GEZ-5337A

Elec-Trak®
Tractor

SERVICE TRAINING MANUAL

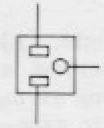
GENERAL ELECTRIC

CONTENTS

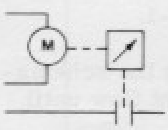
GENERAL INFORMATION

1.1 SCHEMATIC DRAWING SYMBOLS

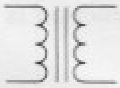
The following symbols will be encountered in using ELEC-TRAK tractor schematics. All service personnel involved with ELEC-TRAK tractors should become familiar with each symbol and the function performed by the device it represents.



Grounded ac Line Plug.

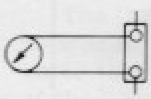


Timer - A motor driven device that shuts off a power source as well as itself after a preset time.

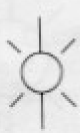


Transformer - Changes ac voltage from one voltage to another. May step up or step down voltage level.

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

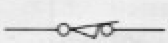


Shunt and Meter - A method of reading high current values. The current is passed through the shunt. The meter reads the voltage drop.

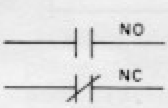


Light or Lamp.

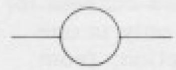
Manual Switch or Disconnect. (Shown in open position)



Cam-operated Switch. (Shown in closed position)



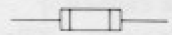
Relay or solenoid-operated contacts. NO - normally open; NC - normally closed.



Actuating coil of relay or solenoid.

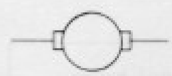
Thermal Overload Protector (Circuit Breaker) - Automatic reset protective device, senses current and/or temperature combinations. Provides a closed circuit until overloaded.

Thermal Overload Protector - Manual reset.



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

Plug-in Disconnect - Eases removal of electrical assemblies.



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

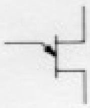
Motor Field - The fixed outside member of a motor produces an electro-magnetic field. (This field is produced by magnetic materials in permanent magnet motors.)

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

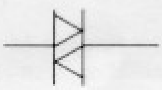
Capacitor - Two electrodes separated by an insulator or dielectric. This device can be charged and discharged at a controlled rate; also can store energy for short periods of time. Sizes considered in μf. (Microfarads)

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

SCR - Solid state semi-conductor 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.

1.2 UNDERSTANDING SCHEMATIC DIAGRAMS

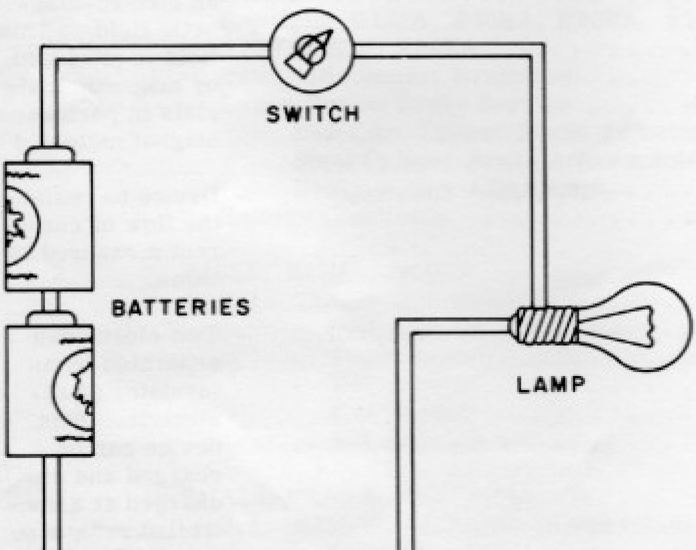
All electrical circuits must have closed paths for current flow in order to operate. The closed path is provided by wires and electric/electronic components in most applications. In tracing closed paths from schematics, the task is simplified by starting the path at the power supply (battery, line cord,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

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



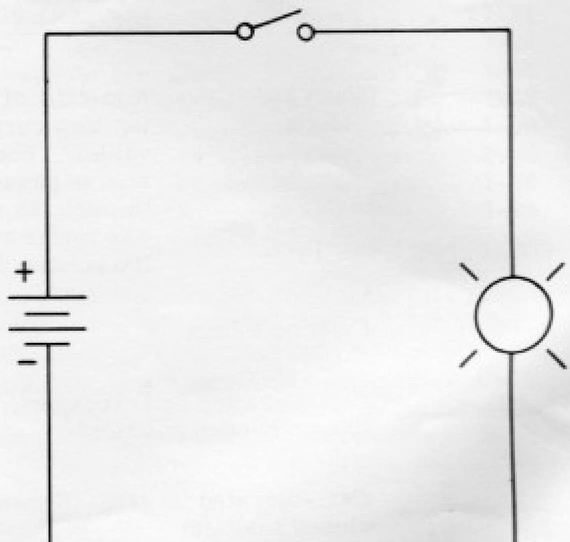


Fig. 1-1

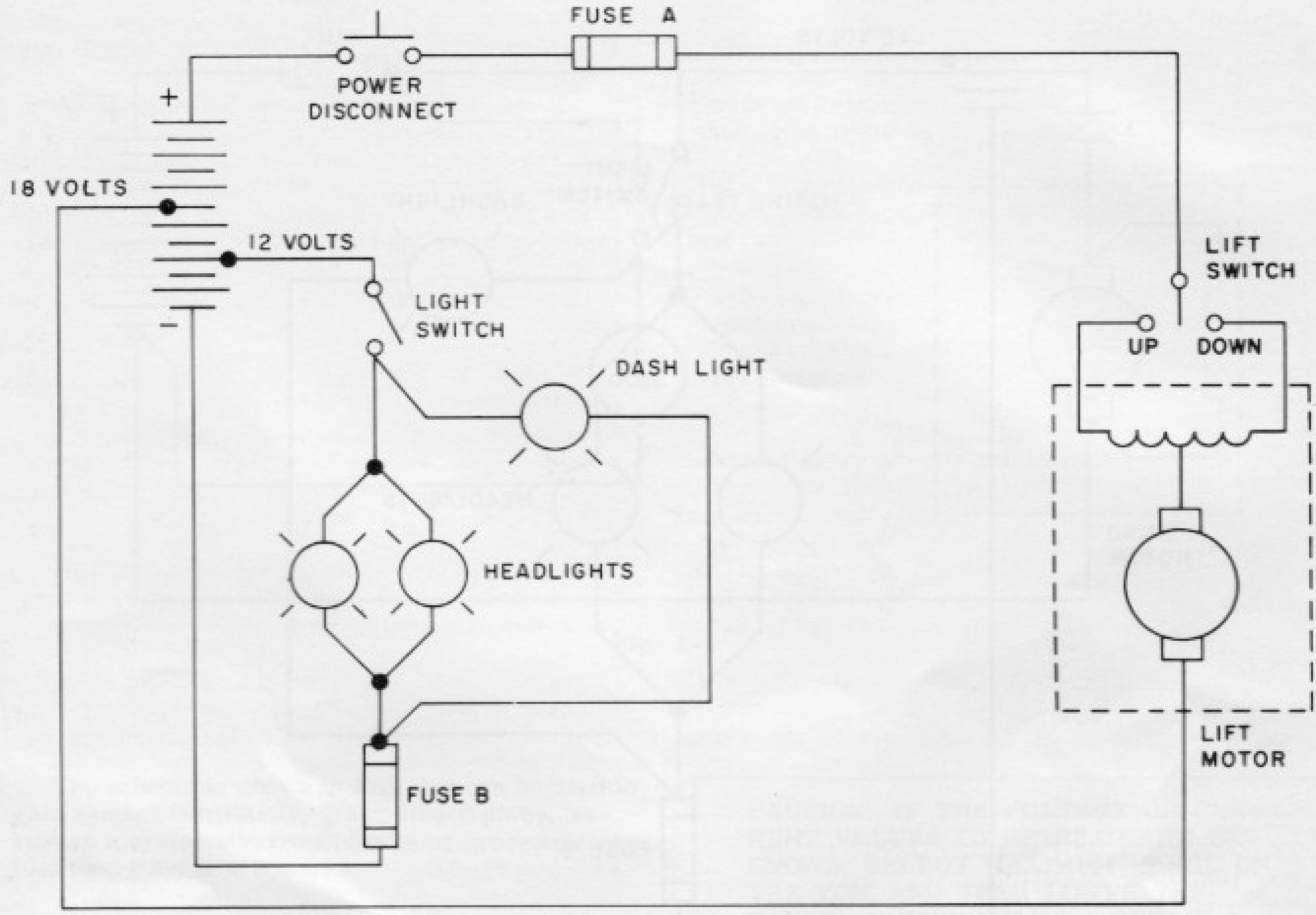


Fig. 1-2

The tractor power pack maximum output is approximately 42 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.

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 bypasses 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.

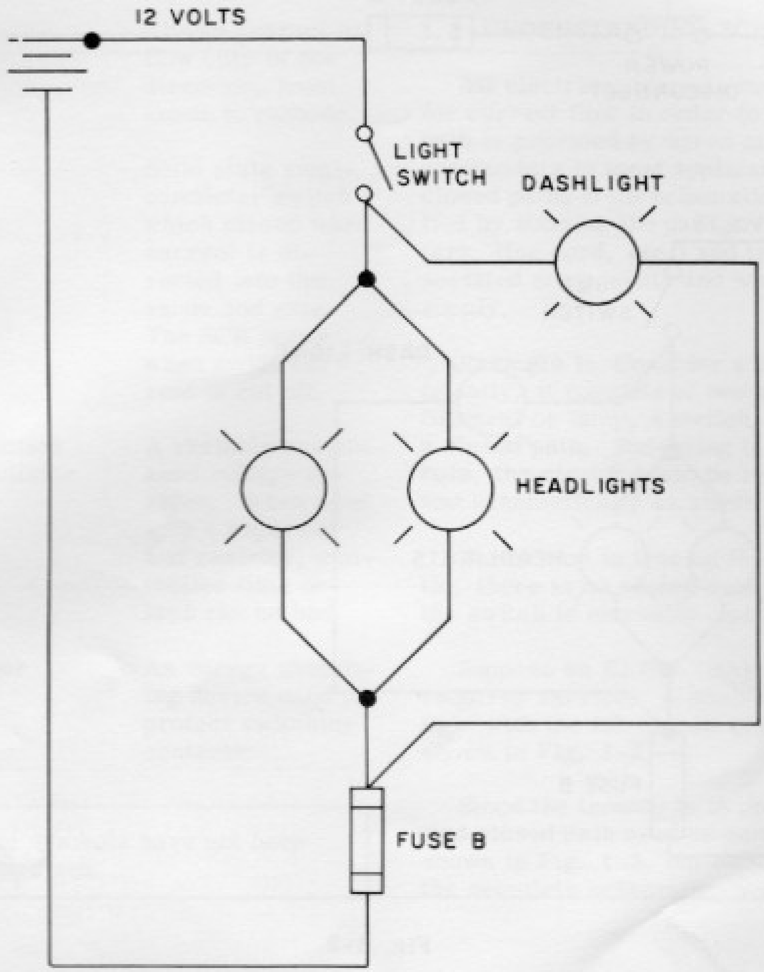


Fig. 1-3

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 wiring. Notice that the power disconnect can shut off lift power, and that the lift switch has a center OFF and two ON positions. Troubleshooting of the wiring and components can be carried out in a manner similar to that used on the light circuit.

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

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

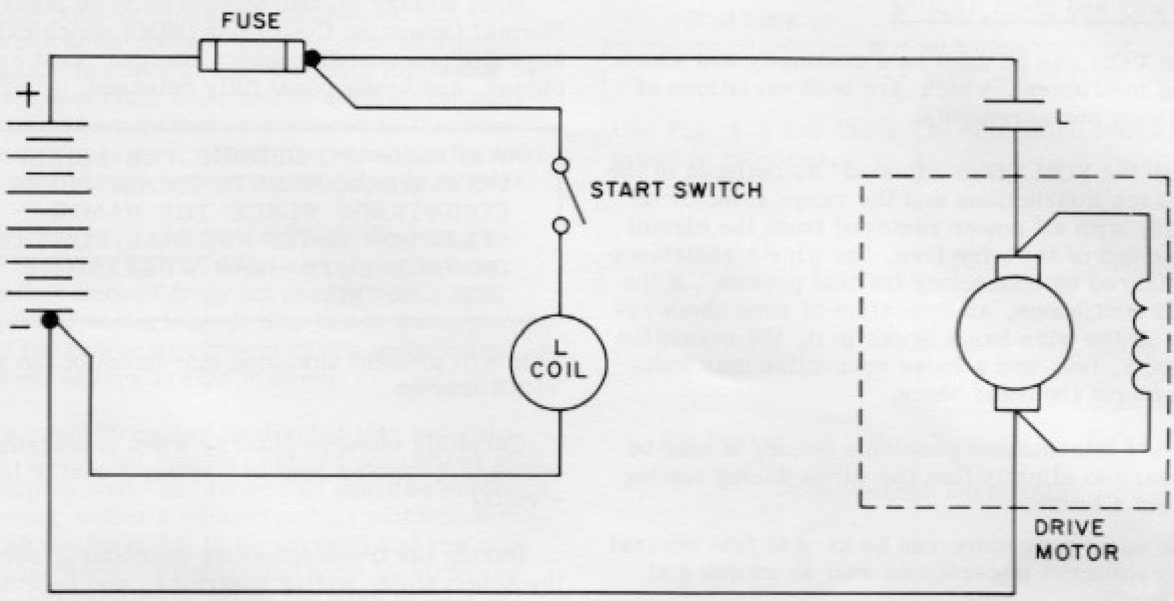


Fig. 1-4

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.

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

Ranges:

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

Voltage and Current Measurements (ac/dc)

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

> CAUTION: IF THE VOLTAGE OR CURRENT VALUES TO BE READ ARE UNKNOWN, SELECT MAXIMUM RANGE ON THE VOM AND THEN LOWER THE RANGE SUFFICIENTLY TO OBTAIN A READING.

Resistance

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

> CAUTION: NEVER ATTEMPT TO MEASURE RESISTANCE IF VOLTAGE IS PRESENT.

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

> NOTE: Replace the internal VOM batteries if the "zero ohm adjust" does nor 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.

1.4 TROUBLESHOOTING TECHNIQUES

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

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

Restore these power sources as needed for the specific test.

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

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

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

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

This will prevent unwanted movement of the ELEC-TRAK 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.

1.5 PARTS REPLACEMENT

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

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

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

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

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.

1.6 WIRE TERMINATION AND TERMINAL IDENTIFICATION

This Section aids the ELEC-TRAK motor mechanic in the selection of the proper wire termination and in preventing component damage during soldering while still providing a good electrical connection.

Two varieties of terminals have been supplied to ELEC-TRAK tractor dealers as spare parts; closed-barrel types and open-barrel types.

To select the proper terminal, consider the following:

Terminal Style	-	Ring, fast-on, edge, mate-n-lok pin, mate-n-lok socket, shur-lug, 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. 1-5 and Table I to determine which terminal is required.

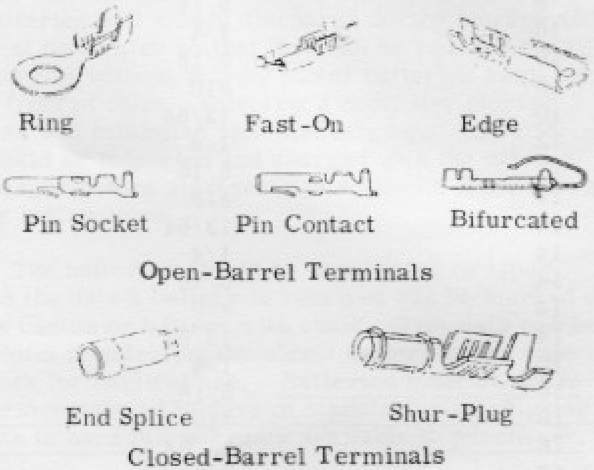


Fig. 1-5

Terminal Crimping

Two types of crimping tools are available:

1. Yellow handle, Part No. 243A4510P1, for crimping closed-barrel terminals and splices.

2. Blue handle, Part No. 243A4510P2, for crimping open-barrel terminals.

Terminals which cannot be accommodated by either of the supplied 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. A good mechanical connection should be made before soldering 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

TABLE I

RING TERMINALS

Wire Gage	Stud Size	Use Part Numbers
6	1/4	243A4541P5, 211A3594P3, 243A4538P1
6	5/16	243A4538P2
8	1/4	243A4541P4, 211A3594P2, 243A4538P1
8	5/16	243A4541P7, 211A3594P5, 243A4538P2
10	1/4	243A4541P3, 211A3594P1, 243A4538P1
10	5/16	243A4541P6, 211A3594P4, 243A4538P2
10	#10	243A4541P1, 211A3594P10
10	13/64	243A4538P7
12	1/4	243A4541P3
12	5/16	243A4541P6
12	#10	243A4541P1
12	13/64	243A4538P7
14	1/4	211A3594P7, 243A4541P9, 243A4538P4
14	5/16	243A4541P10, 211A3594P8, 243A4538P6
14	#10	211A3594P6, 243A4541P8
14	13/64	243A4538P3
16	1/4	243A4541P9, 211A3594P7
16	5/16	211A3594P8, 243A4541P10 & 11, 243A4538P6
16	#10	211A3594P6, 243A4541P8
16	13/64	243A4538P3
18	5/16	243A4541P11, 211A3594P9, 243A4538P5
18	1/4	243A4538P4
18	13/64	243A4538P3
20	5/16	211A3594P9, 243A4541P11, 243A4539P5
22	5/16	243A4541P11

FAST-ON TERMINALS

Wire Gage	Tab Size	Use Part Numbers
12	.250	211A3594P12, 243A4822P2, 243A4570P6
14	.250	211A3594P11 & 12, 243A4822P1 & 2, 243A4570P6 & 7
16	.250	211A3594P11 & 12, 243A4822P1, 243A4570P6 & 7
16	.187	211A3594P13
18	.250	211A3594P11, 243A4570P7
18	.187	243A4553P1, 211A3594P13,
20	.187	243A4553P1, 211A3594P13,
22	.187	243A4553P1

EDGE TERMINALS	
18-20	211A3594P16, 243A4569P1
SHUR-PLUG	
14	243A4660P1
16-18	211A3594P18, 243A4660P1
MATE-N-LOK PIN	
14-20	211A3594P14, 243A4539P3, 243A4539P1
10-14 (Mower Harness)	247A7735P2
MATE-N-LOK SOCKET	
14-20	211A3594P15, 243A4552P1 & 2
10-14 (Mower Harness)	
BIFURCATED	
18-24	243A4823P1
COMMONING TAB	243A4566P1, 211A3594P17
SPLICE	
10-12	243A4567P1, 211A3594P19

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. 1-6). 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.

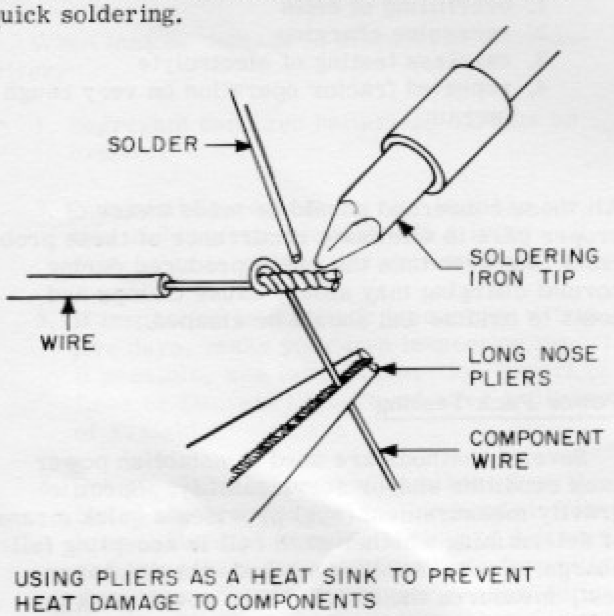


Fig. 1-6

1.7 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. Some of this must be provided by the dealer before sale. This section presents information for initial inspection, charging, storage, watering, cleaning and testing. Recommended procedures should be thoroughly understood and followed completely.

Initial Inspection

Immediately upon receipt, check electrolyte levels to detect possible liquid loss during shipment. If loss is discovered, replenish with acid of the same specific gravity to the proper level. Inspect incoming batteries for mechanical damage, either visible or concealed, which may have been incurred to the contents of a package which is not in evidence at the time of delivery by the carrier but which is later discovered. If loss or damage is encountered, read Appendix A.

Storage

New batteries should be placed in stock, preferably in their shipping cartons, in such a location that the oldest batteries can be used first. Batteries will slowly discharge during storage and must be located so that they can be reached for recharging without moving newer batteries away from in front of them. Selecting a cool, dry storage area will minimize self-discharging. All batteries should be inspected and charged with the external charger before storage. See Appendix B for charging instructions.

The batteries should be segregated by types and the date a battery is received can be marked on the carton or battery with chalk. This date can be helpful in selecting the oldest battery of any type in stock for earliest use. Batteries must be put in service within 150 days of manufacturing shipping date to have full warranty available to purchaser.

The manufacturer's label on each battery can be used to determine the battery's age. This label is coded as follows:

		72	73	74
Jan	A	2	3	4
Feb	B	2	3	4
March	C	2	3	4
April	D	2	3	4
May	E	2	3	4
June	F	2	3	4
July	G	2	3	4
Aug	H	2	3	4
Sept	J	2	3	4
Oct	K	2	3	4
Nov	L	2	3	4
Dec	M	2	3	4

Example: F-2 is June-1972

Loose, flat boards should be used under batteries if the storage area has a concrete floor. This practice prevents moisture accumulation under the batteries and also protects the battery from small stones and objects which could penetrate the case. Under no circumstances should batteries be stacked directly on top of one another; shelving may be used for efficient storage.

All "wet" batteries will slowly discharge on standing and will discharge faster when warm than when cold. At normal temperatures of 80 F, loss of capacity by self-discharge, starting with a fully charged battery, may amount to an average of about 0.001 spg per day over a 30-day period. At the start, it may amount to 0.002 spg loss per day and gradually taper off to less than 0.001 spg loss per day by the end of 30 days. The effect of temperature on self-discharge for the average fully charged new battery in good condition may be about as follows:

at 100 F . . . . . 0.0025 spg per day
at 80 F . . . . . 0.001 spg per day
at 50 F . . . . . 0.0003 spg per day

The above values are approximate for about the first 10 days of standing after being fully charged. To minimize the extent of self-discharge, store batteries in as cool a place as possible, away from hot air ducts or radiators in winter and shielded from direct sunlight in summer.

To make up for the loss of charge while standing in stock, a boosting charge without excessive overcharge should be given batteries whenever they fall below 1.220 spg, (corrected to 80 F for temperature), no matter whether they are to remain in stock or are to be made ready for use. This may be as often as every 30 days at warmer temperatures and less often during colder weather, but the spg should be sampled periodically to establish the exact state of charge. Observe level of electrolyte after charging, and if necessary, add water to the cells to bring to proper level. If electrolyte level is below the perforated cover plate, add water just over this plate before charging and complete filling to proper level after fully charging. Chalk or crayon can be used to date the carton or battery whenever it receives a recharge in stock. This will help to determine which batteries are ready for delivery and which batteries need charging.

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.

Prevention 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

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 C for test procedures.

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

APPENDIX A

Procedures for Damage in Transit

The carrier or carriers are responsible for batteries lost or damaged in transit. The title to goods rests with the consignee (dealer) when batteries are shipped F.O.B. factory, and only he can legally file claims. When loss or damage is noted at time of delivery, require the person making delivery to note loss or damage on freight bill or affix his signature under consignee's memo of the loss or damage. Submit claim by presenting to carrier who made delivery the following information:

1. Standard Form for Presentation of Loss and Damage Claim
2. Original Bill of Lading
3. Original or Certified Copy of Invoice
4. Original Paid Freight Bill with signed notation of loss of damage

When loss or damage is discovered after delivery:

1. Segregate damaged batteries, cartons or crates.
2. Immediately request carrier to make inspection and confirm request with a letter. If inspection is waived, obtain a written "waiver."
3. If inspection is not made by carrier within five days, make your own inspection report. If possible, use form "Inspection Report of Loss or Damage Discovered after Delivery of Freight."
4. Submit claim by presenting all the four items listed above under the section headed "When loss or damage is noted at time of delivery" and in addition submit "Carrier's Inspection Report" or "Waiver" or your request for inspection and your report on your own inspection. If no acknowledgment of claim is received within thirty days, request same by letter. If no settlement is made within sixty days, review claim for a decision regarding necessary action, legal or otherwise. Two years are allowed in which to file suit after a claim is disallowed in writing by the carrier.

Adding Battery Electrolyte

To prevent permanent damage because of spilled electrolyte, add battery grade electrolyte of 1.260 ± .010 specific gravity to just cover the battery plates, and subject the battery to a full charging cycle. Allow 30 minutes after charging and remeasure the specific gravity to be 1.260, and adjust if necessary by adding water if the reading is too high and electrolyte if the reading is too low. Alternate short charging periods and electolyte adjustments should then be made until each cell in the battery in question has a specific gravity reading of 1.260 ± .010. This electrolyte can be obtained from automotive supply stores.

APPENDIX B

Charging Information

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

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

When using the External Charger Kit to charge batteries out of the tractor, the power disconnect must be open. Only six 6-volt, or three 12-volt batteries may be charged at a time.

The six 6-volt batteries are arranged and connected as shown in Fig. 1-7. Connect the (+) positive terminal of battery number 1 to the (-) negative terminal of the second battery. Then the (+) positive terminal of the second battery to the (-) negative of the third battery, etc., until all six battery units are connected as shown.

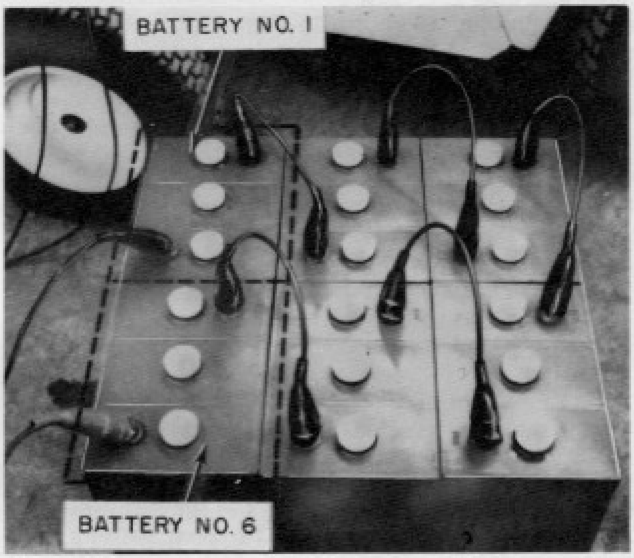


Fig. 1-7. 6-Volt Battery Connections

Disengage the power disconnect on the left side of the control cabinet and insert charger plug into the accessory receptacle. See Fig. 1-8. Connect the red (+) insulated clip of the charge cord to the (+) positive terminal of battery number 6 and the black (-) insulated clip to the (-) negative terminal of battery number 1.

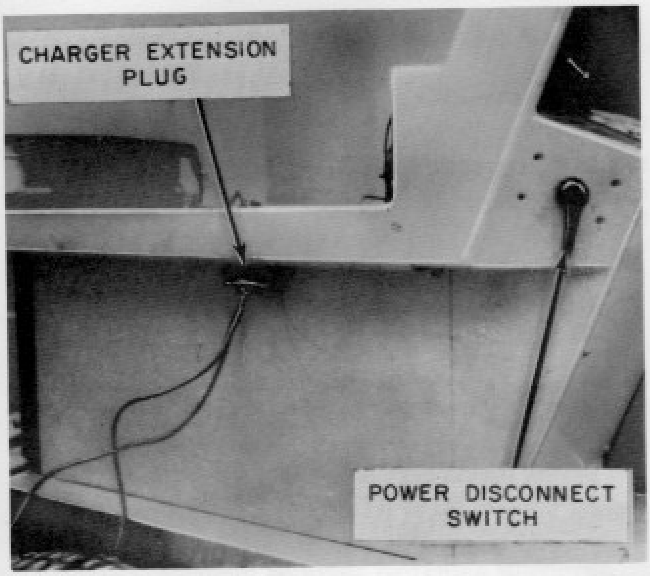


Fig. 1-8. Charging Tractor

Plug tractor line cord into wall receptacle and set timer in normal manner.

To charge three 12-volt batteries, interconnections and charger cord connections are made in similar fashion as shown in Fig. 1-9. After the charger cord is inserted in the accessory outlet, the charger should be started so that it runs for a period equal to one-half that used for 6-volt units.

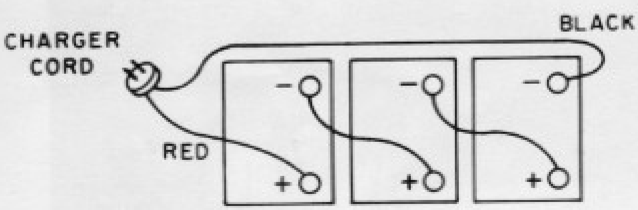


Fig. 1-9. 12-Volt Battery Connections

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" 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.

> NOTE: 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.

APPENDIX C

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 1.260 representing a discharged condition and a charged condition respectively at 80 F. If the spg is higher than 1.260, 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 and 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. Spg varies with temperature, so for correct readings the electrolyte temperature should be at 80 F. Whenever a variation in spg of over 0.050 points is observed, discharge testing should be applied to determine serviceability. If batteries are new, several recharging cycles may be necessary to equalize cells to reach consistency in readings.

Hydrometer Care and Correction

Hydrometers become inaccurate if not cleaned regularly. It is good practice to flush them out with clean water after use. They should be taken apart and cleaned thoroughly every two months. Broken or leaking hydrometer floats prevent correct specific gravity readings. A good hydrometer will read accurately at electrolyte temperatures of 80 F. 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 should be used not to hold the tester in place for over 5 seconds and in 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 enables the ELEC-TRAK tractor mechanic to make this test on 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 volts 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 conditon 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 as 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 the entire pack can be replaced under the terms of the warranty. 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 discharge test.

The tester is put into operation as follows:

1. Before applying discharge test, check all cells for proper specific gravity after a full charge cycle.
2. The unit is shipped from the factory set for 75 ampere discharge.
3. Connect red (+) battery clamp on the positive 36-volt post and the black (-) battery clamp on the negative post.
4. With the timer set at zero, press the "Start" button which will initiate the timing cycle and turn on the load.
5. The test will continue until the total battery pack voltage falls to 31.5 volts (1.75 v/cell). At this point the transistorized trigger will terminate the test, stop the timer and turn off the discharging light.

1.8 CHARGER

TROUBLESHOOTING

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. <u>Be sure the short is removed before replacing the fusible link.</u>
	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 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 charger base, and place the charger near the tractor such that the timer can plug into transformer for operational tests.

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

Transformer Test– See Fig. 1-10

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.

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 should 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 line voltage is within specifications and capacitor used is not faulty.

Voltage Reading	Location	Cause	Correction
40 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. 1-11

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

3. Twenty (20) 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 20 ohms is obtained in one direction and ∞ (infinity) in the opposite direction, then 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

* Test Point will be called T. P.

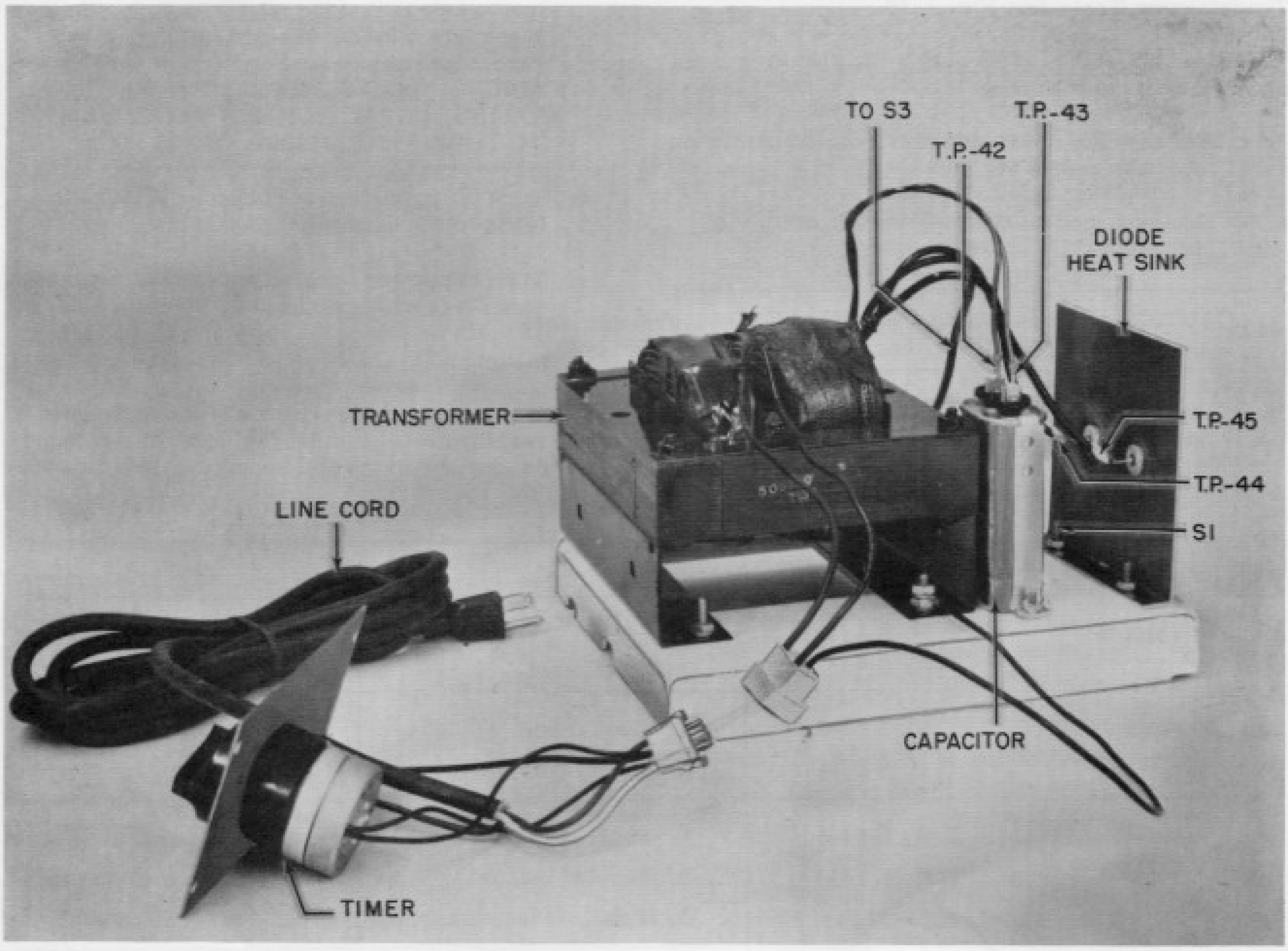


Fig. 1-10 Transformer Test

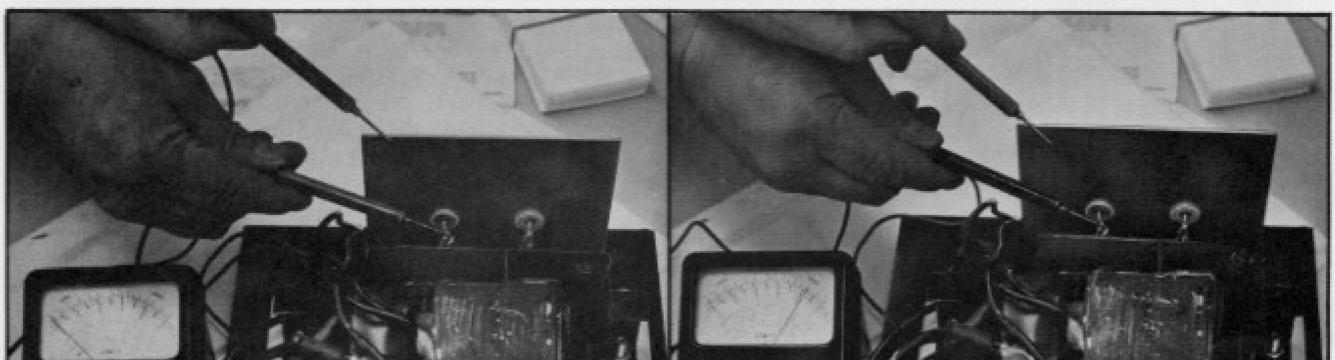


Fig- 1-11 Charger Heat Sink Diode Resistance Measurement lack of reading in both directions of either diode indicates an open diode. Replace the heat sink.

1.9 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 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° and remove from frame.
10. The steering shaft can be lowered through frame.

Assembly of large frame steering

1. Install the set collar and bearing on the steering shaft and install through the hole in the control cabinet.
2. Install the shaft and sector assembly through the hole in 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.
7. Tighten the bearing and set collar on the steering shaft.
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 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).
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 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 the 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.

Assembly:

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.

1.10 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 by the dealer to the repair outlet. Evidence of tractor date of sale should be presented to assure the warranty is in effect effect.

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

d. In-warranty claim for 1/2-hour travel time for tractor pick-up and delivery at the customer's location for transaxle repair only should be submitted to General Electric Company. 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 reimburseable.

E12JA/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.	

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

E15HA/E16/20EA

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	

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	

POWER DISCONNECT EVALUATION

Reports have been received that in a few cases, power disconnects have had high electrical resistance which can cause reduced range by undercharging the power pack or producing electrical loss during tractor operation.

If complaints are received related to shortened range, it is suggested that the following procedure be used:

1. Temporarily remove the battery clamp from the positive post of battery B2.
2. Connect the positive (red) cable clamp of the discharge tester to terminal A of the power disconnect. (See Fig. 1-12 for orientation, Fig. 1-13 for connection.)

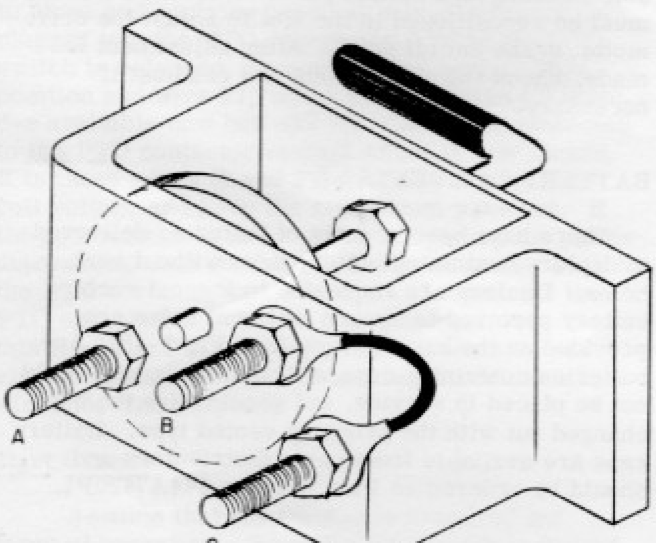


Fig. 1-12

3. Connect the negative (black) cable clamp of the discharge tester to the negative post of battery B5.
4. Reconnect the battery clamp on battery B2.
5. Perform the discharge test with the power disconnect engaged, and during discharge measure the voltage drop across power disconnect terminals A and C, using the 10-vdc voltmeter setting.
6. If voltage reading is 1/2 volt or greater, stop the test, remove battery B2 positive cable, and replace the power disconnect.

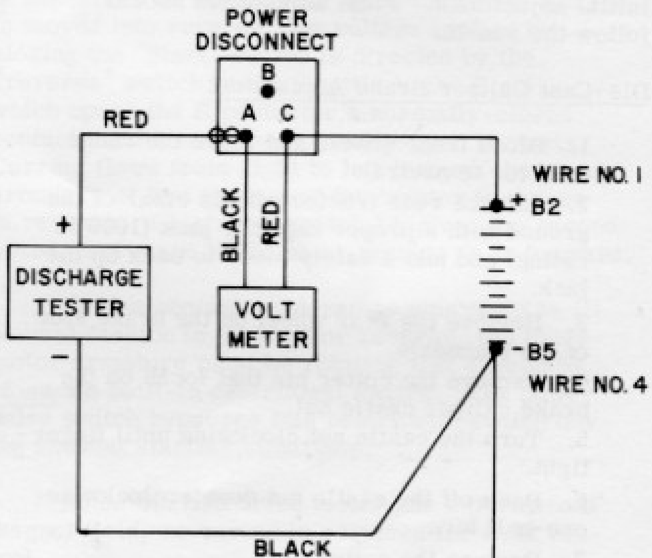


Fig. 1-13

7. If the voltage reading is less than 1/2 volt, continue testing the power pack for evaluation of capacity. Refer to Product Service Bulletin No. 72-25.

Additional potential causes of shortened range or lack of power include:

1. Loose drive belts which slip.
2. Low charger output.
3. Corroded battery connections.
4. Lack of lubrication.
5. Brake drag.

Refer to Product Service Bulletin 72-24 for a detailed list of checks to be performed.

LARGE-FRAME BRAKE SERVICE

To prevent brake drag, which reduces tractor range considerably, instruct homeowners to periodically lubricate the brake pedal shaft at its bushing where it passes through the frame. The pedal should return to its full up position after each depression. If full return does not occur after lubrication, the action of the brake caliper unit and the brake switch should be inspected for interference during depression and release. Also inspect the brake disk for warp, scoring or rust. Replace the disk if necessary.

Two types of brake calipers are used on large frame tractors. When either type is replaced, a short run-in period of repeated applications of the brake while the tractor is in motion should follow initial adjustment. Final adjustment should follow the run-in.

Die-Cast Caliper Brake Adjustment

1. Block 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 caliper castle nut.
5. Turn the castle nut clockwise until finger-tight.
6. Back off the castle nut counterclockwise one-half turn.
7. Replace the cotter pin.
8. Check to be sure there is no brake drag by rotating the brake disk manually.
9. Replace the wheel and lower the tractor.
10. Test the brake function.

Steel Caliper Brake Adjustment

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 rear wheel on brake side of transaxle.
4. Remove the cotter pin from the brake clevis pin.
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 eliminated. The clevis and clevis pin must be temporarily reinstalled 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.

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 causes the drive motor to shut off when the brake pedal is depressed to 1/4 inch from its bottom stop. See Fig. 1-14.

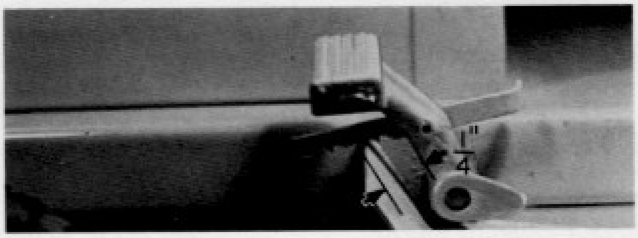


Fig. 1-14. Brake Switch Adjustment

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. It is this bolt that must be repositioned in the slot to adjust the drive motor/brake cut off point. After adjustment is made, check the cut off point and readjust if necessary.

BATTERY CAP VENTS

There have been reports of batteries delivered to dealers containing battery caps without vent holes. Dealers are requested to inspect each battery received to assure that vent holes are provided on the battery caps (See Fig 1-15). Any batteries containing caps without vent holes should not be placed in service, but should have the caps changed out with the properly vented type. Battery caps are available from parts distributors and should be ordered as Part Number 244A7420P1.

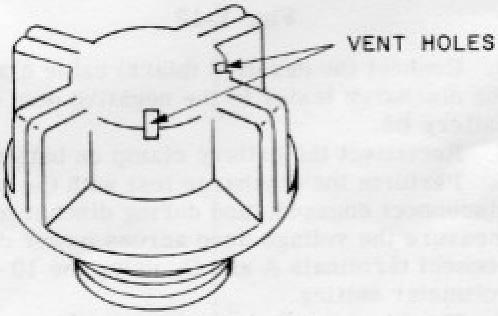


Fig. 1-15
Part Number - 244A7420P1

2.1 THEORY OF OPERATION, MODELS 26AE12JA, 26AE15HA, AND 26AE20EA AND LATER

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 d-c 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. 2-1). 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 d-c 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 Figure 2-1, 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 Control

The complete forward operation of the E12 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 drive motor has a permanent magnet field, no wiring is required for field control.

E15 Control

The E15 drive motor is reversed by the same method as that of the E12 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. 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 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 can not 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.

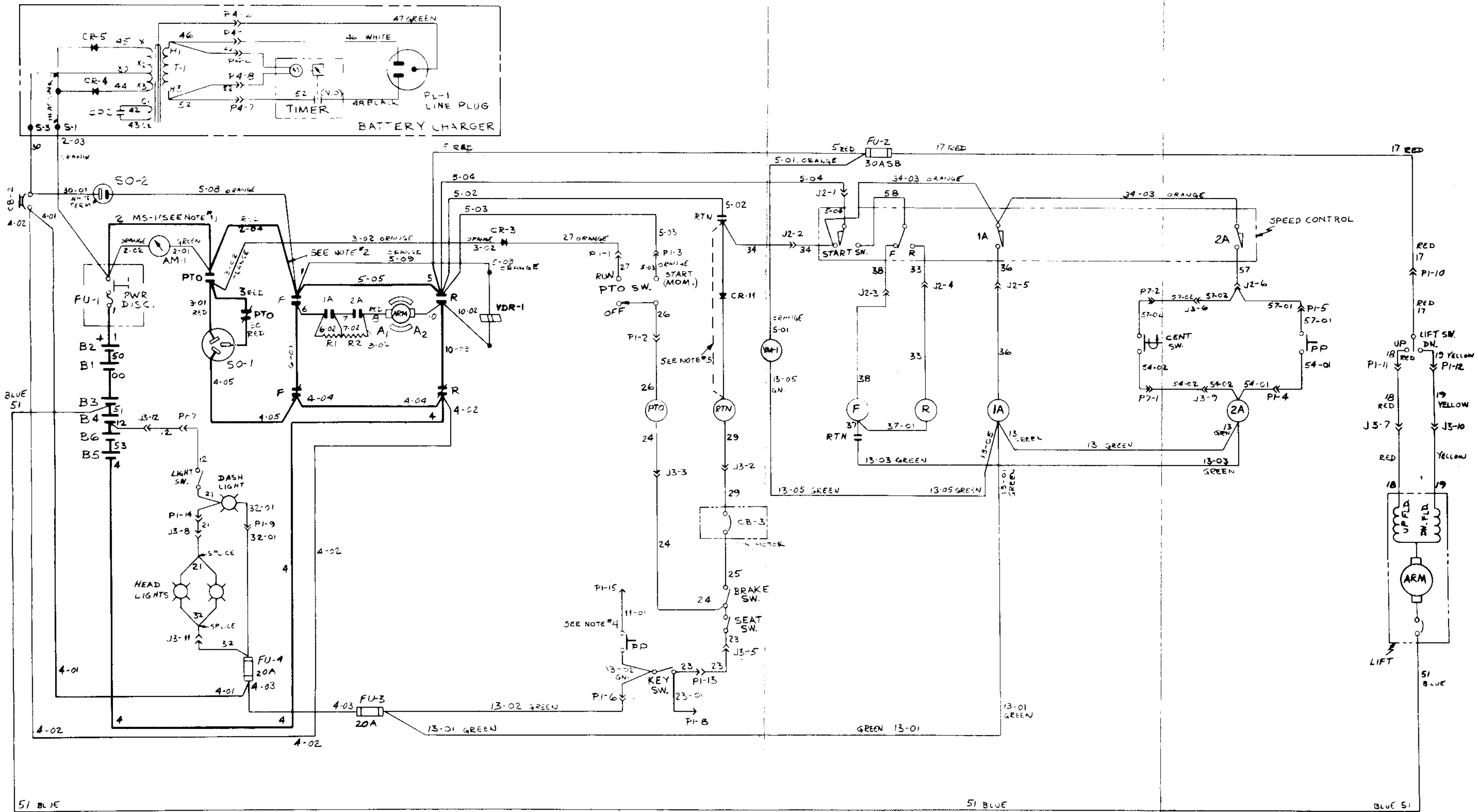
The power pulse button serves an additional function when it is depressed while operating in speeds 4, 5, 6 or 7. The depressed switch bypasses all of the field weakening resistors, and forces the tractor to operate in its most efficient (3rd) speed until the button is released.

E20 Control

The operation of the E20 is the same as that of the E15 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. 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. 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.

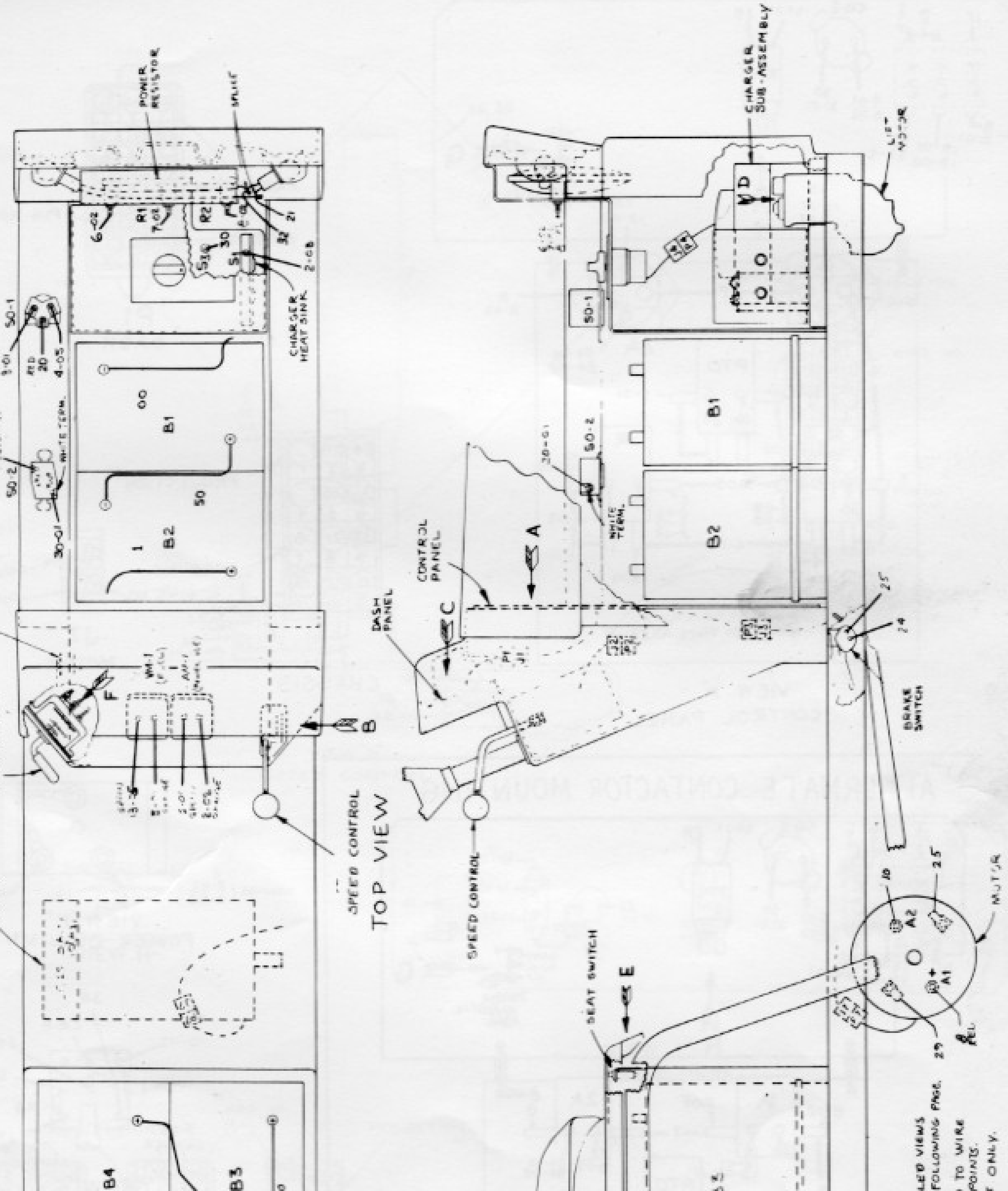
During operation in cruise control, the cruise control switch can be in the "Fast" or "Slow" position. In the "Slow" position, the armature and field voltages are at full battery voltages of about 36-vdc, corresponding to 3rd speed forward. In the "Fast" position the 4th forward speed results because 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 had by interrupting power to the RTN or CC relay coils, including depressing the speed control pedal beyond the third speed position.



NOTES:

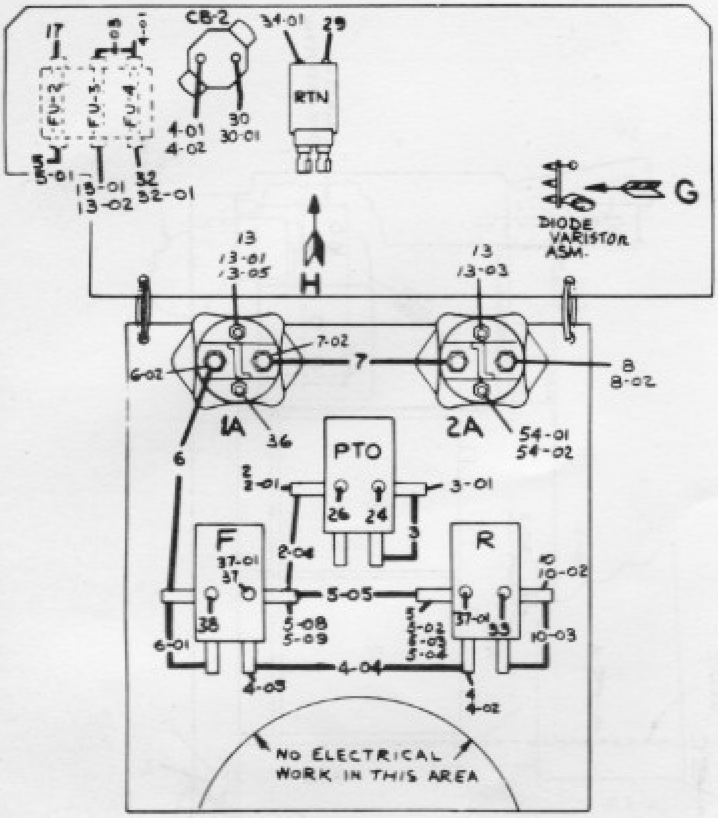
1. MS-1 IS 18¼" OF #6AWG CABLE EXTENDING FROM POWER DISCONNECT TO PTO CONTACTOR.
2. WIRE #2-04 CONNECTS TO CIRCUIT #5 AT F CONTACT.
3. NUMBER AND COLOR DESIGNATIONS CORRESPOND TO WIRE MARKINGS AND COLOR OF INSULATION.
4. NOT USED IN THIS MODEL.
5. MAY 30, 1973 LETTER INSTRUCTED REPLACEMENT OF WIRE 34-01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

Fig. 2-1 Schematic and Connection Diagram Models 26AE12JA and Later

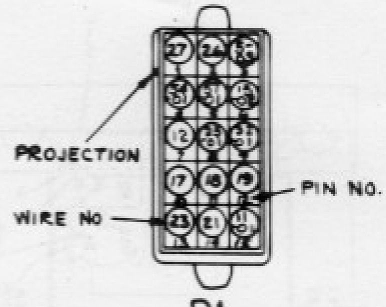


NOTES:
1. LETTERED ARROWS (←) ARE SHOWN IN DETAILED VIEWS CARRYING THE SAME LETTER REFERENCE ON THE FOLLOWING PAGE.
2. NUMBER AND COLOR DESIGNATIONS CORRESPOND TO WIRE NUMBERS AND COLORS TERMINATED AT THOSE POINTS.
3. THIS FIGURE SHOWS MAJOR WIRE CONNECTIONS ONLY.

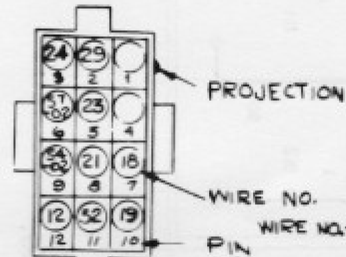
Fig. 2-2 Tractor Wiring
Models 26AE12JA and Later



VIEW "A"
CONTROL PANEL



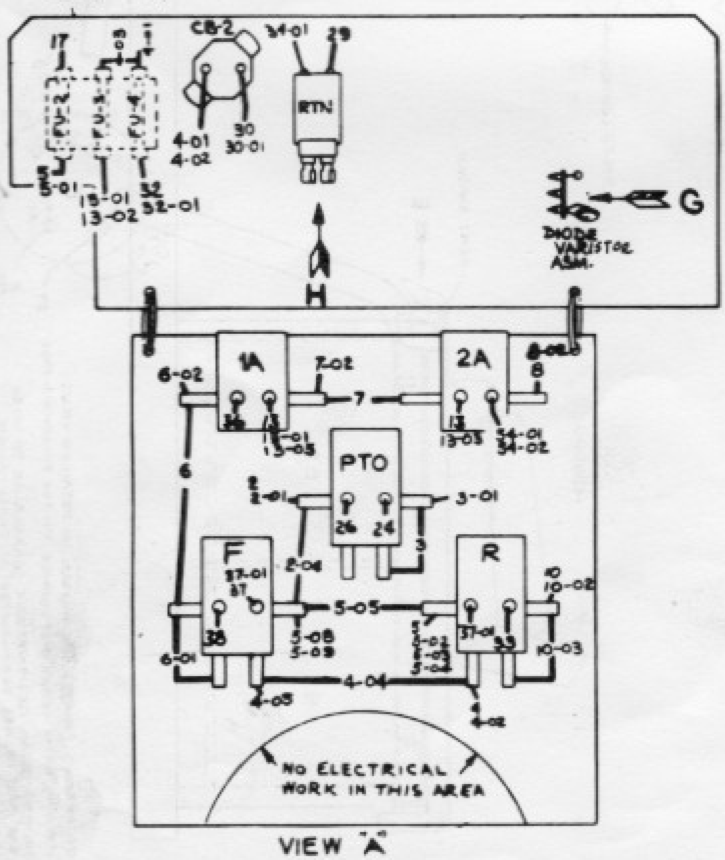
P1
DASH



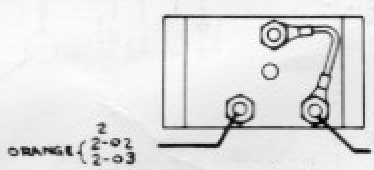
J3
CHASSIS

J7
MOTOR

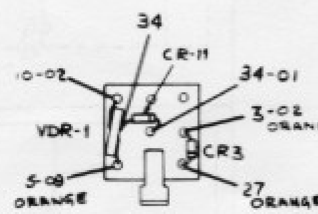
ALTERNATE CONTACTOR MOUNTING



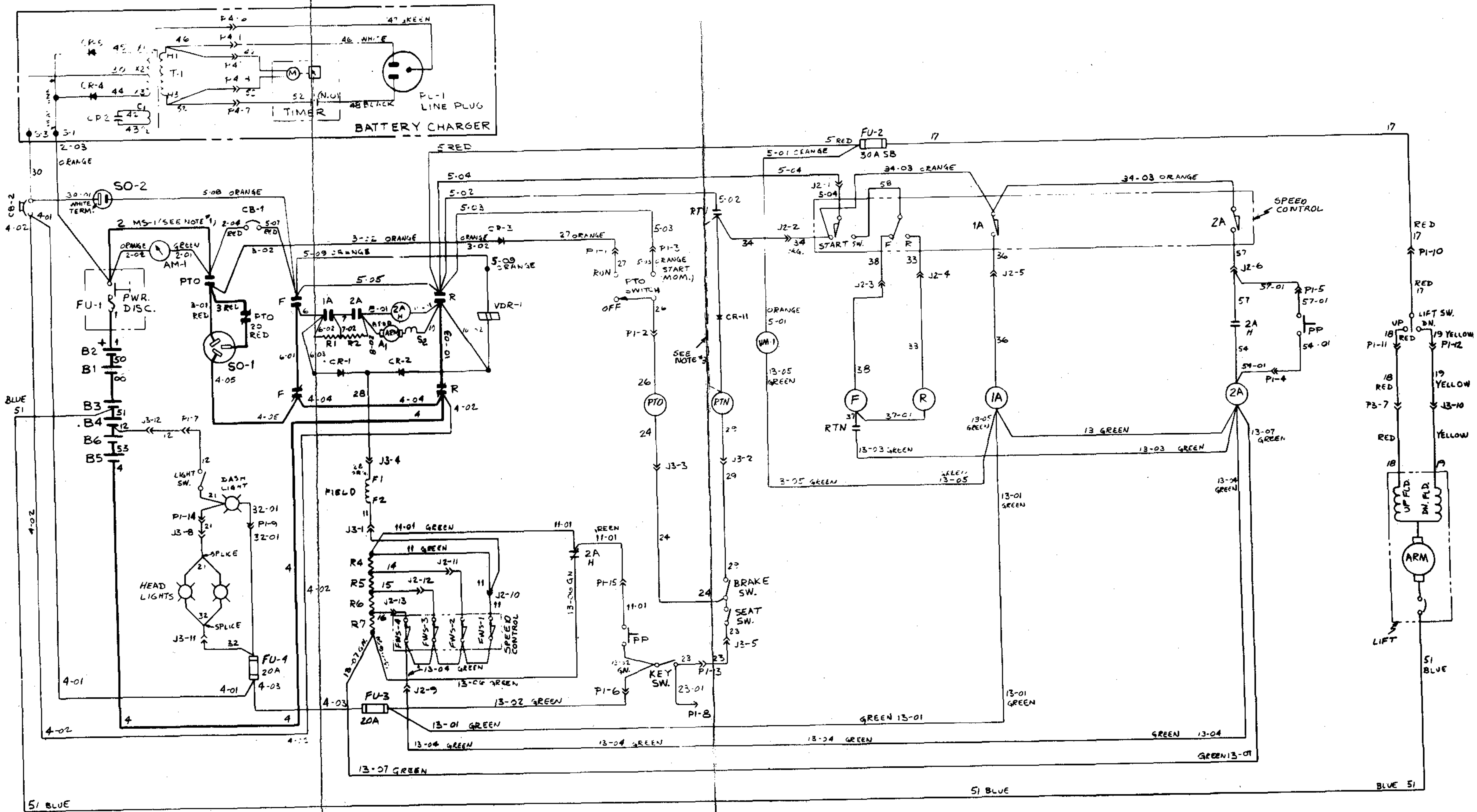
VIEW "A"
CONTROL PANEL



VIEW "F"
POWER DISCONNECT



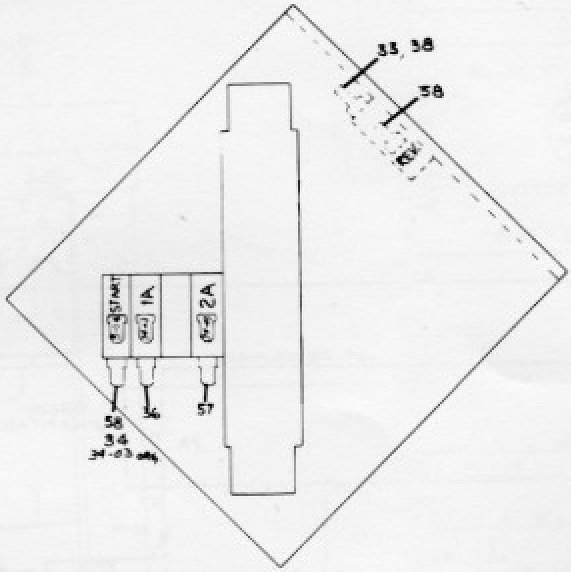
VIEW "G"
DIODE - VARISTOR

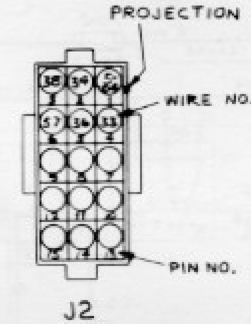


NOTES:

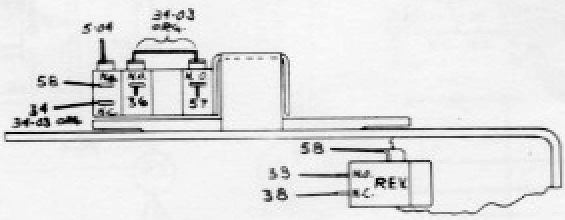
1. MS-1 IS $18\frac{1}{4}$" OF #6AWG CABLE EXTENDING FROM POWER DISCONNECT TO PTO CONTACTOR.
2. NUMBER AND COLOR DESIGNATIONS CORRESPOND TO WIRE MARKINGS AND COLOR OF INSULATION.
3. MAY 30, 1973 LETTER INSTRUCTED REPLACEMENT OF WIRE 34-01 IN MODEL 26AE15HA WITH DIODE ASSEMBLY CR11.

Fig. 2-4 Schematic and Connection Diagram Models 26AE15HA and Later

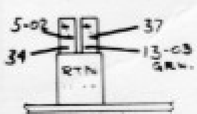




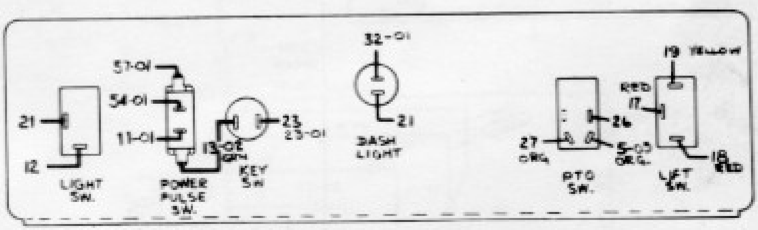
J2
SPEED CONTROL



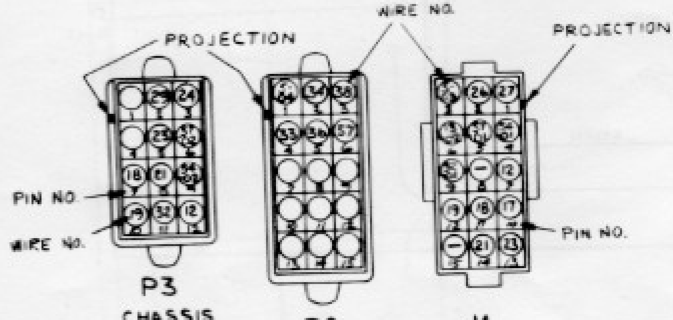
VIEW "B"
SPEED CONTROL



VIEW "H"



VIEW C
DASH PANEL

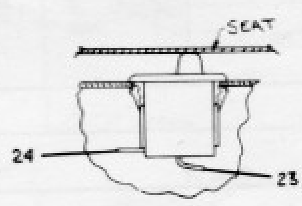


P3
CHASSIS

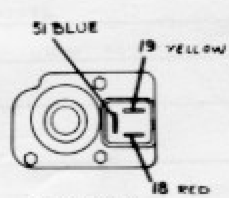
P2
SPEED CONTROL

J1
DASH

CONTROL PANEL
CONNECTOR HOUSINGS

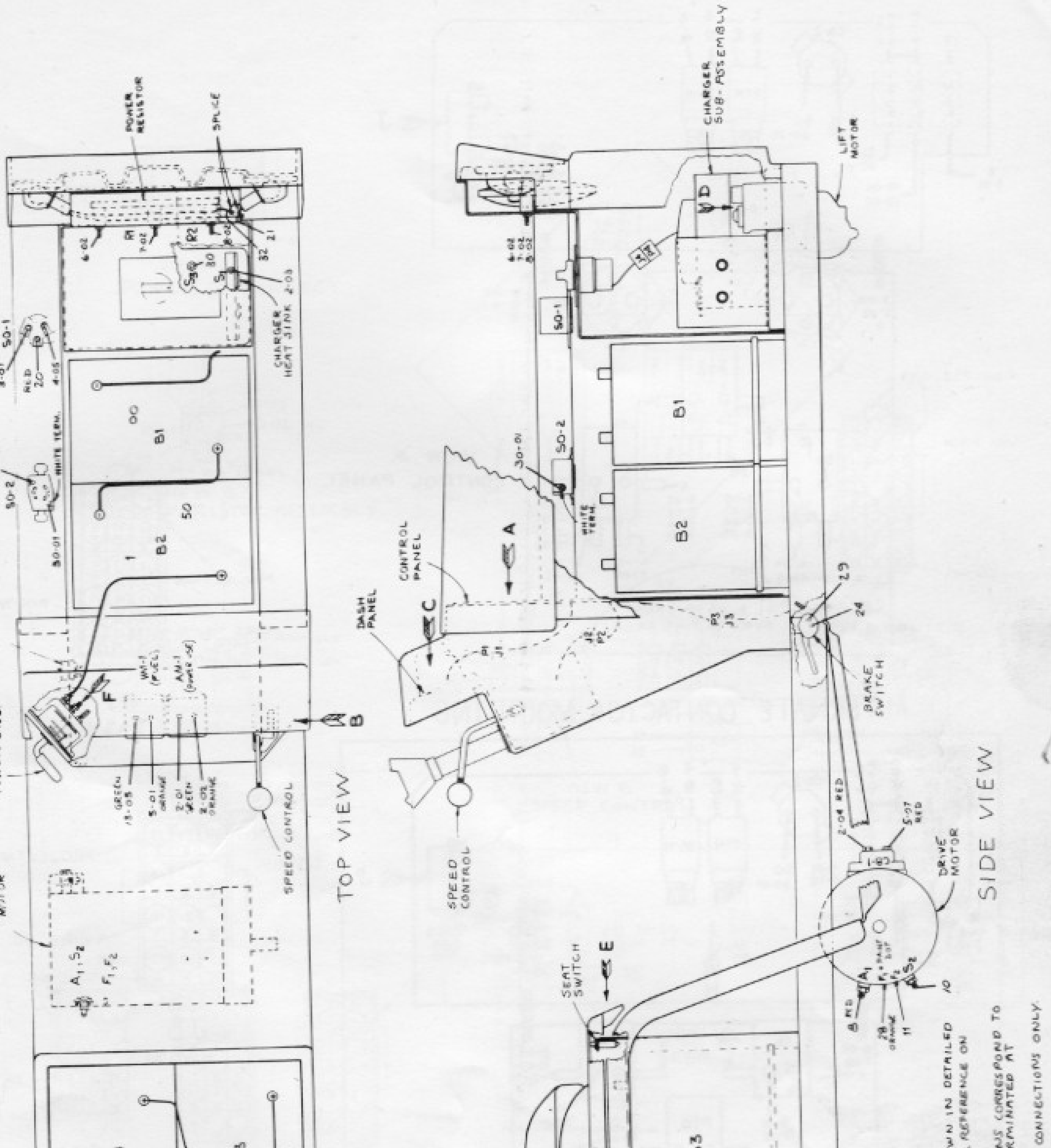


VIEW "E"
SEAT SWITCH



VIEW "D"
LIFT MOTOR

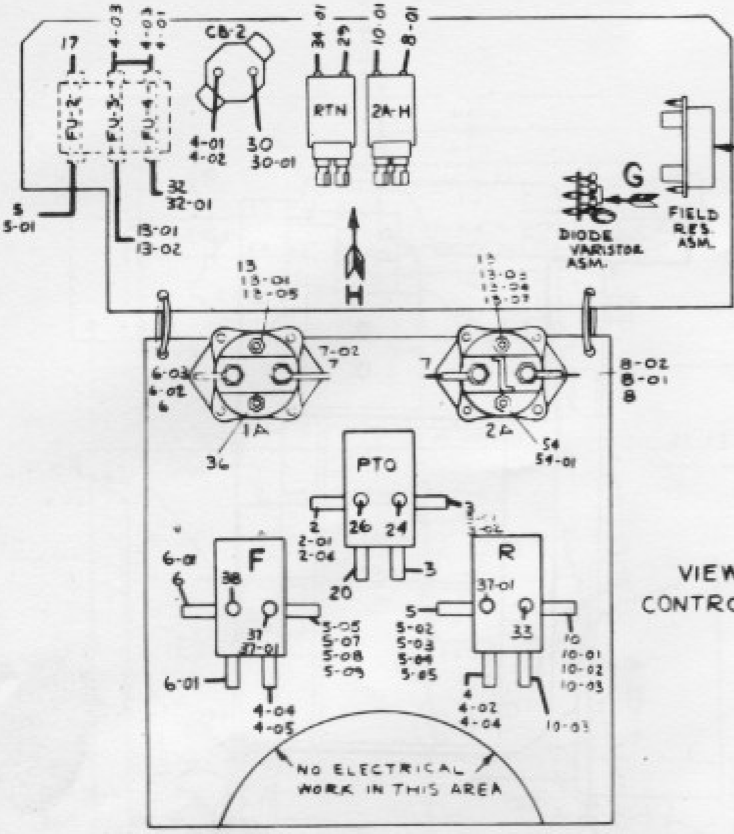
Fig. 2-3 Detailed Wiring Views
Models 26AE12JA and Later



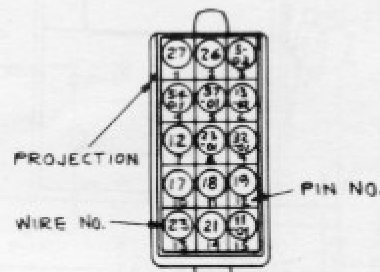
NOTES:

1. LETTERED ARROWS ( ) ARE SHOWN IN DETAILED VIEWS CARRYING THE SAME LETTER REFERENCE ON THE FOLLOWING PAGE.
2. NUMBER AND COLOR DESIGNATIONS CORRESPOND TO WIRE NUMBERS AND COLORS TERMINATED AT THOSE POINTS.
3. THIS FIGURE SHOWS MAJOR WIRE CONNECTIONS ONLY.

Fig. 2-5 Tractor Wiring
Models 26AE15HA and Later

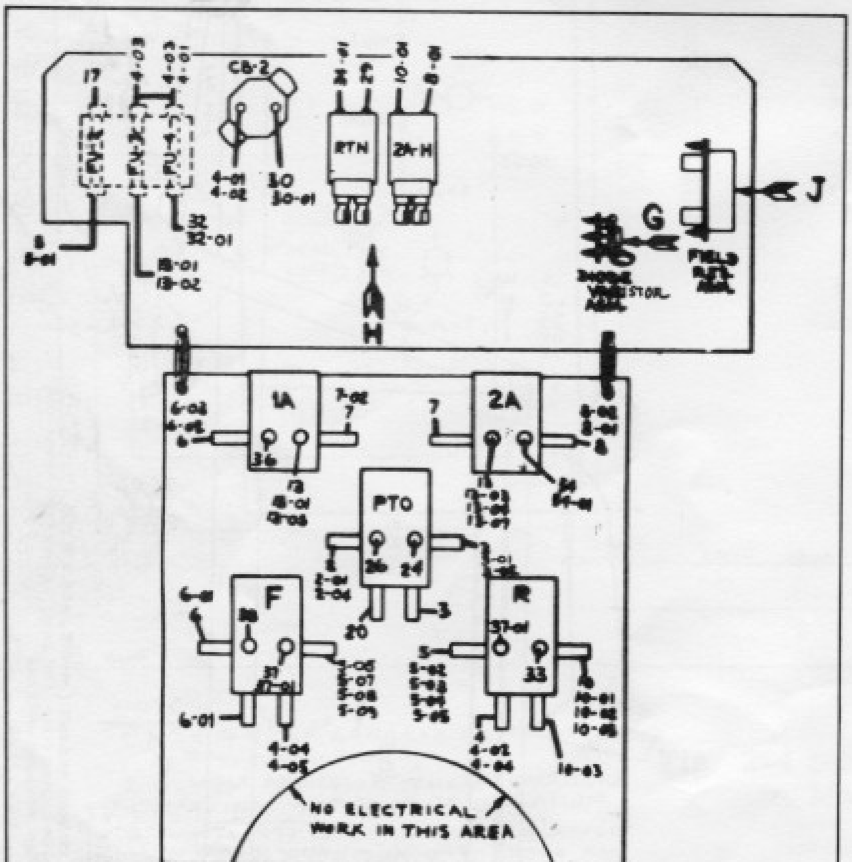


VIEW "A"
CONTROL PANEL

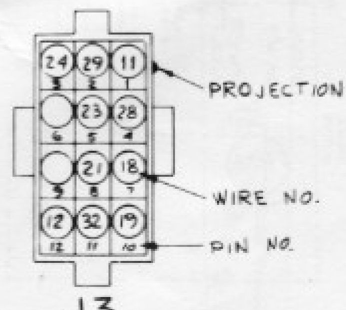


P1
DASH

ALTERNATE CONTACTOR MOUNTING



VIEW "A"
CONTROL PANEL



J3
CHASSIS

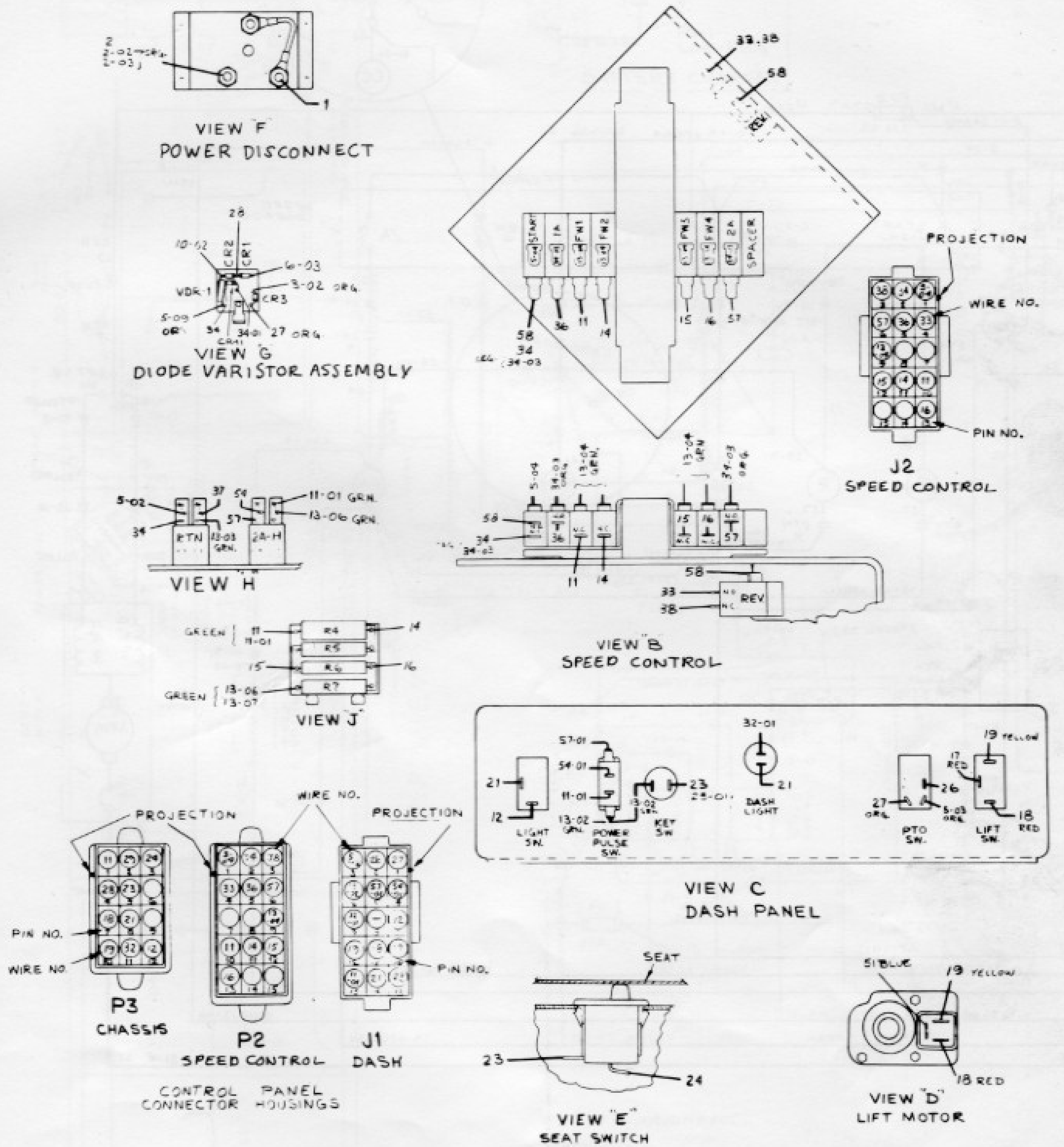
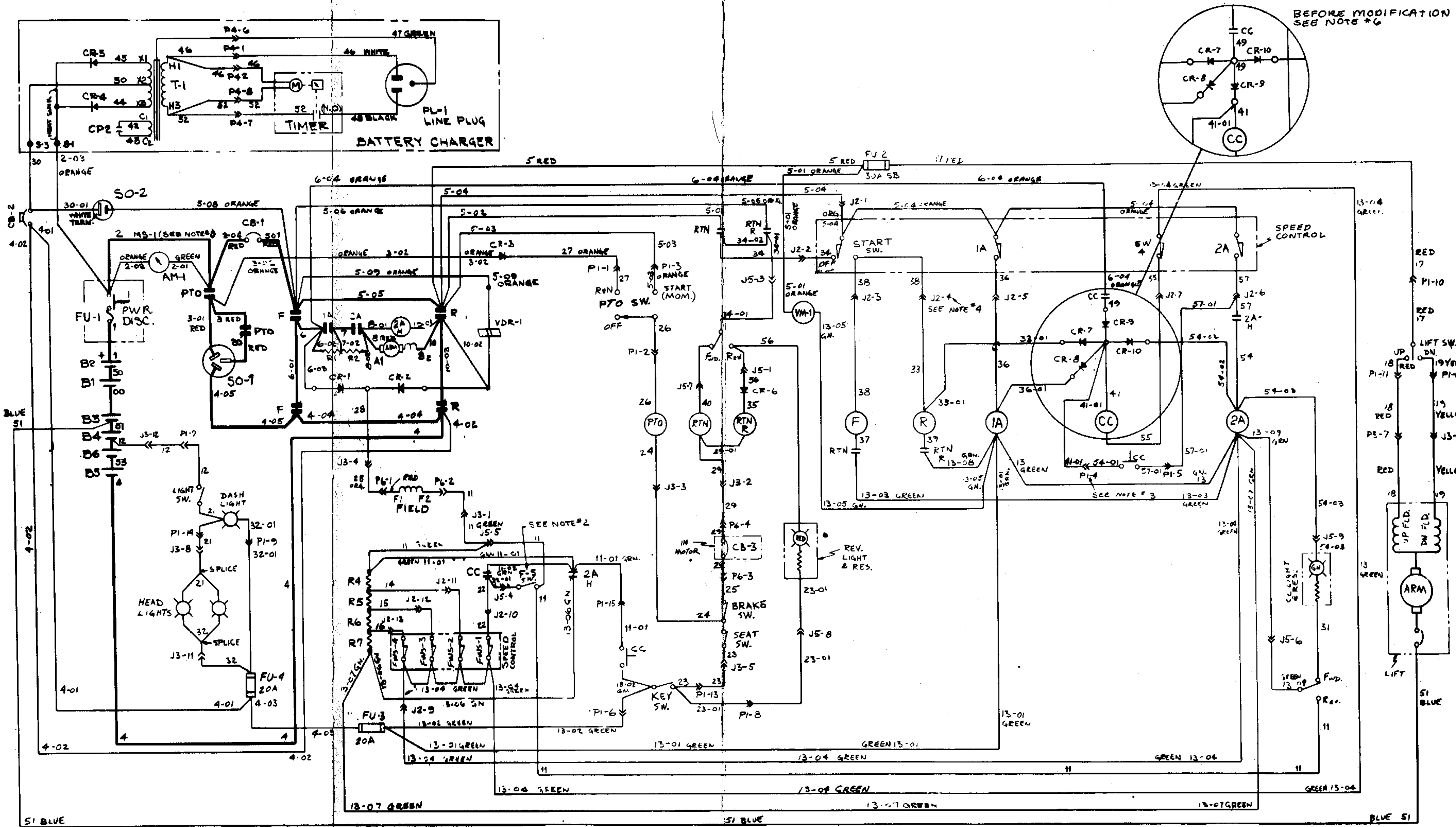


Fig. 2-6 Detailed Wiring Views
Models 26AE15HA and Later



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. 2-7 Schematic and Connection Diagram
Models 26AE20EA and Later

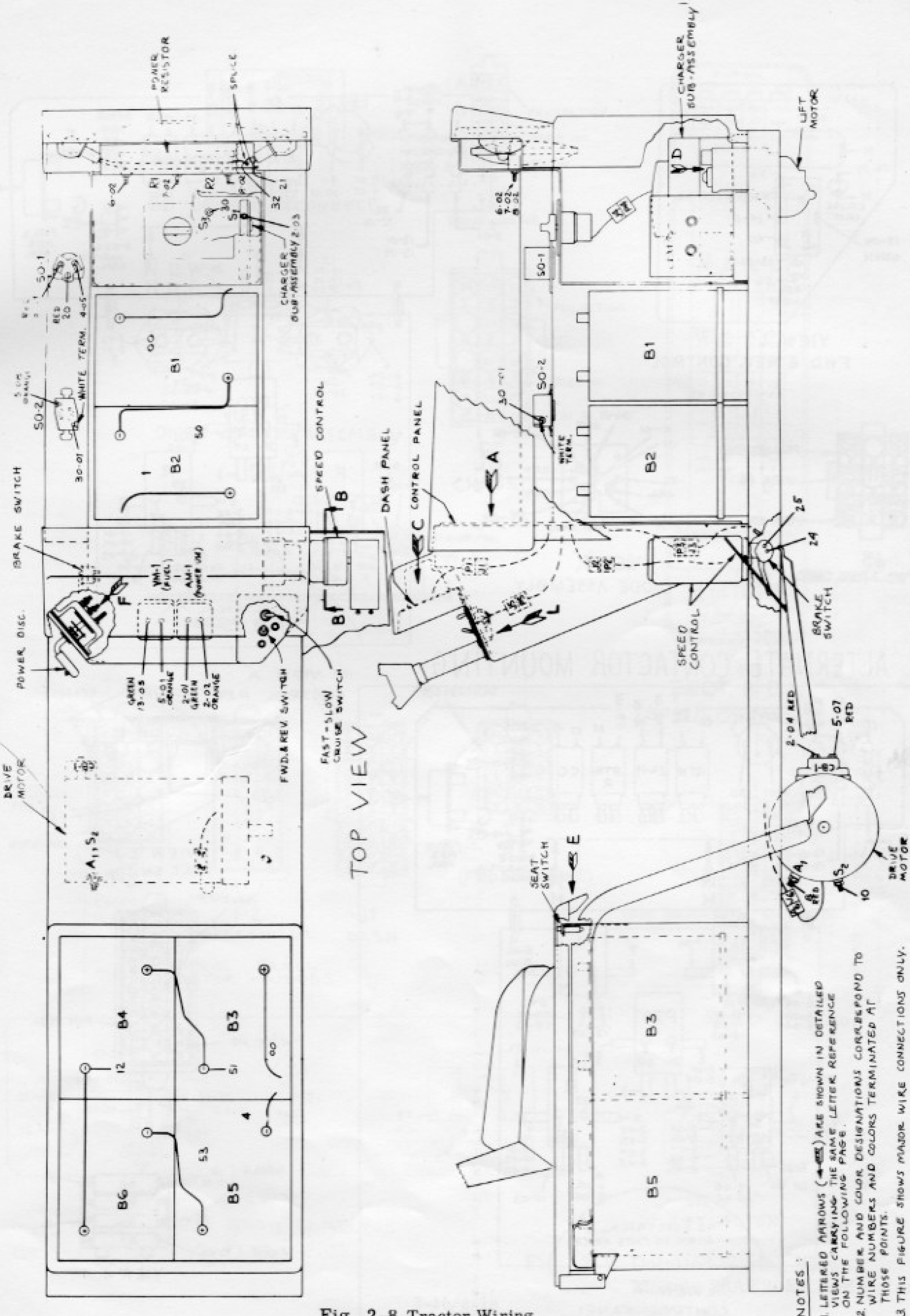
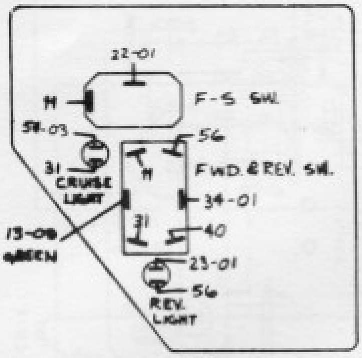
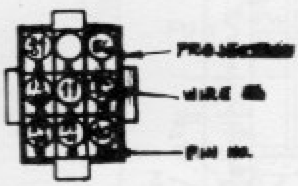


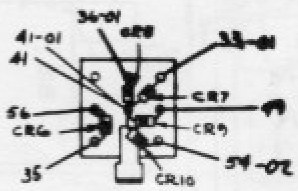
Fig. 2-8 Tractor Wiring
Models 26AE20EA and Later



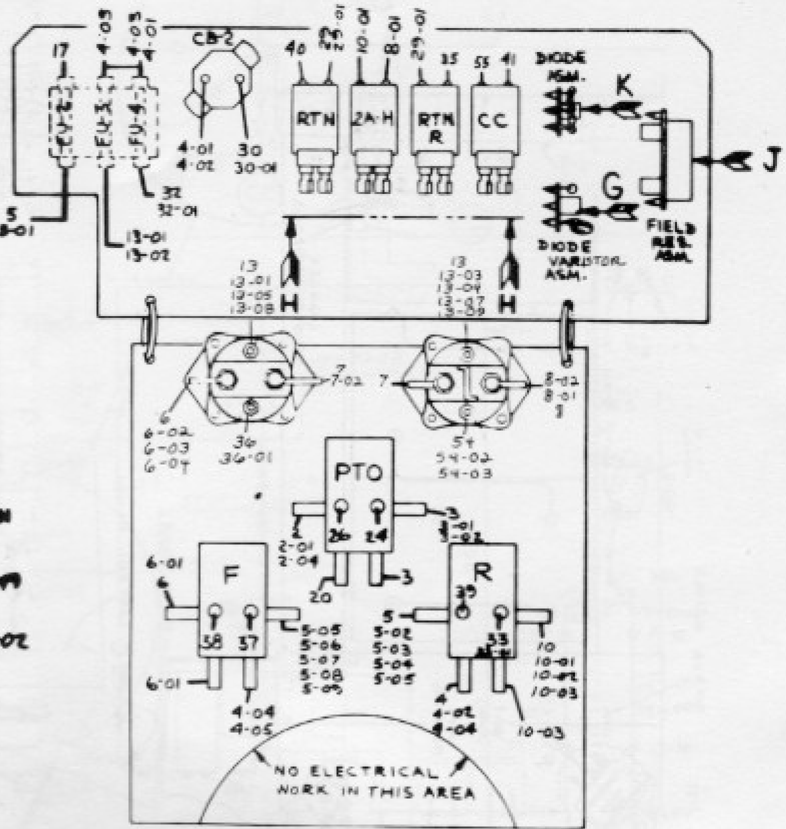
VIEW "L"
FWD. & REV. CONTROL



J5
FWD. & REV. CONT.

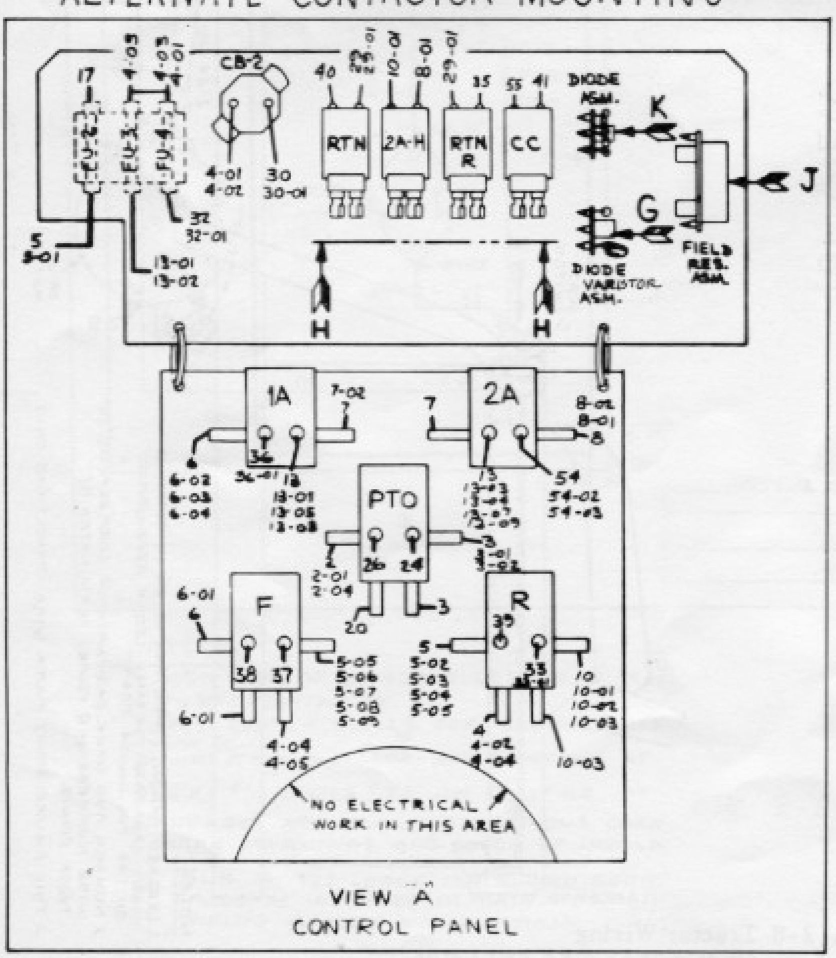


VIEW "K"
DIODE ASSEMBLY

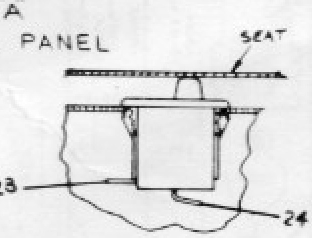


VIEW "A"
CONTROL PANEL

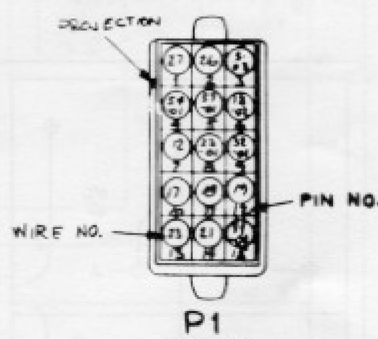
ALTERNATE CONTACTOR MOUNTING



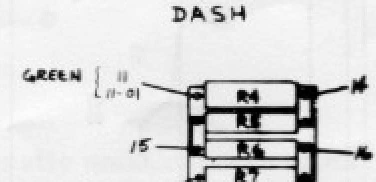
VIEW "A"
CONTROL PANEL



VIEW "E"
SEAT SWITCH



P1
DASH



VIEW "J"

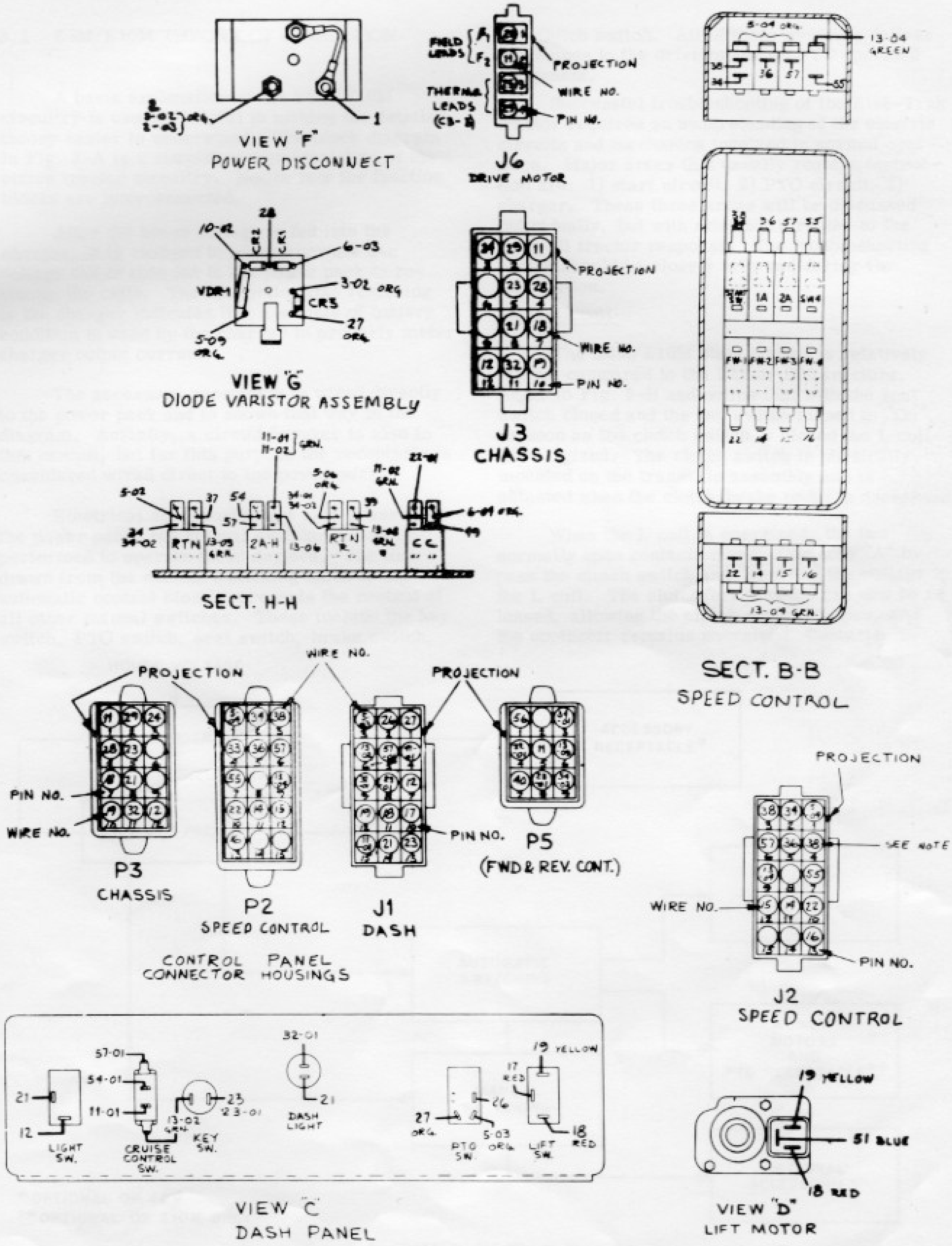


Fig. 2-9 Detailed Wiring Views
Models 26AE20EA and Later

3.1 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. 3-A 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 d-c voltage and is then fed to the power pack to recharge the cells. The connecting line returning to the charger indicates that a sample of battery condition is used by the charger to properly meter charger output current.

The accessory receptacle is wired directly to the power pack and is shown that way in the diagram. Actually, a circuit breaker is also in this circuit, but for this purpose 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.

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 over-all 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. 3-B and notice that with the seat switch closed and the key switch turned to "On", as soon as the 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"

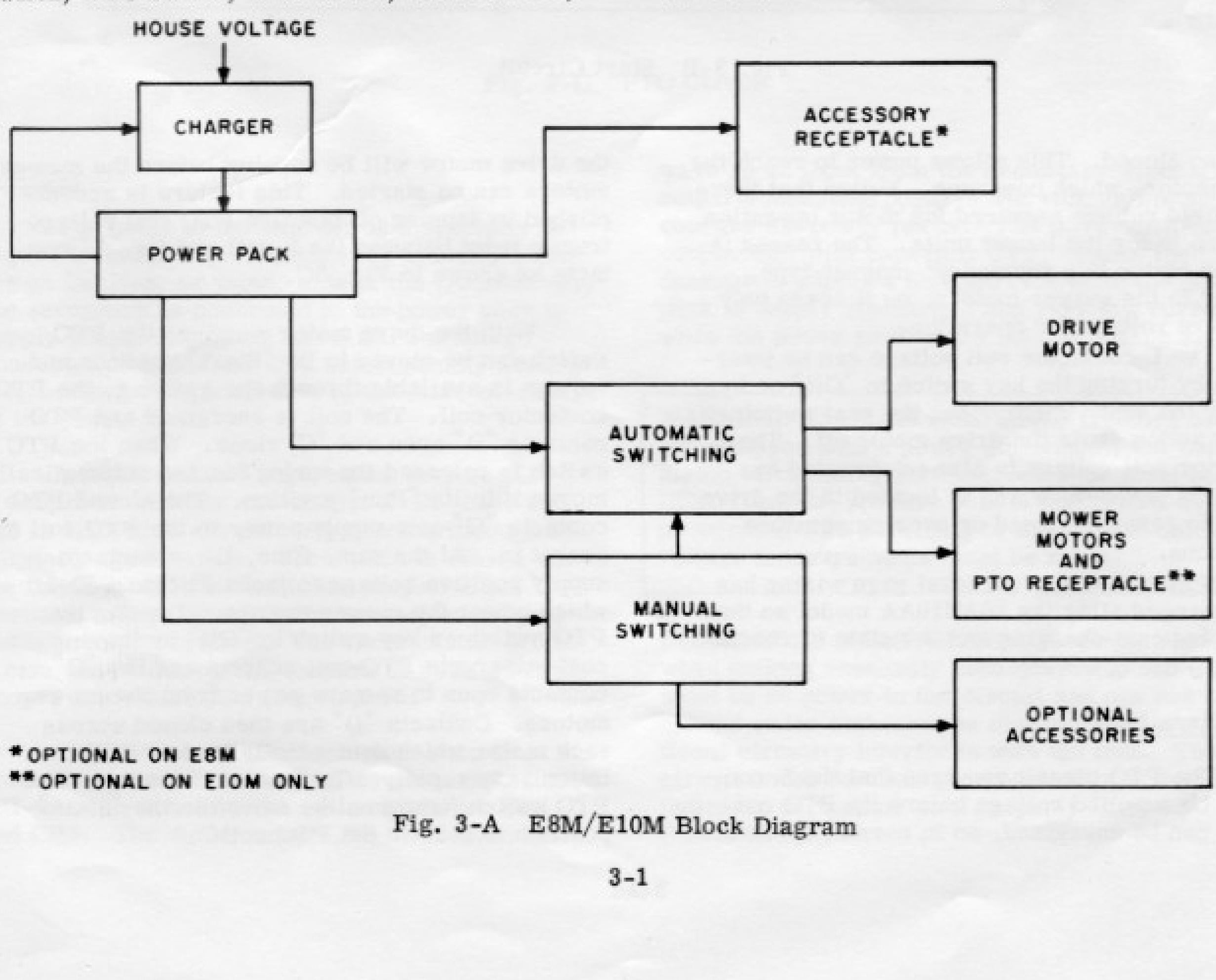


Fig. 3-A E8M/E10M Block Diagram

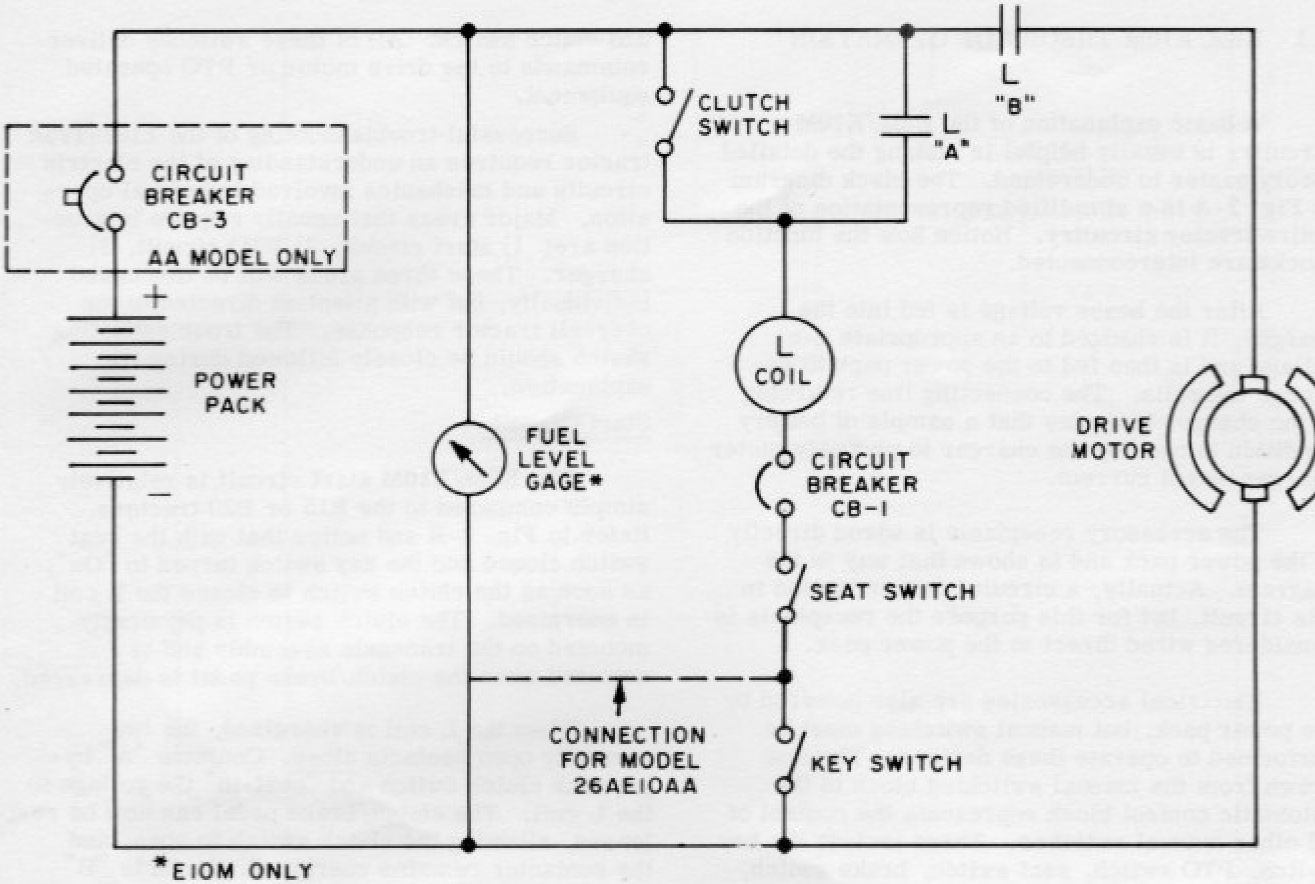


Fig. 3-B Start Circuit

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.

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. 3C.

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.

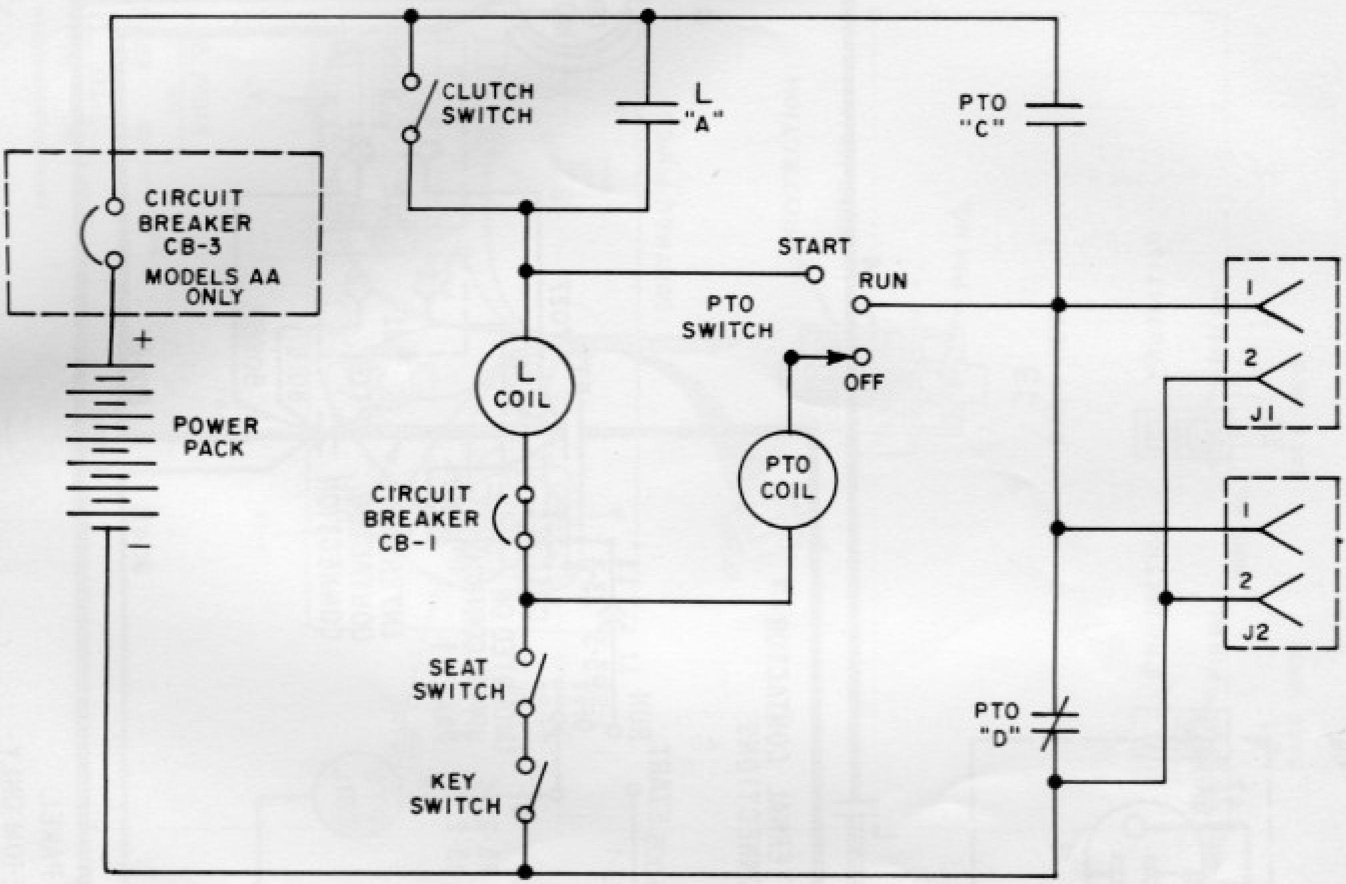


Fig. 3-C PTO Circuit

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. 3-D. 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 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 d-c voltage which charges the power packs. The third winding, in conjunction with capacitor CP2, causes the charger to supply a high current when the power pack is deeply discharged and very low current when the power pack nears its full charge state.

WARNING: Since the E8M/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!

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.

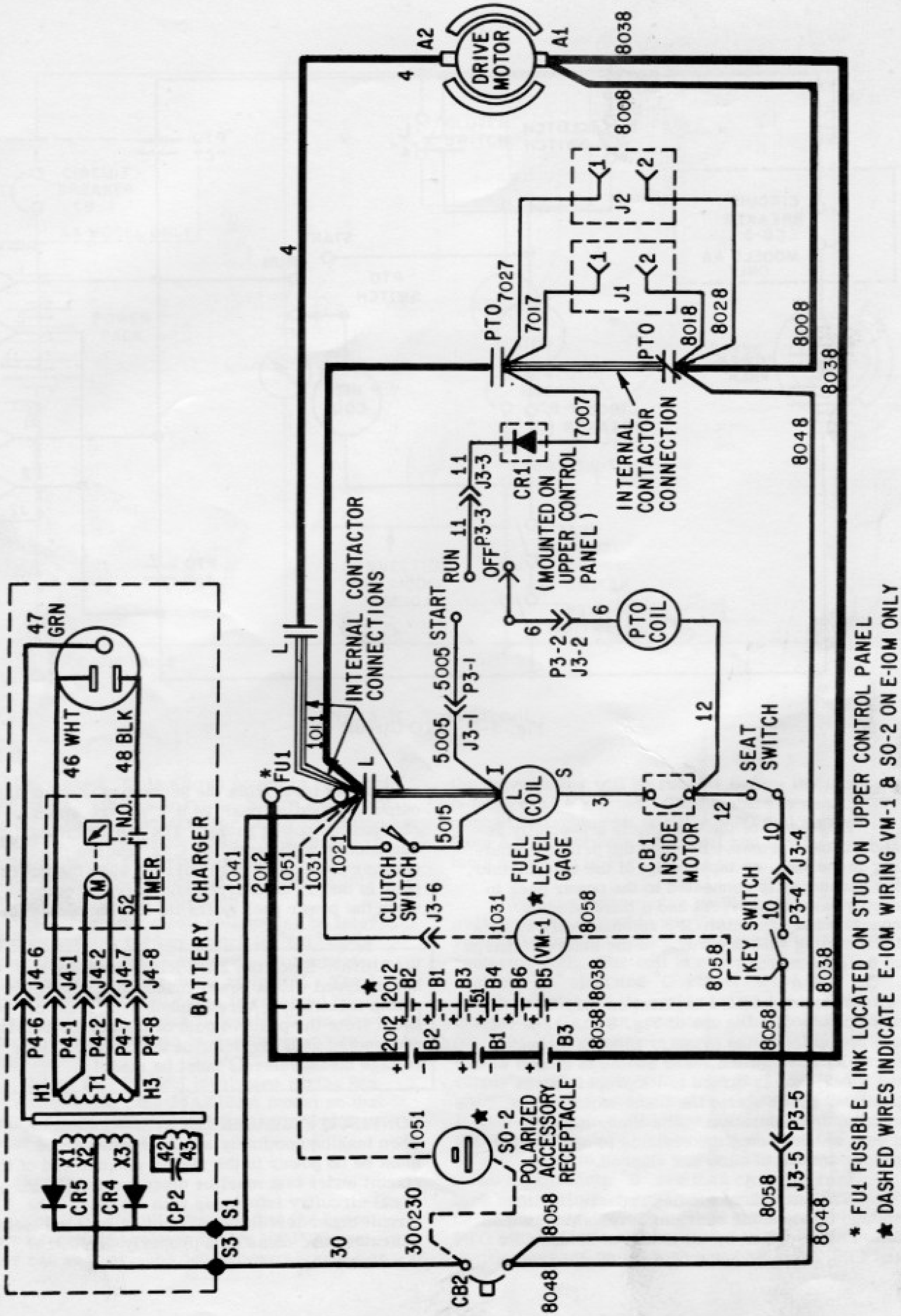


Fig. 3-1 E8M/E10M Troubleshooting Sketch (BA Models)

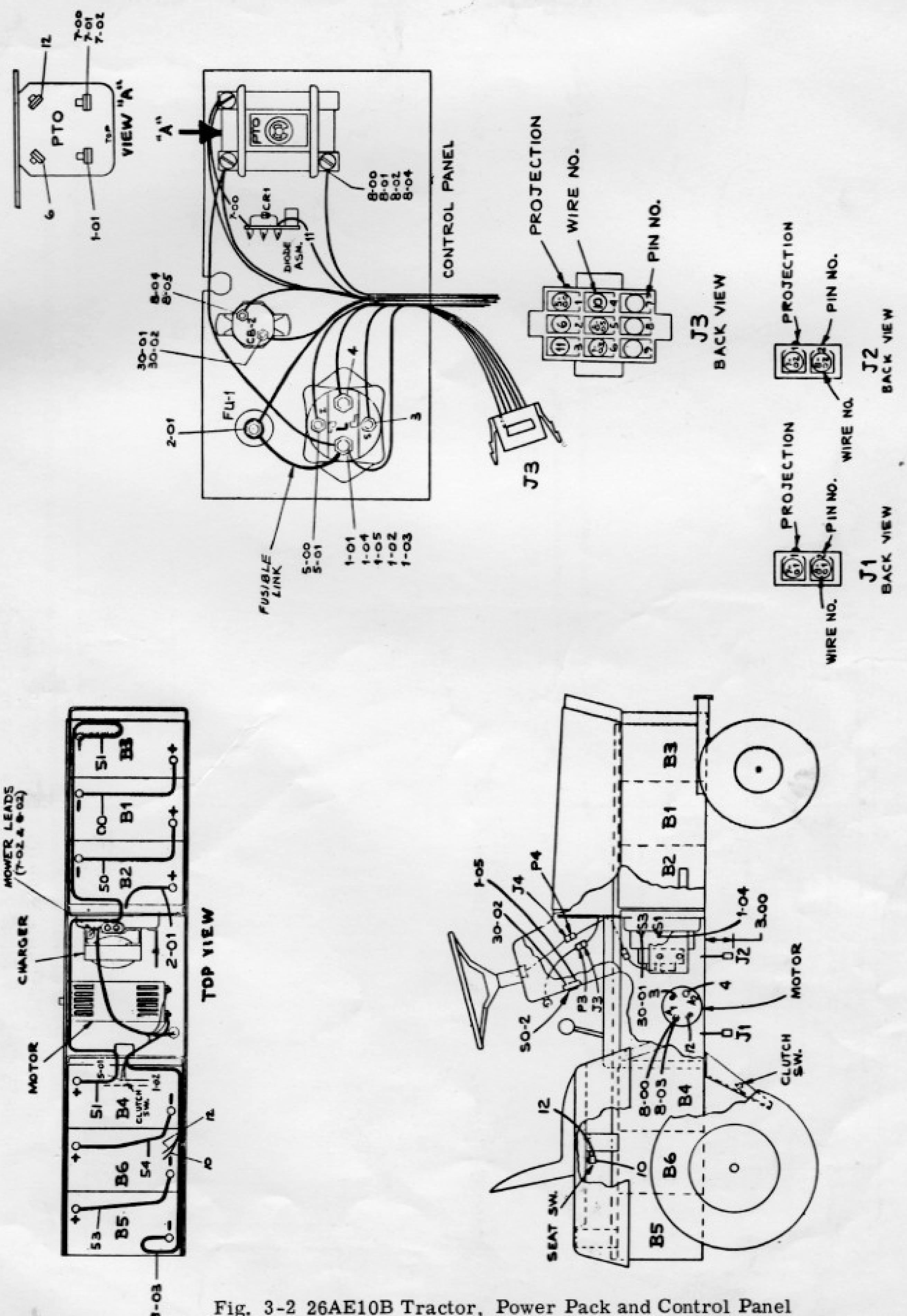


Fig. 3-2 26AE10B Tractor, Power Pack and Control Panel Wiring and Layout

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GENERAL ELECTRIC

1–74 (1M)