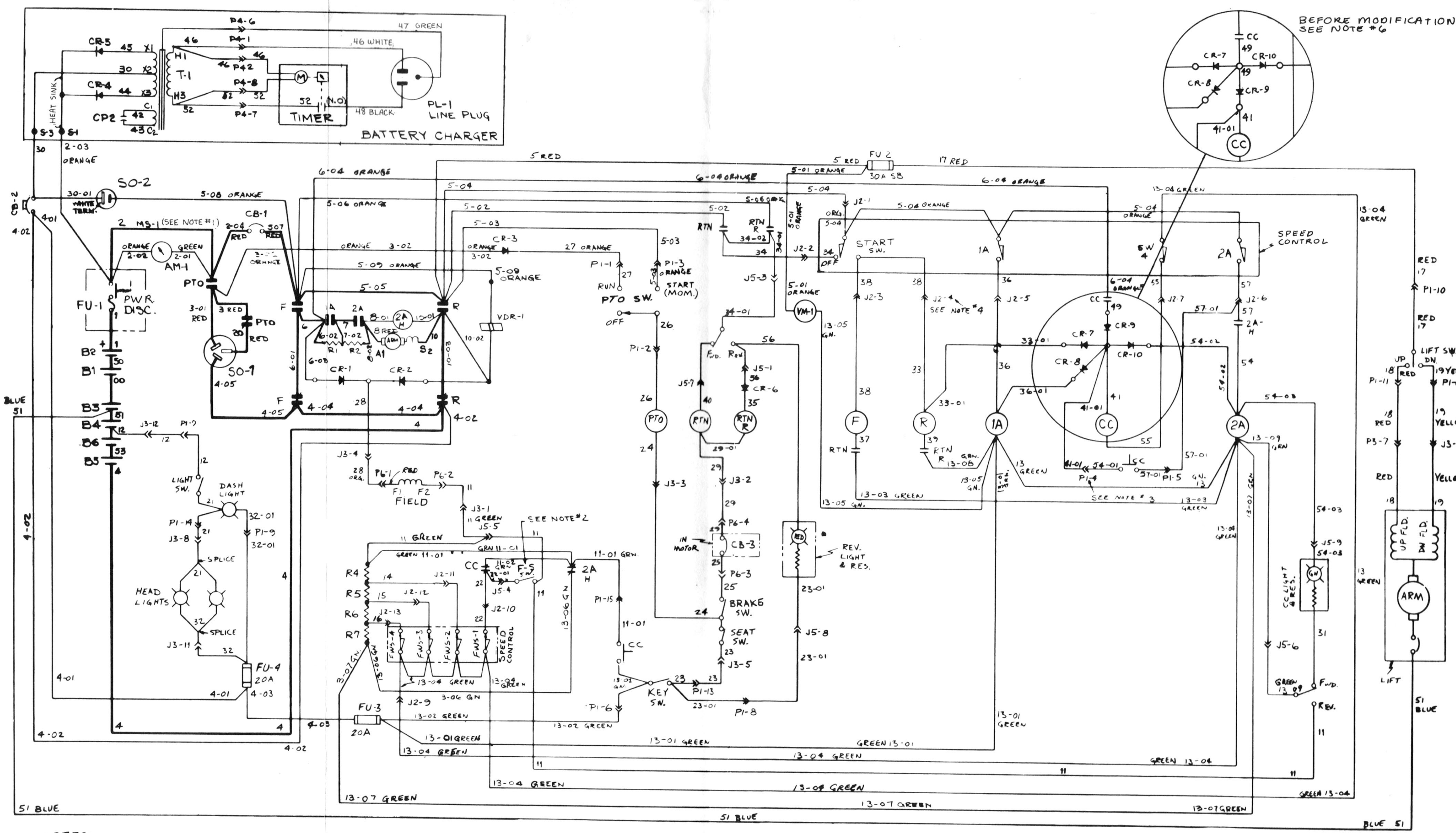


Fig. 7-6 Detailed Wiring Views, Models 26AE15HA and Later
Models 26AE16AA and Later



NOTES:

1. MS-1 IS 18¼' OF #6AWG CABLE EXTENDING FROM POWER DISCONNECT TO PTO CONTACTOR.
2. F-S SWITCH CLOSED FOR SLOW CRUISE.
3. WIRE #41.01 & WIRE #54.01 JOIN TOGETHER AT J1-4 & P1-4
4. WIRE #33 & WIRE #38 JOIN TOGETHER AT P2-4 & J2-4
5. NUMBER AND COLOR DESIGNATIONS CORRESPOND TO WIRE MARKINGS AND COLOR OF INSULATION.
6. JUNE 18, 1973 LETTER INSTRUCTED ADDITION OF DIODE AND SPLICE AS INDICATED IN MAIN SCHEMATIC. INSET ILLUSTRATES WIRING BEFORE MODIFICATION.

Fig. 7-7 Schematic and Connection Diagram, Models 26AE20EA and Later

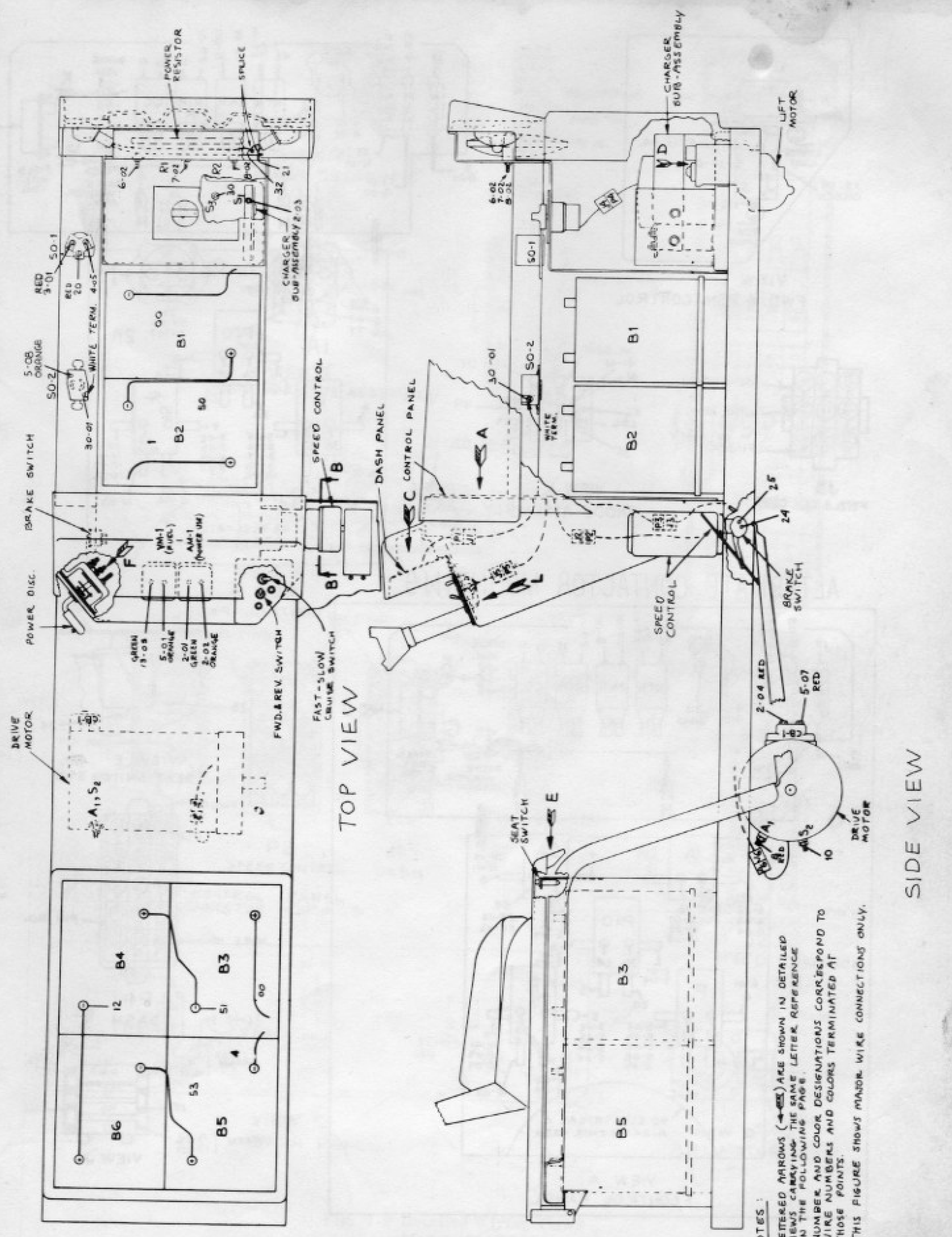
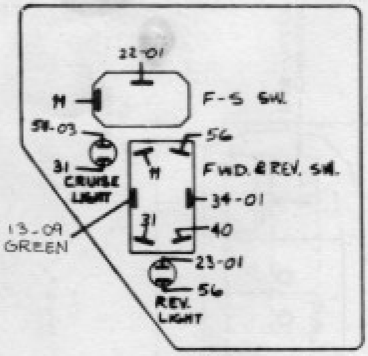
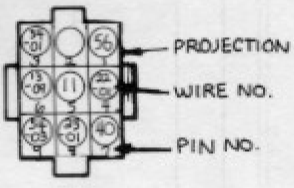


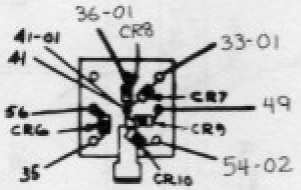
Fig. 7-8 Tractor Wiring, Models 26AE20EA and Later



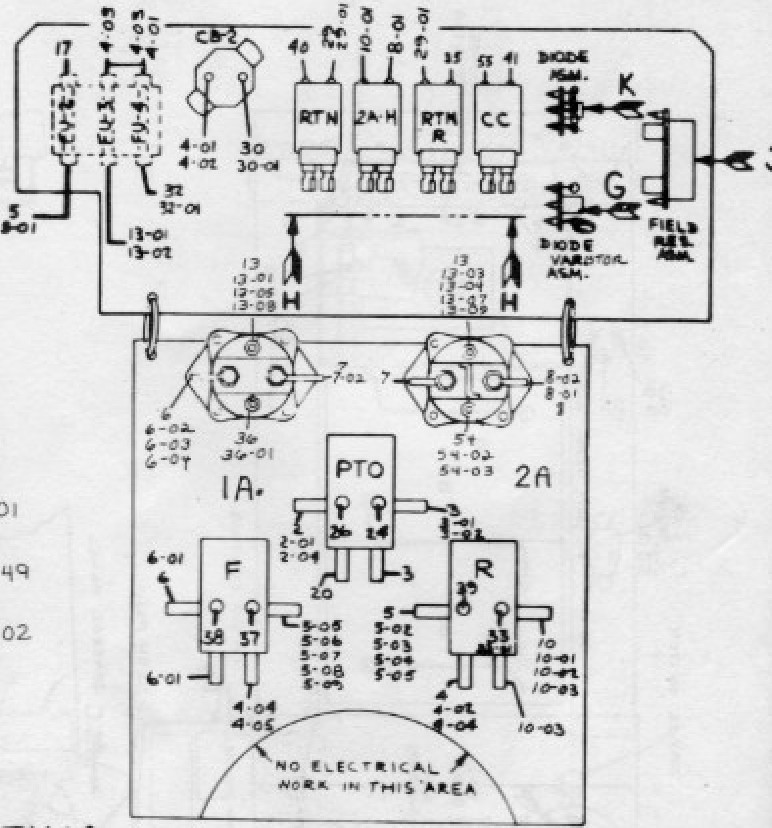
VIEW "L"
FWD. & REV. CONTROL



J5
FWD. & REV. CONT.

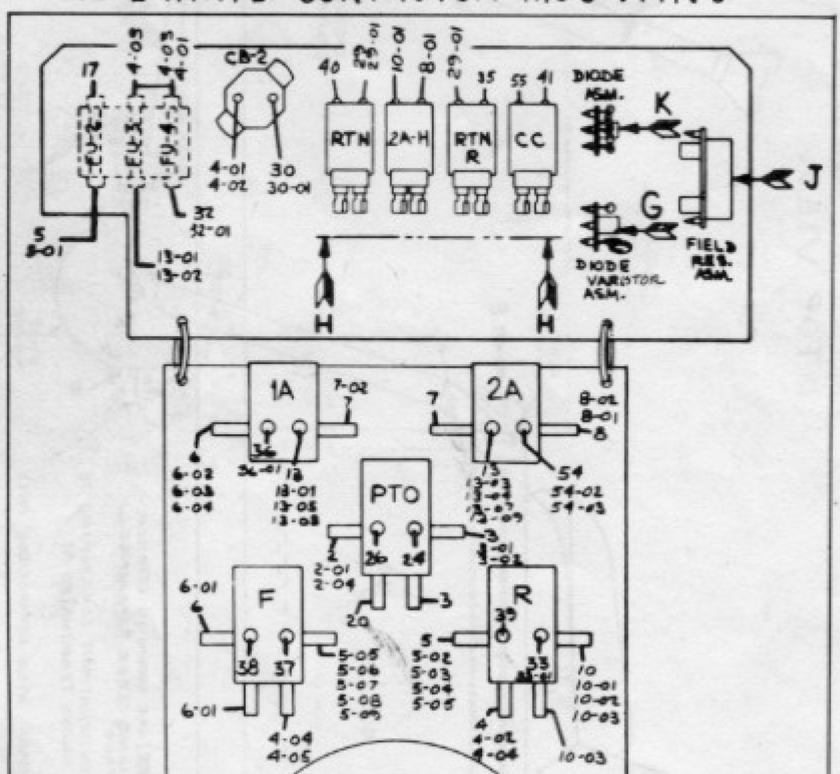


VIEW "K"
DIODE ASSEMBLY

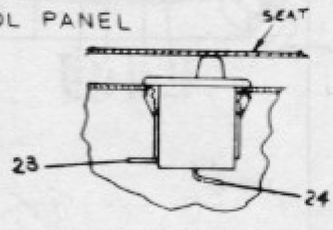


VIEW "A"
CONTROL PANEL

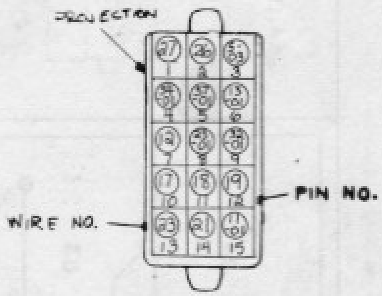
ALTERNATE CONTACTOR MOUNTING



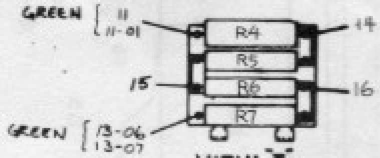
VIEW "A"
CONTROL PANEL



VIEW "E"
SEAT SWITCH



P1
DASH



VIEW "J"

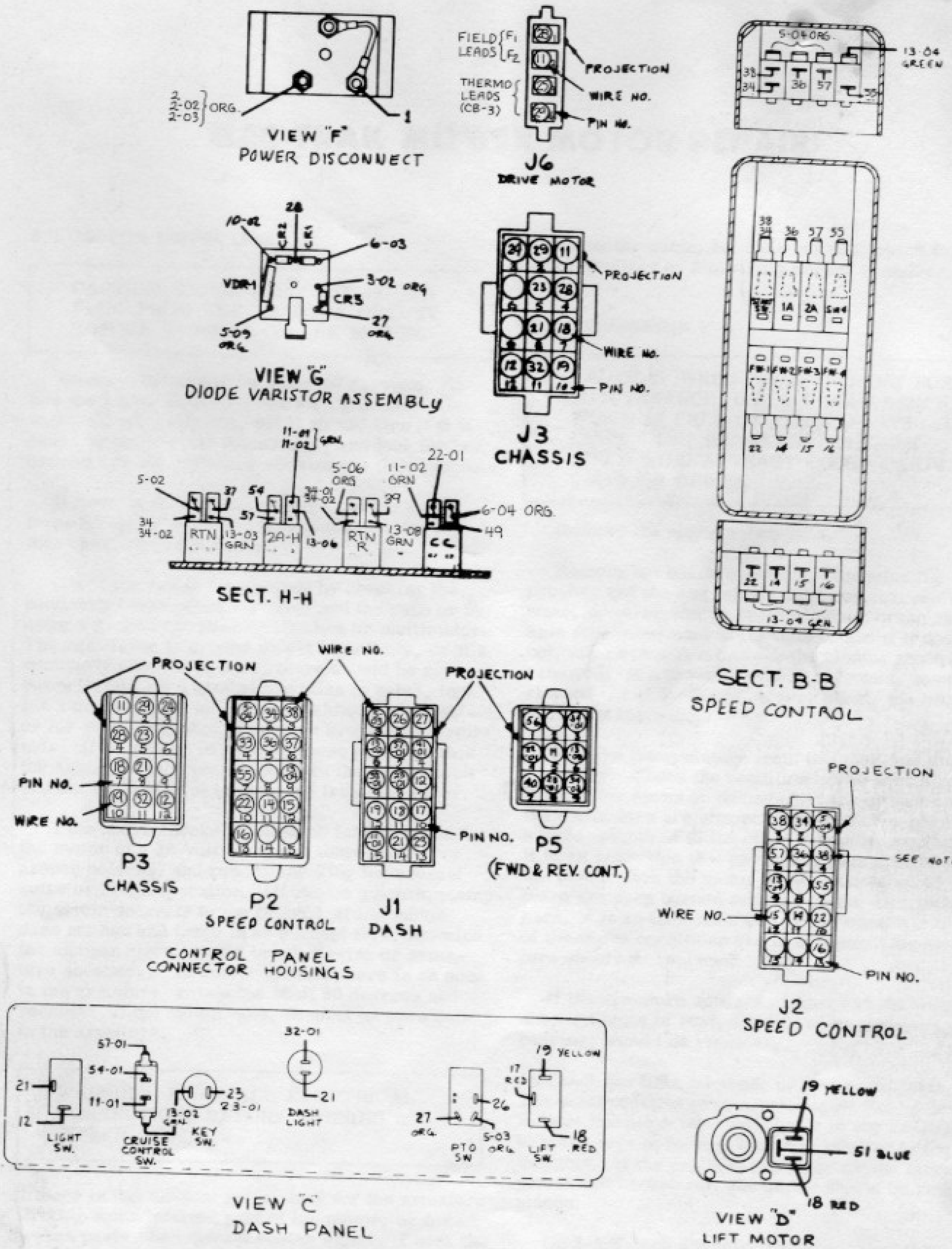


Fig. 7-9 Detailed Wiring Views
Models 26AE20EA and Later

ELEC-TRAK MOWER MOTOR REPAIR

8.1 MOTOR INSPECTION

> CAUTION: DISCONNECT THE POWER PLUG FROM THE TRACTOR OUTLET BEFORE WORKING ON THE MOTOR.

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.

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

Check the motor for grounds by checking the continuity between one terminal and the case or by 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.

If the above checks disclose no faults, connect the motor to a 36-volt dc power source (observe proper polarity) and run it, checking for unusual noise or rough operation. (If run on a bench, clamp the stator securely to the bench.) 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.

8.2 DISASSEMBLY

> CAUTION: WHEN DISASSEMBLING FOR MAINTENANCE, USE A CLEAN BENCH WHICH IS FREE OF STEEL PARTS OR CHIPS. THE PERMANENT MAGNET FIELD WILL ATTRACT LOOSE PARTS, CHIPS OR DEBRIS.

Remove the clamp screw nuts.

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.

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.

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

Check the field for loose or broken magnets. The shell contains permanent magnet field poles. Inspect and clean the motor prior to any reassembly 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.

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.

8.3 ASSEMBLY

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 helps prevent water entry into the cavity.

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 400 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 in this manner, the armature should be replaced.

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.

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

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.

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. See Fig. 8-1. 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 the shaft by hand prior to power connection to assure proper assembly.

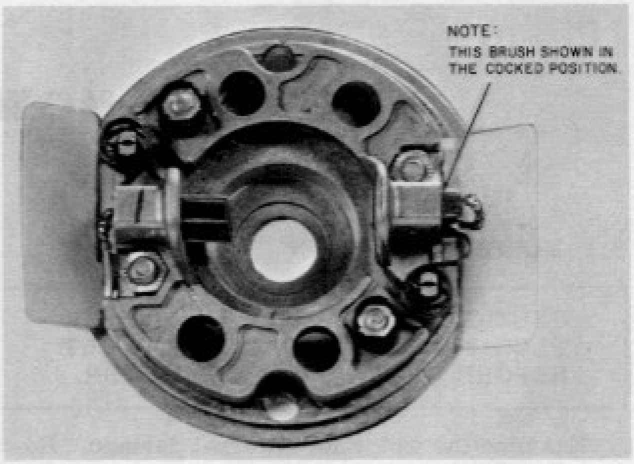


Fig. 8-1

Connect the motor to a 36-volt dc 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.

8.4 GENERAL INFORMATION

Brushes

Brushes should be inspected periodically to assure uninterrupted service. The mower motors are equipped with two brushes which are 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.

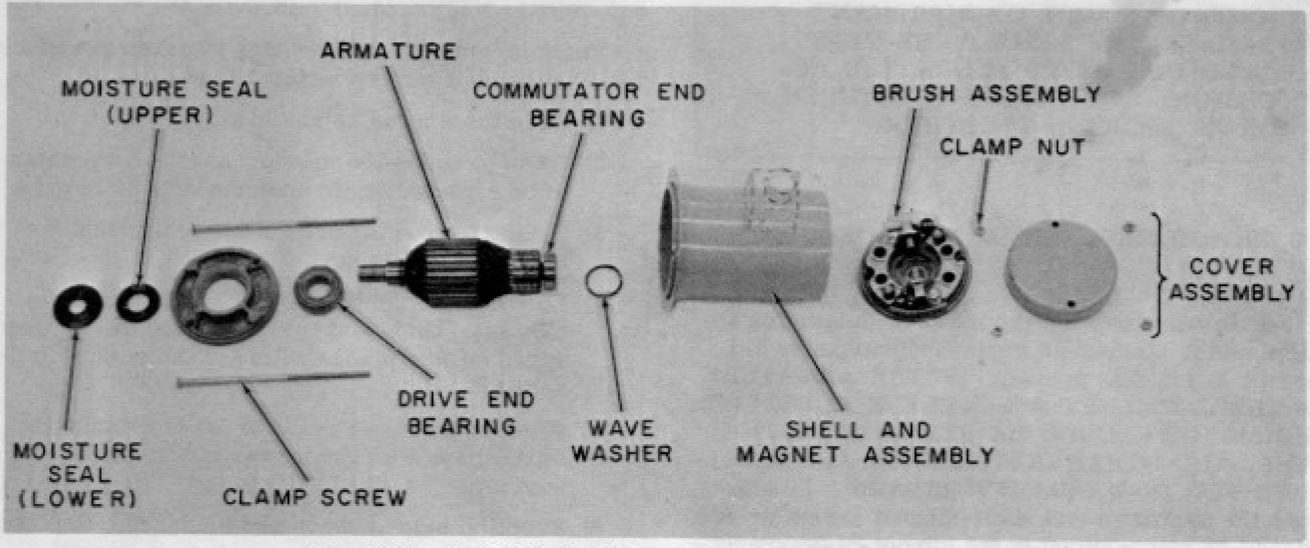


Fig. 8-2. 4-1/2 Inch Diameter Mower Motor (Typical)

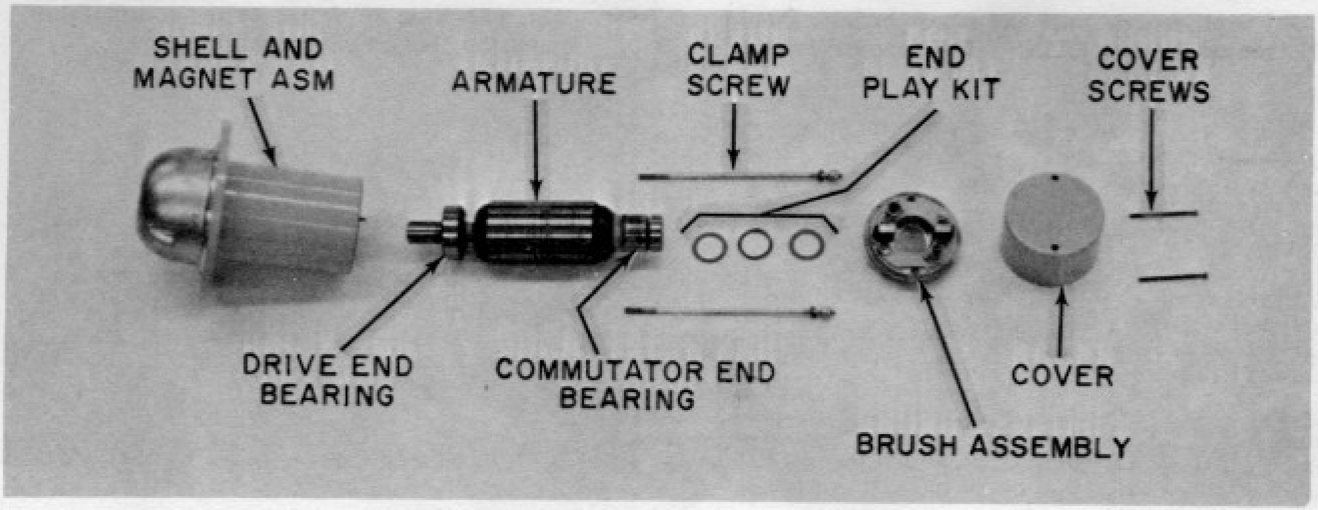


Fig. 8-3. 3-3/8 Inch Diameter Mower Motor

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 of normal). If demagnetizing occurs, the speed will increase slightly. Magnets can be purchased only as part of the shell and magnet assembly. Your dealer can order the correct part for you.

8.5 BENCH TESTING POWER SOURCE

The accessory charger cord (Part No. 243A-4817G1) and a large-frame tractor provide a convenient source of 36-vdc for bench testing of mower motors. Before making connections, secure the motor to the bench (clamp, vise, etc). Then, make the motor terminal connections with the accessory cord clamps. Open the tractor power disconnect (out) and shut the charger off. The power cord can now be plugged into the tractor's accessory receptacle. When the power disconnect is pushed in, the motor should run. If motor rotation is in the wrong direction, open the power disconnect, reverse the motor terminal connections, and engage the power disconnect and complete the motor test.

WARNING: MAKE CONNECTIONS WITH THE POWER DISCONNECT DISENGAGED

(OUT) OR INJURY OR EQUIPMENT DAMAGE MAY RESULT. BE VERY CAREFUL NOT TO ALLOW THE ACCESSORY CORD CLAMPS TO TOUCH OR BE SHORTED TOGETHER.

8.6 REPAIR/REPLACEMENT PROCEDURE

For in-warranty mower motors, determine the failed motor component as outlined on pages 8-1 through 8-4 of this manual. IF THE ARMATURE OR SHELL-MAGNET ASSEMBLY IS DEFECTIVE, THE MOTOR SHOULD BE REPLACED; HOWEVER, ALL OTHER COMPONENTS ARE AVAILABLE FOR IN-WARRANTY REPAIRS. In addition, the armature and shell-magnet assembly are offered as replacement parts for out-of-warranty motors if required.

All replacement part and motor orders should be directed to your ELEC-TRAK tractor dealer.

8.7 PREVENTIVE MAINTENANCE

The following procedures may be taken to reduce the likelihood of mower motor failures:

1) Keep the mower stored in a dry place.
2) When cleaning the mower, never allow water to be directed on the motor shafts or covers.
3) Clean the mowing area of all debris that the blades could strike.
4) Do not overload the mower by cutting grass too fast. On heavy grass, reduce the forward speed so that blades rotate at the normal full-speed.
5) When mowing tall grass or weeds, make the initial pass with the mower set in a high position.
6) Keep the blades sharp and balanced. Replace them after several sharpenings if proper balance cannot be achieved.
7) Have the dealer service the mower seasonally, checking for brush wear, commutator condition, bearing lubrication, etc.

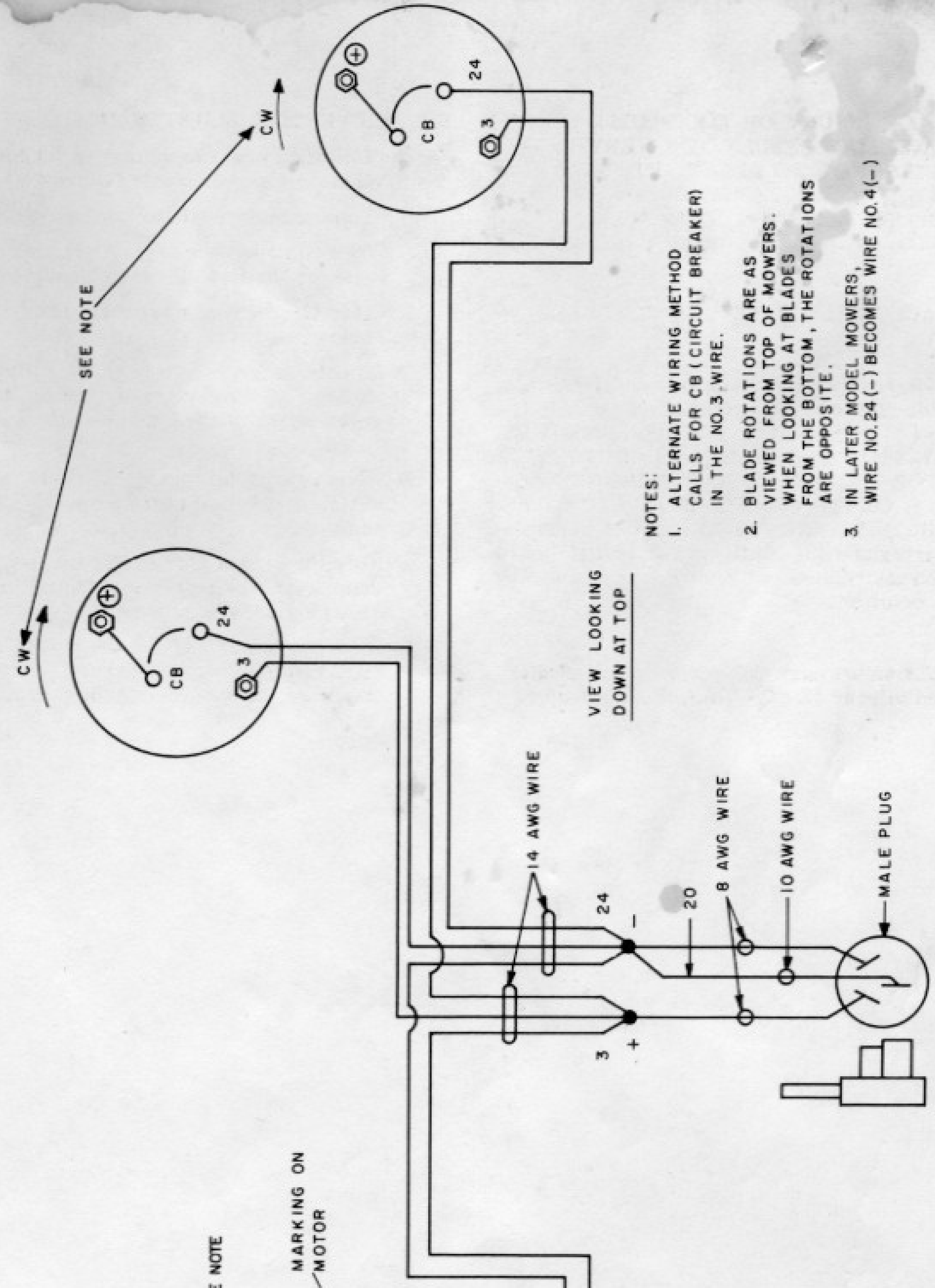


Fig. 8-4 26AA42 Mower Wiring