SUBJECT: SERVICE TRAINING MANUAL - E12s & E15

ELEC-TRAK Dealers

The enclosed E12s and E15 Service Training Manual will assist your service personnel in becoming familiar with the electric tractor and in trouble shooting. The service manual points out all of the important items on the ELEC-TRAK tractor and gives details of its operation. It is very important that your service personnel understand how the ELEC-TRAK tractor operates. Knowing this makes trouble shooting very easy. Be sure your service personnel review this manual.

This Service Training Manual is sent to you at no charge. Additional copies of this manual are available at $2.95 each, less 25%. To order additional copies for your shop personnel or customers, address correspondence to Advertising and Sales Promotion.

In the near future a similar section on the E20 will be added and you will receive this as soon as it is available.

Very truly yours,

J. L. Armstrong
Manager - Dealer Training

JLA:bk
Enc.

cc: E. L. Re
Home Office Marketing
GENERAL ELECTRIC

E-12S AND E-15

ELEC-TRAK TRACTOR

SERVICE

TRAINING MANUAL

OUTDOOR POWER EQUIPMENT OPERATION

Schenectady, New York 12305
THIS ELEC-TRAK TRAINING MANUAL WILL HELP FAMILIARIZE NEW ELEC-TRAK DEALERS WITH THE ELEC-TRAK TRACTOR COMPONENTS AND OPERATION.

FOR DETAILS ON SERVICING, TROUBLESHOOTING AND PARTS INFORMATION, REFER TO THE ELEC-TRAK PRODUCT SERVICE MANUAL.
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SCHEMATIC DRAWING SYMBOLS

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

Grounded AC line plug.

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

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

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

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

Manual switch or disconnect. (Shown in open position)

Cam-operated switch. (Shown in closed position)

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

Actuating coil of relay or solenoid.

Thermal overload protector (circuit breaker) - Automatic reset protective device, senses current and/or temperature combinations. Provides a closed circuit until overloaded.

Thermal overload protector - manual reset.

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

Plug-in Disconnect- Eases removal of electrical assemblies.

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

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

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

NOTE: Schematic symbols have not been completely standardized.
MECHANICAL SECTION
MAJOR COMPONENTS

- Power Pack - Six 6-Volt Batteries
- Battery Charger - 120 Volts A.C. to 40 Volts D.C.
- Electric Lift - 18 Volts D.C.
- Drive Motor - 36 Volts D.C.
- Control Panels - 36 Volts D.C.
- Speed Control - 36 Volts D.C.
LOCATION OF MAJOR ELECTRICAL COMPONENTS
DRIVE MOTOR
(Underside of Tractor)

CIRCUIT BREAKER CB-1
(Thermal breaker - opens and shuts motor off when temperature or current gets too high, resets automatically when it cools off)

TRACTOR DRIVE MOTOR
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.
CONTROL SECTION COMPONENTS

<table>
<thead>
<tr>
<th>Speeds Forward</th>
<th>Speeds Reverse</th>
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<tbody>
<tr>
<td>E-12</td>
<td>3</td>
</tr>
<tr>
<td>E-15</td>
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</table>

- Speed Control
- 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

<table>
<thead>
<tr>
<th>Forward</th>
<th>Contactor/Switch</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Start &quot;L&quot;</td>
<td>Power to drive motor, $R_1$ &amp; $R_2$ in circuit</td>
</tr>
<tr>
<td>2</td>
<td>1A</td>
<td>Bypass $R_1$ current limiter, $R_2$ in circuit</td>
</tr>
<tr>
<td>3 (maximum field - max. torque)</td>
<td>2A</td>
<td>Bypass $R_2$ current limiter, FW* relay picks up, (FW contacts open)</td>
</tr>
<tr>
<td>4*</td>
<td>FW1</td>
<td>Field Limiter 4 in field</td>
</tr>
<tr>
<td>5*</td>
<td>FW2</td>
<td>Field Limiter 5 in field</td>
</tr>
<tr>
<td>6*</td>
<td>FW3</td>
<td>Field Limiter 6 in field</td>
</tr>
<tr>
<td>7*</td>
<td>FW4</td>
<td>Field Limiter 7 in field</td>
</tr>
</tbody>
</table>

#### Reverse

<table>
<thead>
<tr>
<th>Left-hand Neutral</th>
<th>Reverse Switch, reverses motor field polarity</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Start &quot;L&quot;</td>
<td>Power to drive motor, $R_1$ &amp; $R_2$ in circuit</td>
</tr>
<tr>
<td>2</td>
<td>1A</td>
<td>Bypass $R_1$ current limiter, $R_2$ in circuit</td>
</tr>
<tr>
<td>3 (max. field - max. torque)</td>
<td>2A</td>
<td>Bypass $R_2$ current limiter (FW* will pick up)</td>
</tr>
</tbody>
</table>

*Does not apply to E-12S
No Voltage Applied

PLUNGER IS RAISED
NO ELECTRICAL CONNECTION
ACROSS LARGE STUDS

Voltage Applied

COPPER WASHER MAKES
CONTACT ACROSS LARGE
STUDS

PLUNGER IS PULLED DOWN
BY MAGNETIC COIL

LARGE STUDS
POWER TO MOTOR

36 VOLTS DC APPLIED
ENERGIZING COIL

NO VOLTAGE APPLIED

CONTACCTOR

(L, 1A & 2A)
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)
- 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, \( R_1 \) and \( R_2 \) in motor circuit.
- Second speed control position, 1A switch on the speed control closes, supplying power to the 1A contactor coil and the 1A contacts close - \( R_1 \) 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 - \( R_2 \) 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.
- 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. Tractor motor now rotates in reverse, allowing 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
- 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 on card #3 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 (R₄, R₅, R₆, and R₇), the field weakening relay (FW) and FW switches on speed control, directly control the 4th, 5th, 6th and 7th speeds on the E-15.
- 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.
CARD NO. 1

- 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.
- 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.
- 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.
BATTERY CHARGER, FRONT LIFT, LIGHTS, AND P.T.O.
- CR₄ and CR₅ are diodes
- CP₂ is the capacitor
- Wires #30 to 44 or 30 to 45 will measure about 40 volts AC when charger is on
- Wires #44 to 45 will measure about 80 volts AC when charger is on
- Wires #2 to 30 will measure about 40 volts DC when charger is on
Charger Description

- 120 Volt, 15 Amp AC input for Charger
- Transformer reduces 120 volts AC to 80/40 volts AC
- Diodes convert 40 volts AC to 40 volts DC
- 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
ELECTRIC LIFT, LIGHTS & PTO CIRCUITS

- Electric lift circuit is 18 volts.

- Lights are a 12-volt system - does not connect to disconnect.

- PTO contacts are shown in power-off condition. When PTO coil is energized (see page 45), the PTO contact shown open, closes, and PTO contact shown closed, opens. 36 volts are then applied between wires #3 and #24. The dotted connection between plug connections 3 and 20 is in the mower housing (when mower is plugged in) and when PTO shuts off, the mower motor acts as a generator via closed connection between wires 24 and 20, and stops the motor in less than 3 seconds.
FRONT LIFT, LIGHTS AND P.T.O.
### Lever Position

<table>
<thead>
<tr>
<th>Forward</th>
<th>Contactor/Switch</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Start &quot;L&quot;</td>
<td>Power to drive motor, R₁ &amp; R₂ in circuit</td>
</tr>
<tr>
<td>2</td>
<td>1A</td>
<td>Bypass R₁ current limiter</td>
</tr>
<tr>
<td>3</td>
<td>2A</td>
<td>Bypass R₂ current limiter, FW* relay opens</td>
</tr>
<tr>
<td>4*</td>
<td>FW₁*</td>
<td>* Limiter 4 in field</td>
</tr>
<tr>
<td>5*</td>
<td>FW₂*</td>
<td>* Limiter 5 in field</td>
</tr>
<tr>
<td>6*</td>
<td>FW₃*</td>
<td>* Limiter 6 in field</td>
</tr>
<tr>
<td>7*</td>
<td>FW₄*</td>
<td>* Limiter 7 in field</td>
</tr>
<tr>
<td>Reverse</td>
<td>Reverse Switch</td>
<td>ON CARD #3</td>
</tr>
<tr>
<td>Left-hand neutral</td>
<td>Start &quot;L&quot;</td>
<td>Reverses motor field polarity</td>
</tr>
<tr>
<td>1</td>
<td>1A</td>
<td>Power to drive motor, R₁ and R₂ in circuit</td>
</tr>
<tr>
<td>2</td>
<td>2A</td>
<td>Bypass R₁ current limiter</td>
</tr>
<tr>
<td>3</td>
<td>2A</td>
<td>Bypass R₂ current limiter</td>
</tr>
</tbody>
</table>

*Does not apply to E-12S
ELEC-TRAK ELECTRICAL
ELEMENTARY

* DOES NOT APPLY TO E-128
REFER TO THE ELEC-TRAK PRODUCT SERVICE MANUAL FOR SERVICE DETAILS AND TROUBLE-SHOOTING ASSISTANCE.