

OPERATION AND MAINTENANCE MANUAL WITH PARTS LIST

MODEL:	P2-49
SERIAL NO:	81946 & up
MANUAL NO:	MP-249-01

****IMPORTANT****

READ AND FOLLOW INSTRUCTIONS GIVEN IN
SAFETY AND OPERATIONS SECTIONS, AND
THOSE SECTIONS RELATED TO YOUR SERVICE
AND REPAIR RESPONSIBILITIES.



TAYLOR-DUNN®
Commercial and Industrial Vehicles Since 1949

2114 W. Ball Rd., Anaheim, CA 92804 (714)956-4040 (FAX) (714)956-0504
Mailing Address: P.O. Box 4240, Anaheim, California 92803

IMPORTANT INFORMATION

This vehicle conforms to applicable portions of ANSI B56.8 (American National Standard Personnel and Burden Carriers). This manual is designed for use by Vehicle Operators and Service Personnel alike. Throughout the manual, there are various WARNINGS, CAUTIONS and NOTICES which must be carefully read to help reduce the possibility of personal injury. Maintenance personnel must understand that if a service procedure or method is used that is not recommended by Taylor-Dunn, it then becomes the personal responsibility of the person performing the work to first satisfy himself that neither his safety, the safety of others, or the safety of the vehicle will be endangered.

Definitions of the three terms are as follows.

WARNING - There is a potential for injury to yourself or others.

CAUTION - There is a potential for damage to the vehicle.

NOTE - Specific information clarifying or giving the reason for a particular maintenance or service procedure.

Before operating your Taylor-Dunn vehicle, it is your responsibility to read, understand and follow the safety and operating instructions contained in this manual to help ensure your safety and comfort. If this car is to be used for rental purposes, it is your responsibility to explain to the operator about the various controls and vehicle operating characteristics. Equally important is the operators need to know the basic rules required for safe operation of the vehicle in day to day usage. Operations For Tractors have been inserted in Section 3, of this manual for your specific operating guidelines.

1. Vehicle is to be operated only by qualified persons and only in designated areas.
2. Vehicle must not be started until all occupants are seated.
3. Occupants must remain seated while vehicle is in motion.
4. Arms, legs and feet must be kept inside while vehicle is in motion.
5. Slow down when making a turn.
6. Drive slowly straight up and down inclines.
7. Set parking brake before leaving vehicle.
8. Forward/Reverse lever must be in the correct position for direction of travel desired.

WARNING: Failure to comply with above instructions could result in injury to the vehicle occupants, bystanders and to property.

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Model P 2-49 and Model P 2-50

MANUAL NUMBER MP-249-01

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INSPECTION AND INTRODUCTION

ARRIVAL INSPECTION CHECKLIST

Visual inspection should be made to determine that the truck has remained in good condition during transit. If any damage is found, the details should be noted on the delivery receipt immediately. After delivery the truck should be most carefully checked for HIDDEN DAMAGE. Any concealed damage not noted on the delivery receipt should be reported, in writing, to the delivering carrier within 48 hours.

The following check list has been prepared to aid you during arrival and inspection of your vehicle.

- a. Open all packages and examine any accessories which may be shipped detached from vehicle.
- b. Examine wiring for visible evidence of damage. Check all connections to ensure that none have loosened during transit.
- c. Check all battery connections and electrolyte level in each cell.
- d. Inspect battery charger in accordance with manufacturers installation instructions.
- e. Check tires for damage and proper inflation. Check wheel lugs to ensure tightness.
- f. If vehicle is equipped with hydraulic brakes, check hydraulic lines for evidence of damage.
- g. Check brake fluid level in master cylinder.
- h. Examine entire vehicle for damage such as dents or cracks.
- i. Check operation of controls to see that they are working freely.

Upon completion of the Visual inspection, an operational test should be made. Refer to Operating Instructions.

INSPECTION AND INTRODUCTION

INTRODUCTION

This unit is designed as an in plant tractor, to tow trailers. This tractor is designed to tow trailers in and around buildings and yards on smooth concrete or paved surfaces. It is designed to be powered by an electric motor that uses storage batteries as a power source. The operator rides on the vehicle in a sitting position. This vehicle is not designed to be driven on the public highways. It is not designed to be driven downhill or towed in excess of 10 miles per hour.

MODEL NUMBER:

The following model numbers are covered by this manual P 2-49 and P 2-50.

SERIAL NO. BEGINNING WITH 80066

THE SERIAL NUMBER

The serial number of your unit is stamped into the top edge of the frame member, to the left of the seat. The model number and serial number are on a nameplate riveted to the dash panel steering support shelf forward of the steering column. In ordering parts or referring to your unit, please use these numbers. Replacement parts can be purchased directly from your local authorized dealer or direct from the factory in Anaheim, California.

TAYLOR-DUNN LIMITED 90 DAY WARRANTY

TAYLOR-DUNN MANUFACTURING COMPANY (TDMC), warrants each new Taylor-Dunn vehicle for ninety (90) days according to the following terms:

This warranty provides coverage for the original retail purchaser only and becomes effective on the date of the original retail purchase.

Any part of the Taylor-Dunn vehicle manufactured or supplied by TDMC and found in the reasonable judgment of TDMC to be defective in material or workmanship will be repaired and/or replaced at the business location of an authorized Taylor-Dunn distributor only without charge for parts and labor. The Taylor-Dunn vehicle (including any defective part) must be delivered to an authorized Taylor-Dunn distributor within the warranty period.

All costs of a service call regarding warranty-related repairs and/or replacements on the Taylor-Dunn vehicle at the owner's location, the labor performed by the distributor at the owner's location, all costs of delivering the Taylor-Dunn vehicle to the distributor for warranty work and the costs of returning the Taylor-Dunn vehicle back to the owner after repair or replacement will be paid for by the owner. Proof of purchase will be required by the authorized Taylor-Dunn distributor to substantiate any warranty claim. All warranty work must be performed by an authorized Taylor-Dunn distributor.

TDMC does not provide a warranty related to SCR's, tires, batteries, chargers, or other parts not of their manufacture as such parts are usually warranted separately by their respective manufacturers.

This warranty does not include service items subject to normal wear such as brake linings, seals, belts, light bulbs and fuses.

This warranty does not provide coverage for any Taylor-Dunn vehicle that has been subject to misuse, neglect, negligence, accident, or operated in any way contrary to the operating or maintenance instructions as specified in the TDMC operator's manual. The warranty does not apply to any Taylor-Dunn vehicle that has been altered or modified so as to adversely affect the vehicle's operation, performance or durability or that has been altered or modified so as to change its intended use. In addition, the warranty does not extend to repairs made necessary by normal wear, or by the use of parts or accessories which in the reasonable judgment of TDMC are either incompatible with the Taylor-Dunn vehicle or adversely affect its operation, performance or durability.

Repairs or replacements qualifying under this warranty will be performed by an authorized Taylor-Dunn distributor following delivery of the vehicle to the distributor's place of business. TDMC's responsibility in respect to claims is limited to making the required repairs or replacements. No claim of breach of warranty shall be cause for cancellation of the contract of sale of any Taylor-Dunn vehicle.

TDMC assumes no liability or responsibility for loss of use of the Taylor-Dunn vehicle, loss of time, inconvenience, or other damage, consequential or otherwise, including, but not limited to, all costs for delivering the Taylor-Dunn vehicle to the distributor and all costs of returning the vehicle back to the owner, mechanic's travel time, telephone or telegram charges, trailering or towing charges, rental of a like vehicle during the time warranty repairs are being performed, travel, lodging, loss or damage to personal property, or loss of revenue.

TDMC reserves the right to change or improve the design of any vehicle without assuming any obligation to modify any TDMC vehicle previously manufactured.

All implied warranties are limited in duration to the ninety (90) day warranty period. Accordingly, any such implied warranties

including merchantability, fitness for a particular purpose, or otherwise, are disclaimed in their entirety after the expiration of the ninety (90) day warranty period. TDMC's obligation under this warranty is absolutely and exclusively limited to the repair or replacement of defective parts, and TDMC does not assume, or does not authorize anyone to assume for them, any other obligation.

This warranty applies to all TDMC vehicles sold in the United States.

WARRANTY SERVICE

To make a claim under warranty, contact an authorized Taylor-Dunn distributor immediately upon realizing a problem exists. We recommend having the warranty work performed by the distributor who originally sold you the vehicle; however, warranty work can be obtained from any authorized Taylor-Dunn distributor. Remember, your Taylor-Dunn vehicle must be delivered to an authorized distributor within the warranty period, and all warranty work must be performed only by an authorized Taylor-Dunn distributor. Your proof of purchase will be required by the dealer to verify any warranty claim.

Examples of Items Not Covered by Warranty

Provisions of the warranty will not apply to:

Normal service requirements occurring during the warranty period, such as adjustment and cleaning or wear of a drive belt, drive chain, brake or rheostat.

Normal service work over and above the repair and replacement of defective parts. Vehicles subject to misuse, neglect, negligence, or accident.

Vehicles that have been altered or modified so as to adversely affect their operation, performance or durability or to change their intended use.

Repairs made necessary by the use of parts or accessories which are either incompatible with the vehicle or adversely affect its operation, performance or durability.

Vehicles not operated or maintained in accordance with the instructions in the Taylor-Dunn Operator's Manual.

Periodic checking, lubricating the vehicle or service check-up.

All costs of delivering the vehicle to the distributor and all costs of returning the vehicle back to the owner, mechanic's travel time, trailering or towing charges, or rental of a like vehicle during the time warranty repairs are being performed.

This warranty applies only to the original retail purchaser. Second-owner or subsequently owned vehicles are not covered under the warranty.

Owner's Obligation and Responsibility

Normal maintenance service and replacement of service items are the responsibility of the owner and as such are not considered defects in material or workmanship with the terms of this warranty. Individual operating habits and usage may contribute extensively to the need for maintenance service.

Consult with your authorized Taylor-Dunn distributor for advice on proper maintenance and care of your vehicle. Proper maintenance and care will be very helpful in keeping your overall operating costs at a minimum.

To assure warranty coverage, it is the owner's responsibility to maintain all components in proper adjustment and to service the vehicle as specified in the Taylor-Dunn Vehicle Operator's Manual. It is the owner's responsibility to provide proper lubrication for all components and provide correct recommended battery maintenance, to maintain the battery liquid level and charge as specified, as well as maintain the correct pressure in the tires of the vehicle.

OPERATING INSTRUCTIONS

The controls on your Taylor-Dunn vehicle have been designed and located for convenience of operation and efficient performance. Before driving your vehicle for the first time, familiarize yourself with each of the controls. Read the following instructions and with power OFF, operate each control. By following this suggestion you will attain a "feel" for their operation prior to traveling under power for the first time.

STEERING

The steering wheel and steering system is similar to automotive types. Turn the steering wheel to the right (or clockwise) for a right turn and left (or counterclockwise) for a left turn.

KEY LOCK

Your vehicle is equipped with a keyed lock located in the dash panel. It is designed to lock the switch in neutral position only. The key will remove from the lock in the locked position turning power to control and contactors off.

BRAKE - AUTOMATIC (DEADMAN)

The driver's seat operates the automatic "Deadman" brake. The weight of the person moves the seat down and operates the brake release linkage. The brake is automatically applied when the seat is vacated. In conjunction the power to the drive motor is disconnected as the brake is applied.

BRAKE - FOOT

The brake pedal is designed and located for right foot operation. It is the pedal located to the left of accelerator pedal. It functions the same as the brake pedal in your automobile. Depressing the pedal applies the braking action. The greater the effort applied to the pedal with your foot, the greater the braking action to your vehicle. Removing your foot from the pedal allows immediate release of the braking action to your vehicle.

FORWARD-REVERSE SWITCH

The forward-reverse is located on the steering column. It is operated by the handle. To place in forward position push the handle forward. To place in reverse position pull the handle backward.

ACCELERATOR PEDAL

The accelerator pedal is located to the right of the brake pedal. It is designed for right foot operation similar to your automobile. Depressing the pedal turns the power on to the motor. It also controls the amount of power delivered to the motor. When driving your vehicle you will be able to feel full power when accelerator is fully depressed and minimum power when only partially depressed. You will have the same control of power in both directions of travel. Your forward-reverse switch determines the direction of travel and your accelerator pedal controls the speed.

HORN BUTTON

The horn button is located at center of steering wheel. Depressing button sounds horn. Releasing button will immediately silence horn.

LIGHT SWITCH

The light switch that controls headlamps and taillamps is located in the dash panel. It is labelled for ON-Off positions.

BATTERY CHARGER

Refer to Section 17 for proper instructions to operate your battery charger.

SPECIAL ACCESSORIES

Refer to the appropriate section of this manual for separate operating instructions pertaining to any special feature or accessory your vehicle may have.

OPERATING RESPONSIBILITIES FOR TRACTORS
OPERATING RULES AND PRACTICES

OPERATOR QUALIFICATIONS

Only trained and authorized operators should be permitted to operate this Tractor. Operators should be qualified as to visual, auditory, physical, and mental ability to safely operate the equipment.

OPERATORS' TRAINING

(a) The tractor owner, lessee, or employee of the tractor operator shall conduct an operators' training program for the carrier operators.

(b) Successful completion of the operators' training program shall be required by the owner, lessee, or employer of the operator before operation of the tractor by any operator.

(c) An effective operator's training program should center around user company's policies, operating conditions, and their Taylor-Dunn tractor by any operator.

(d) Information on operator training is available from several sources.

(e) The tractor owner, lessee, or employer of the tractor operator should include in the operators' training program the following:

(1) Careful selection of the operators, considering physical qualifications, job attitude and aptitude.

(2) Emphasis on safety of stock, equipment operator, and other employees.

(3) General safety rules contained in this standard and the additional specific rules determined by the carrier owner, lessee, or employer of the carrier operator in accordance with this standard, and why they were formulated.

(4) Introduction of equipment, control locations and functions, and explanation of how they work when used properly and when used improperly; and ground and floor conditions, grade, and other conditions of the environment in which the tractor is to be operated.

(5) Operational performance tests and evaluations during, and at completion of the program.

(6) Rules of the employer and any applicable labor contract governing and dealing with discipline of employees for violation of employer's rules, and including safety rules.

OPERATOR RESPONSIBILITY

Operators of Personnel and Burden Carriers shall abide by the following safety rules and practices.

GENERAL

(a) Safeguard the pedestrians at all times. Do not drive carrier in a manner that would endanger anyone.

(b) Riding on the tractor by persons other than the operator is not authorized. Do not put any part of the body outside the outer perimeter of the tractor.

(c) When a tractor is left unattended, stop carrier, place directional controls in neutral, check for brake application, turn off power, turn off the control or ignition circuit, remove the key, and block the wheels if machine is on an incline.

OPERATING RESPONSIBILITIES continued

GENERAL continued

(d) A tractor is considered unattended when the operator is 25 ft. (7.6 m) or more from the carrier which remains in his view, or whenever the operator leaves the carrier and it is not within his view. When the operator of a tractor is dismounted and within 25 ft. (7.6 m) of the tractor still in his view, he still must have controls neutralized, and brakes set to prevent movement.

(e) Maintain a safe distance from the edge of ramps and platforms.

(f) Use only approved tractors in hazardous locations.

(g) Report all accidents involving personnel, building structures, and equipment.

(h) Operators shall not add to, or modify, the tractor.

(i) Fire aisles, access to stairways, and fire equipment shall be kept clear.

(j) Operators and personnel shall be warned of the hazards of long hair and loose clothing.

TRAVELING

(a) Observe all traffic regulations, including authorized plant speed limit. Under normal traffic conditions keep to the right. Maintain a safe distance, based on speed of travel, from the tractor or vehicle ahead; and keep the tractor under control at all times.

(b) Yield the right of way to pedestrians, ambulances, fire trucks, or other carriers or vehicles in emergency situations.

(c) Do not pass another tractor or vehicle traveling in the same direction at intersections, blind spots, or at other dangerous locations.

(d) Keep a clear view of the path of travel, observe other traffic and personnel, and maintain a safe clearance.

(e) Slow down and sound the audible warning device at cross aisles and other locations where visibility is obstructed.

(f) Ascend or descend grades slowly.

(g) Use extra caution when operating on grades. Never turn on any grade, ramp, or incline; always travel straight up and down.

(h) Under all travel conditions the tractor shall be operated at a speed that will permit it to be brought to a stop in a safe manner.

(i) Make starts, stops, turns, or direction reversals in a smooth manner so as not to shift the load, overturn the tractor, or both.

(j) Do not indulge in stunt driving or horseplay.

(k) Slow down when approaching, or on, wet or slippery surfaces.

(l) Do not run tractor onto any elevator unless specifically authorized to do so. Approach elevators slowly, and then enter squarely after the elevator car is properly leveled. Once on the elevator, neutralize the controls, shut off power, and set brakes. It is advisable that all other personnel leave the elevator before a tractor is allowed to enter or leave.

(m) Avoid running over loose objects on the roadway surface.

(n) Prior to negotiating turns, reduce speed to a safe level, turning hand steering wheel or tiller in a smooth, sweeping motion.

LOADING

(a) Handle only stable or safely arranged loads. When handling off-center loads which cannot be centered, operate with extra caution.

(b) Handle only loads within the capacity of the tractor recommended by the manufacturer.

(c) Handle loads exceeding the dimensions used to establish tractor capacity with extra caution. Stability and maneuverability may be adversely affected.

OPERATING RESPONSIBILITIES continued

OPERATOR CARE OF MACHINE

(a) At the beginning of each shift during which the tractor will be used, the operator shall check the carrier condition and inspect the tires, warning devices, lights, battery, controller, brakes, and steering mechanism. If the tractor is found to be in need of repair, or in any way unsafe, or contributes to an unsafe condition, the matter shall be reported immediately to the designated authority, and the tractor shall not be operated until it has been restored to safe operating condition.

(b) If, during operating the tractor becomes unsafe in any way, the matter shall be reported immediately to the designated authority, and tractor shall not be operated until it has been restored to safe operating condition.

(c) Do not make repairs or adjustments unless specifically authorized to do so.

(d) Do not operate a tractor with a leak in the fuel system or battery.

(e) Do not use open flames for checking electrolyte level in storage batteries.

MAINTENANCE PRACTICES

INTRODUCTION

Tractors may become hazardous if maintenance is neglected. Therefore, maintenance facilities, trained personnel, and procedures shall be provided.

MAINTENANCE PROCEDURES

(a) Maintenance and inspection of all tractors shall be performed in conformance with the manufacturer's recommendations and the following practices.

(b) A scheduled preventive maintenance, lubrication, and inspection system shall be followed.

(c) Only qualified and authorized personnel shall be permitted to maintain, repair, adjust, and inspect tractors.

(d) Before leaving the tractor, stop, place directional controls in neutral, apply the parking brake, stop the engine or turn off power, turn off the control or ignition circuit, and block the wheels if tractor is on an incline.

(e) Before undertaking maintenance or repair on tractor, raise drive wheels free of floor or disconnect battery, and use chocks or other positive carrier positioning devices.

(f) Block chassis before working under it.

(g) Operation to check performance of the tractor shall be conducted in an authorized area where safe clearance exists.

(h) Before starting to operate the tractor:

1) Have operator in the operating position.

2) Depress treadle to operate brake.

3) Place directional controls in neutral.

4) Switch ignition key (clockwise) to "on" position.

5) Check functioning of directional speed controls, steering, warning devices, steering, warning devices, and brakes.

(i) Avoid fire hazards and have fire protection equipment present in the work area. Do not use an open flame to check level of electrolyte. Do not use open pans of fuel or flammable cleaning fluids for cleaning parts.

(j) Properly ventilate work area.

(k) Brakes, steering mechanisms, control mechanisms, warning devices, lights, guards, and safety devices shall be inspected regularly and maintained in a safe operating condition.

(l) Special tractors or devices designed and approved for hazardous area operation shall be inspected to ensure that maintenance preserves the original approved safe operating features.

MAINTENANCE PRACTICES continued

(m) The tractor should be checked for leaks and condition of parts. Action shall be taken to prevent the use of the tractor until the leak has been corrected.

(n) The Tractor manufacturer's capacity, operation and maintenance instruction plates, tags, or decals shall be maintained in legible condition.

(o) Batteries, motors, controllers, limit switches, protective devices, electrical conductors, and connections shall be inspected and maintained in conformance with good practice.

(p) Tractors shall be kept in a clean condition to minimize fire hazards and facilitate detection of loose or defective parts.

(q) Modifications and additions which affect capacity and safe machine operation shall not be performed by the customer or user without manufacturer's prior written authorization; where authorized modifications have been made, the user shall ensure that capacity, operation, warning and maintenance instruction plates, tags, or decals are changed accordingly.

(r) Care shall be taken to assure that all replacement parts are interchangeable with the original parts and of a quality at least equal to that provided in the original equipment.

VEHICLE OWNER AND OPERATOR'S GUIDELINES

OPERATING YOUR VEHICLE

To put your vehicle into operation, unlock forward/reverse switch by turning keyed lock counter clockwise. Select direction you wish to travel by moving handle of forward/reverse switch into position. Release parking brake, slowly depress accelerator pedal until vehicle is moving at the desired speed. Steer vehicle as required utilizing the foot brake and accelerator to control your speed as desired.

CAUTION: DO NOT "hold" vehicle at a standstill on a hill or incline using accelerator only. Continued "stalled" condition as described will damage motor and electrical controls. Use either your foot brake or hand brake to hold the vehicle on a hill safely.

CAUTION: When you leave your vehicle, it is best to always place forward/reverse switch in neutral position. Set parking brake to prevent vehicle from rolling free, and lock and remove key.

Drive safely and enjoy your Taylor-Dunn vehicle.

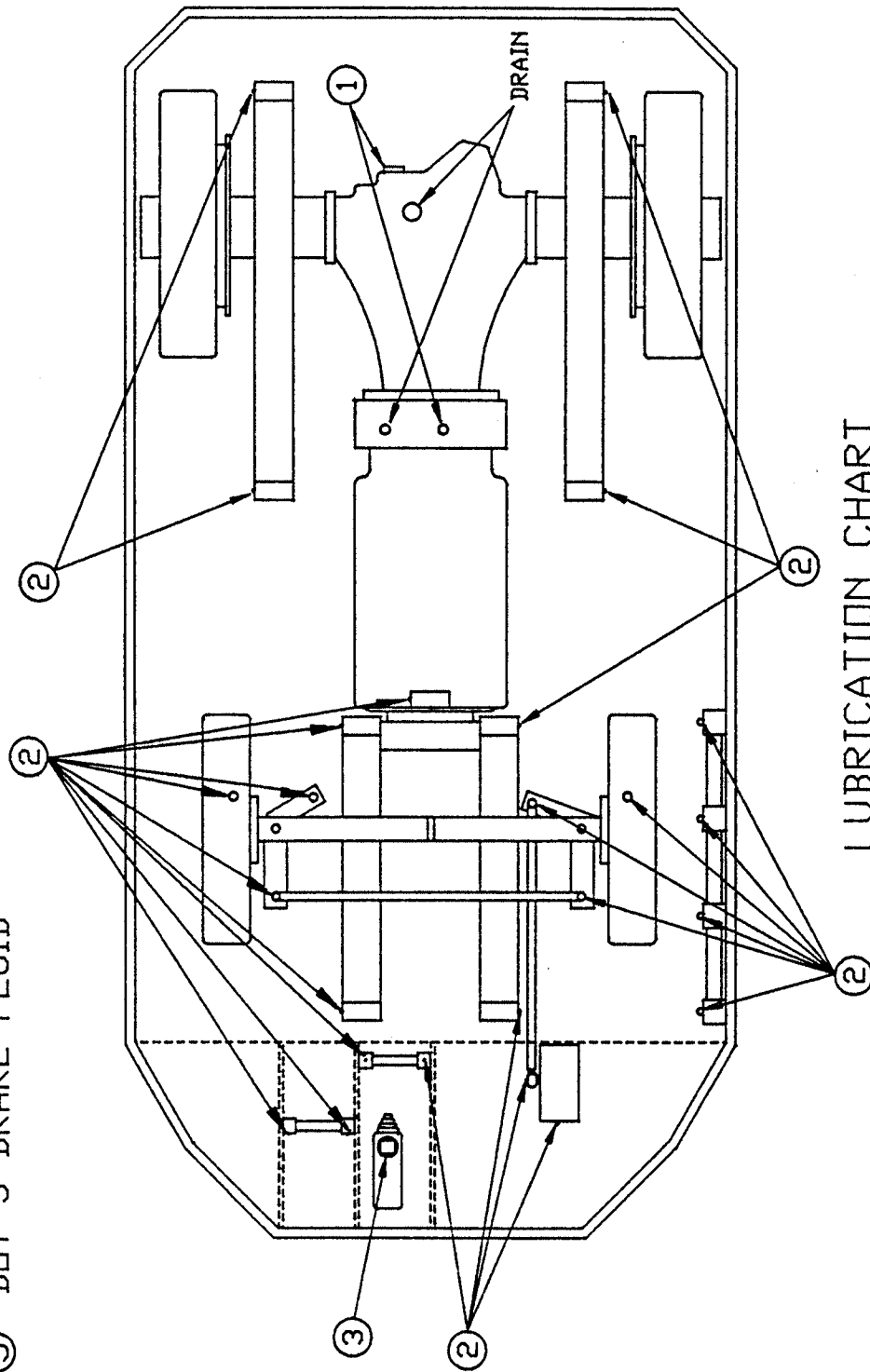
MAINTENANCE GUIDE CHECKLIST

This checklist is provided for your convenience as a guide for servicing your vehicle. If followed you will enjoy a good running and trouble free unit. It has been set up for average normal use. More frequent service is recommended for extreme or heavy usage. If desired your Taylor-Dunn dealer will gladly perform these services for you as he has expert service men in the field for this purpose. Do not hesitate to call your Service Manager if any questions arise.

CAUTION: When performing maintenance on any part of the electrical system, turn key to off position and remove from switch, disconnect main battery leads and place Forward/Reverse switch in neutral.

MAINTENANCE	REFER SECTION	EVERY WEEK	EVERY MONTH	EVERY 3 MONTHS	EVERY YEAR
Check and fill batteries. If necessary fill with distilled water only.	21	X	X	X	X
Check all contact points on EV1-B contactor and replace when necessary.	17		X	X	X
Lubricate all Zerk Fittings.	5		X	X	X
Lubricate all moving parts without Zerk Fittings. Use all purpose engine oil.	5		X	X	X
Wash off batteries with water (Use soda if necessary)	21		X	X	X
Check all wire connections. Be sure they are all clean and tight.	16		X	X	X
Check service and adjust deadman brake.	14		X	X	X
Check hydraulic brake system for leaks, also check brake fluid level in master cylinder.	14		X	X	X
Check rear axle differential oil level (refer to lubrication diagram).	5		X	X	X
Check, clean and adjust forward reverse switch	15		X	X	X
Check motor brushes. Blow out carbon dust. (Replace if necessary)	12			X	X
Check and adjust front wheel bearings and fork spindle bearings	10			X	X
Check brake lining for wear, adjust brake shoes (hydraulic).	11 & 13			X	X
Drain differential and refill with SAE 140 oil (refer to Lubrication diagram)	5 & 11				X
Repack front wheel bearings (use wheel bearing grease).	5 & 10				X

- ① SAE 140 MULTI-SERVICE GEAR LUBE
- ② SUPER LITHIUM GREASE
- ③ DOT 5 BRAKE FLUID



LUBRICATION CHART
FIG. 1

MODEL 'P'

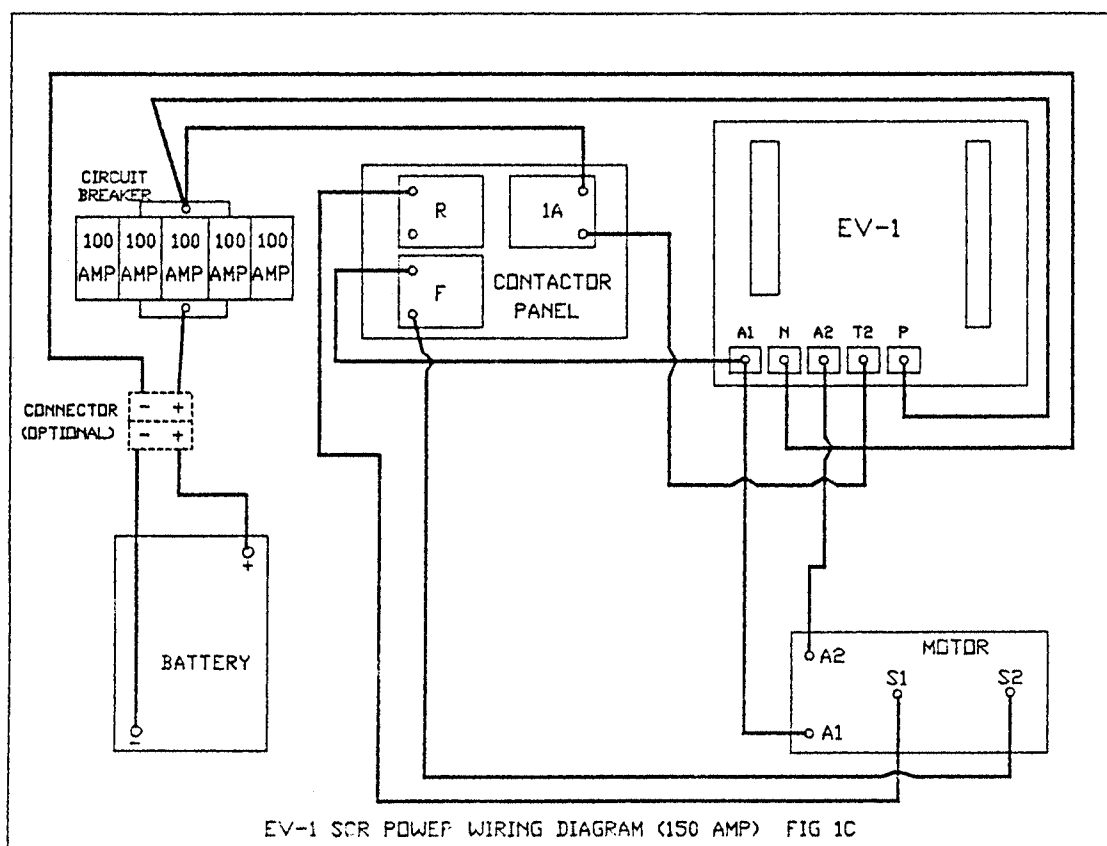
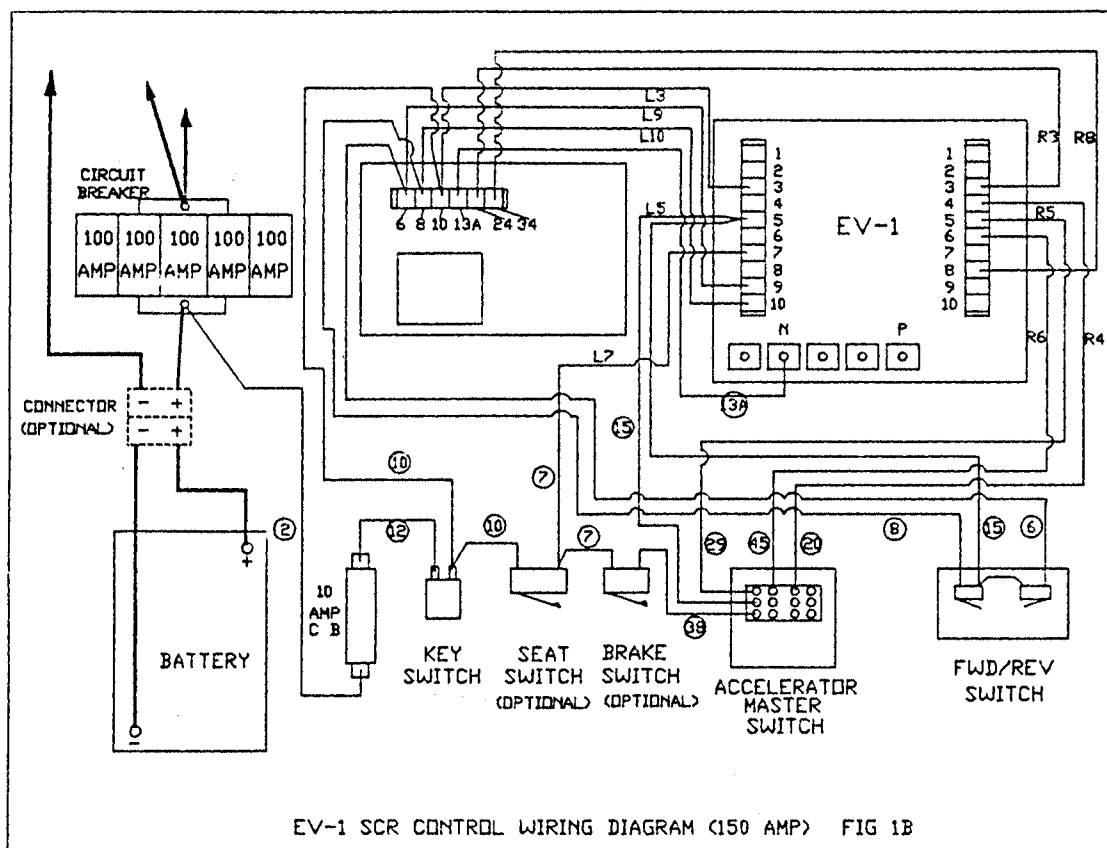
*TROUBLE SHOOTING PROCEDURES

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
1. <u>Steering:</u>		
a) Pull in one direction	1. Check for bent steering linkage	Replace or straighten
b) Hard Steering	1. Bad or frozen bearing in spindle	Replace
c) Sloppy or loose	2. Loose wheel bearing	Adjust
2. <u>Brakes:</u>		
a) Soft brakes	1. Check for worn lining	Adjust or replace when 1/16 or less of lining left
	2. Alignment of brake shoes	Realign
	3. Oil on brake lining	Find oil source and correct, wash brake band
	4. Dirt on brake lining	Clean
	5. Bind in linkage	Loosen or realign
	6. Weak spring	Replace
	7. Air in hydraulic brake	Bleed brakes
	8. Bad seals in brake cyl.	Replace
b) No Brakes	1. Broken shoe	Replace
	2. Broken Connection in linkage	Replace
	3. Brake in hydraulic line	Repair
	4. Seal failure in brake cylinder	Replace
3. <u>Drive axle</u>		
a) No power	1. Disconnect batteries for recharging	Recharge or replace
	2. Check circuit breakers	Reset
	3. Check contactor for contact	Replace contacts
	4. Check motor brushes for contact	Clean or replace
	5. Poor contact on forward-reverse switch	Replace contact
	6. Check for loose wire	Tighten or replace
	7. Check continuity through motor	Repair or replace
b) Erratic operation	1. Contact making poor contact	Replace contacts
	2. Motor brushes	Clean or replace
	3. Check motor commutator for burning or wear	Turn or replace
	4. Check for loose wiring	Tighten

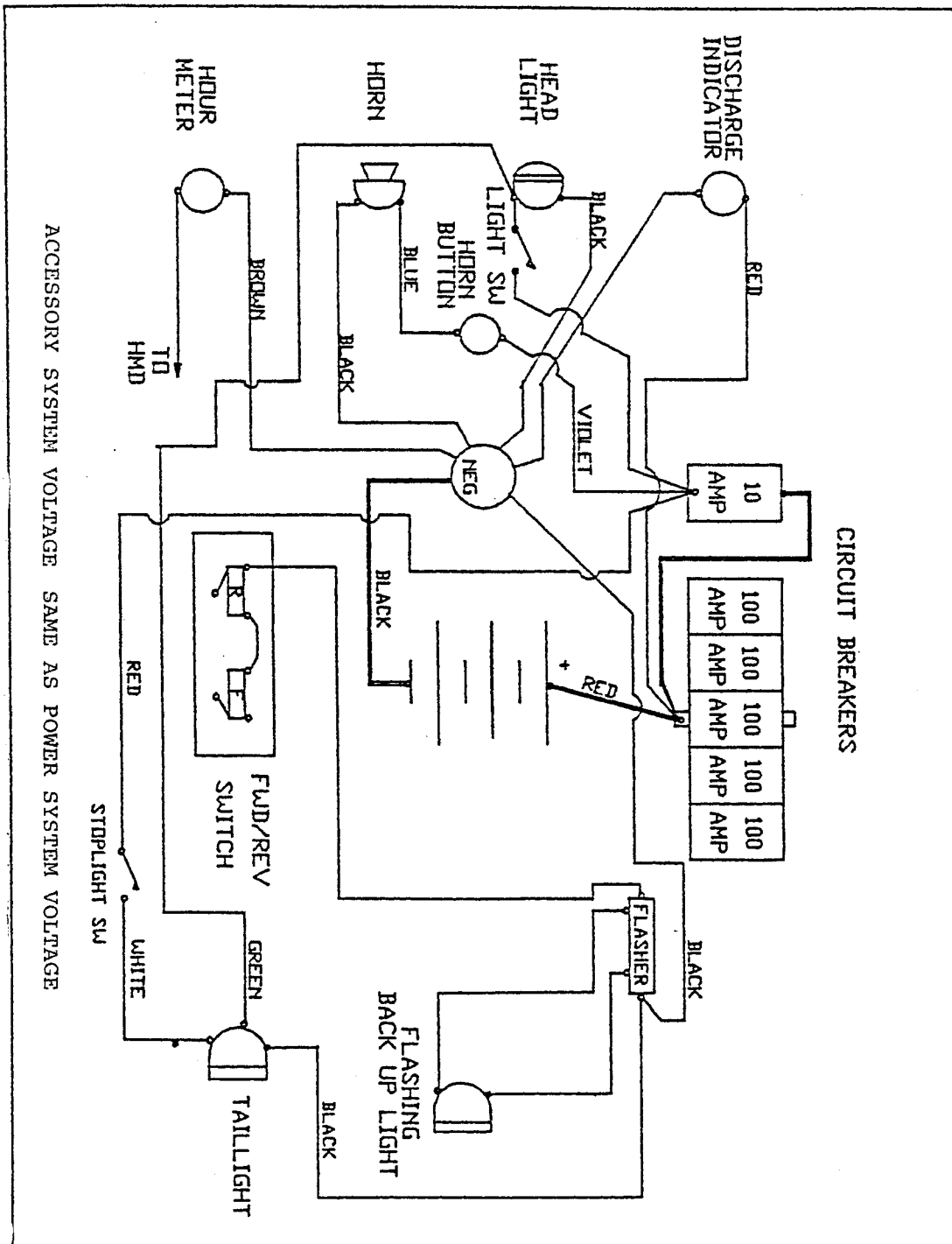
TROUBLE SHOOTING PROCEDURES

SYMPTOM	PROBABLE CAUSE	CORRECTIVE ACTION
c) Jerky Starting	1. Bad contactor 2. Bad SCR adjustment	Replace Adjust
d) Takes off in forward or reverse without accelerator depressed	1. Burned together contacts on contactor 2. Short in wiring circuit 3. Burned forward/reverse switch	Replace Correct Replace
e) Lack of power or slow operation	1. Dragging brake 2. Tight front wheel bearings 3. Contact not making contact on high speed bar 4. Loose connection in wiring 5. Partially burned out or thrown lead. 6. Weak batteries 7. Bind or drag on differential	Re-adjust Re-adjust Re-adjust or replace contacts Tighten Replace or re-solder Replace Repair
f) Thump or grinding noise in drive axle	1. Motor bearing 2. Defective bearing in differential 3. Defective gears in differential	Replace Replace Replace

EV-1 SCR CONTROL AND POWER WIRING DIAGRAMS (150 AMPS)



EV-1 SCR ACCESSORY WIRING DIAGRAMS



PARTS ORDERING PROCEDURE

Parts may be purchased from your local authorized Taylor-Dunn dealer.

When ordering parts, be sure to specify the complete model number and serial number of the unit. Also specify the full Taylor-Dunn part number, description of part, and quantity of parts required. You will find a complete listing of part numbers and descriptions in the following pages of this manual. When ordering parts for the drive motor, also include the specifications found on the motor nameplate. Be sure to give complete shipping and billing address on all orders. Example:

- 1 - Part number 45-010-00 Motor Gasket
 - 1 set of 4 - Part number 70-112-00 Motor brushes for G.E. motor, 10/15 HP
24/36 Volt, Specification No. 5BT1326B96
- Above parts are for Model P 2-49 Tractor, Serial Number 81496 and up

Parts ordered under warranty must be placed with your authorized Taylor-Dunn dealer. Be sure to include original invoice number, date of shipment of vehicle, and vehicle serial number.

NOTE: On contracts with National Federal Government Agencies, Defense General Supply Agency, and United States Post Office Department, orders for all warranty parts must be placed directly with the Taylor-Dunn factory in Anaheim, California.

TAYLOR-DUNN MANUFACTURING COMPANY
2114 W. BALL ROAD
ANAHEIM, CALIFORNIA 92804

PHONE: 714-956-4040

TELEX: 65-5393

SUGGESTED SPARE PARTS LIST

FIG. I.D.	T-D PART NO.	DESCRIPTION	QUANTITY OF 1 - 20 UNITS
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REFER TO FIGURE NO. 4 FRONT AXLE, STEERING AND TIRES

4-2	71-501-00	HORN BUTTON	1
4-7	96-320-00	LUG BOLT	10
4-16	46-338-00	OIL SEAL	2
4-21	32-213-00	BUSHING (NYLON) (SAME ON REAR AXLE)	14
4-22	88-171-20	SHACKLE BOLT (NON LUBRICATED TYPE) (SAME AS REAR AXLE)	14
4-23	16-870-00	SHACKLE STRAP (PUNCHED HOLE)	5
4-24	16-871-00	SHACKLE STRAP	5
4-36	88-179-81	LOCKNUT 9/16" FN (HEX)	6
4-35	87-000-00	GREASE FITTING 1/8" - 27 THREAD (STRAIGHT)	4
4-45	13-952-10	TIRE AND DEMOUNTABLE CAST IRON WHEEL 16 X 4 X 12-1/2 SOLID CUSHION TIRE (FIVE 1/2" HOLES ON 4-1/2" BOLT CIRCLE ON WHEEL)	2

REFER TO FIGURE NO. 5 FULL FLOATING REAR AXLE MOTOR & BRAKES

5-51	13-957-10	TIRE AND DEMOUNTABLE WHEEL 18 X 5 X 14 SOLID CUSHION TIRE (TRACTORS WITH 18" TIRES ONLY)	2
5-51	13-958-10	TIRE AND DEMOUNTABLE WHEEL 21 X 5 X 15 SOLID CUSHION TIRE (TRACTORS WITH 21" TIRES ONLY)	1
5-44	45-010-00	MOTOR GASKET	2
5-45	45-507-00	SHAFT OIL SEAL	2
5-46	70-059-00	MOTOR, 5 H.P., 26000 RPM, 36 VOLT	1
5-47	70-126-00	MOTOR BRUSHES, SET OF 8	1 - 4
5-47	80-203-00	BALL BEARING FRONT AND REAR	4

NOTE: REFER TO SECTION 11 FOR SUGGESTED SPARE PARTS LIST OF
DIFFERENTIAL AND BRAKE ASSEMBLY

REFER TO FIGURE NO. 6 HYDRAULIC BRAKE SYSTEM

6-2	71-110-00	BRAKE SWITCH	2
6-6	99-510-00	MASTER CYLINDER	1
6-6	99-510-61	KIT-MASTER CYLINDER REPAIR	2
6-7	99-554-00	FLEXIBLE HOSE	1
6-10	99-552-01	1/4 TUBING 18" LONG WITH ENDS	1
6-11	99-552-02	1/4 TUBING 114" LONG WITH ENDS	1
6-12	99-553-00	TUBING ENDS	6

REFER TO FIGURE NO. 7 MECHANICAL CONTROL LINKAGE

7-3	85-280-00	SPRING DEADMAN BRAKE RETRUN	1
7-4	85-295-00	SPRING ACCELERATOR RETURN	1
7-7	96-762-00	3/8 CLEVIS	3
7-8	96-772-00	3/8 CLEVIS PIN	3
7-11	98-200-00	PAD RUBBER BRAKE PEDAL	1
7-12	98-253-00	PAD ACCELERATOR PEDAL	1
7-14	85-270-00	BRAKE RETURN SPRING	1
7-22	85-060-00	SPRING	1
7-24	41-520-10	BRAKE DRUM	1
7-25	41-650-00	BRAKE BAND	1
7-37	88-014-13	ROUND HEAD MACHINE SCREW 6-32 X 1-1/4"	6
7-38	88-019-80	NUT 6-32 (HEX)	6
7-41	71-130-00	MICRO SWITCH (STANDARD)	2

SUGGESTED SPARE PARTS LIST

T-D PART	DESCRIPTION	QUANTITY OF 1-20 UNITS
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GENERAL ELECTRICAL SYSTEM

71-100-00	LIGHT SWITCH	2
71-120-00	KEY SWITCH	1
72-034-00	STOP AND TAILLIGHT - 36 VOLT	1
73-002-00	HORN - 36 VOLT	1
74-000-00	HOUR METER	1
75-071-00	WIRE HARNESS - LIGHT AND ACCESSORIES	1
75-072-00	WIRE HARNESS - POWER	1
76-024-00	BATTERY RECEPTACLE, ANDERSON EC 5816B (300 AMP)	1
76-022-00	BATTERY RECEPTACLE, ANDERSON N-150 (150 AMP)	1
76-020-00	BATTERY RECEPTACLE, ANDERSON SB 6313 (175 AMP)	1
78-010-00	FUSE HOLDER WITH FUSE	1
79-823-00	FUSE BUSS TYPE 20 AMP	1
72-007-00	HEADLIGHT OR BACKUP LIGHT 36 VOLT	3
77-200-00	HYDROMETER	2
77-201-00	BATTERY FILLER	1
72-500-00	SOLENOID 200 AMP	1
79-842-00	CIRCUIT BREAKER 10 AMP (1 POLE)	3
79-843-00	CIRCUIT BREAKER 100 AMP (2 POLE)	2
79-843-11	CIRCUIT BREAKER 100 AMP (3 POLE)	2

GENERAL BODY AND TRIM PARTS

97-307-00	BATTERY COMPARTMENT LID SAFETY LOCK	1
97-306-00	BATTERY COMPARTMENT LID LATCH	2
97-809-00	HITCH (PIN & EYE)	1
97-808-00	HITCH AUTOMATIC COUPLING	1
97-809-51	HITCH PIN	2

MAINTENANCE PROCEDURES
REFER TO FIGURE 4
FRONT AXLE, STEERING AND TIRES

Your front axle and wheel assembly consists of an axle mounted on 2 leaf springs with automotive spindles, steering worm, and steering linkage. It has been designed for rugged dependable service with little maintenance requirements, other than lubrication and an occasional check of all nuts and bolts for tightness. Your wheels revolve on roller bearings and the spindles are mounted with heavy kingpins.

Zerk type grease fittings have been provided to ensure proper amounts of lubricant reaching wear points.

It is recommended that you follow the maintenance guide and lubrication diagrams for normal maintenance of the assembly. They are located in Sections 4 and 5 of this manual.

The maintenance guide is set up for average use. If the vehicle is subject to long hours of running and heavy work loads, the frequency of lubrication and service should be increased accordingly.

Refer to Service and Adjustment Section 10 of this manual for guidance when performing major repairs and adjustments.

The steering worm gear box and steering linkage is similar to those used on autos. It requires very little attention.

Refer to maintenance guide and lubrication diagrams (Section 4 & 5) for normal care.

If service and adjustment are required, refer to appropriate section of this manual.

SERVICE AND ADJUSTMENT
FRONT AXLE, FORK, STEERING AND TIRES

WHEEL HUB REMOVAL AND ADJUSTMENT

1. Jack up front of vehicle until wheel is free from ground.
2. Remove dust cap.
3. Remove cotter pin and unscrew spindle nut.
4. Remove outer washer and bearing
5. Remove wheel hub.
6. Before re-assembly wash and clean bearings thoroughly. Also do spindle and hub assembly. Inspect bearings for wear or damage. Insert inner seal. Replace damaged or worn parts. Seal condition is important on models with brake assembly as grease will leak onto brake shoes causing poor braking.
7. Generously pack bearings with wheel bearing grease.
8. Re-assemble parts in reverse order of removal.
9. ADJUST wheel bearings by tightening spindle nut until bearing drag is felt. Back off approximately 1/4 turn until wheel turns freely, but does not have play in bearings. Important Note: On models utilizing front wheel hydraulic brakes, drum must be clean and dry when re-assembling. Be certain that brake shoes do not come in contact with brake drum when adjusting wheel bearings. A false feel of drag will occur and you will be unable to adjust bearings properly.
10. Install cotter pin and dust cap.
11. Wheel hub has 1 zerk fitting for grease lubrication.
12. Shackle bolts and spring "U" bolts should be kept tight for best steering control and least amount of wear.

REMOVE KING PINS AND BUSHINGS

1. Remove wheel and hub from spindle. See preceding subsection.
2. Remove ball joints from steering arms. Remove cotter pin and nut. Rap stud sharply with soft hammer, or soft block and regular hammer, to loosen tapered stud from steering arm.
3. Remove 7/8 lock nut which retains spindle and steering arm assembly to kingpin.
4. Remove king pin from axle. If it is necessary to force the pin from the axle, use a soft rod, such as bronze or aluminum.
5. Remove spindle and steering arm assembly, and thrust bearing, from axle yoke.
6. Press bushings from spindle and steering arm assembly.
7. Clean bushing housing and king pin before installling new bushings.

SERVICE AND INSTALL KING PINS AND BUSHINGS

1. Press bushings into sleeve. It may be necessary to ream the bushings after they are installed in the sleeve because of slight distortion when pressing them into place. If the right press and reamer are not available, most automotive supply houses and repair shops can perform this service.
2. Reassemble in reverse order. Lightly oil king pin. Tap into axle. Where it is necessary to use force to assemble components, use a soft hammer or punch.
3. After reassembly, tighten ball joints. Lubricate bushing and king pin through grease fitting. Adjust wheel bearings as described in this section. Align front end as described in subsection titled "Align Front End: Adjust Toe-In".
4. Perform trial lubrication on each bushing. Make certain grease will travel through bushing for proper lubrication.
5. Place dust seal cap in socket with crown facing outward. Expand into place by hammering lightly on center of crown to flatten and lock into seal sockets.
6. Replace ball joints and tighten.
7. Replace cotter pins.
8. Replace wheels.
9. Check and adjust "Toe-In"

SERVICE AND ADJUSTMENT continued
FRONT AXLE, FORK, STEERING & TIRES

ADJUSTMENT OF "TOE-IN"

To adjust toe-in, jack front end of tractor off ground. With a pencil, mark around center of tire tread by holding pencil point against tire and turning wheel. Mark both front wheels. Let truck down on ground. Loosen lock nuts on each end of the tie rod shaft so that portion of shaft between tie rods ends will turn. Next, in as straight a forward position as possible, measure between marks on wheels. Measure both front and rear side of wheel. Retighten lock nuts on each of tie rod. Camber and caster are set at factory and will not need resetting in the field.

REMOVE AND INSTALL BALL JOINTS

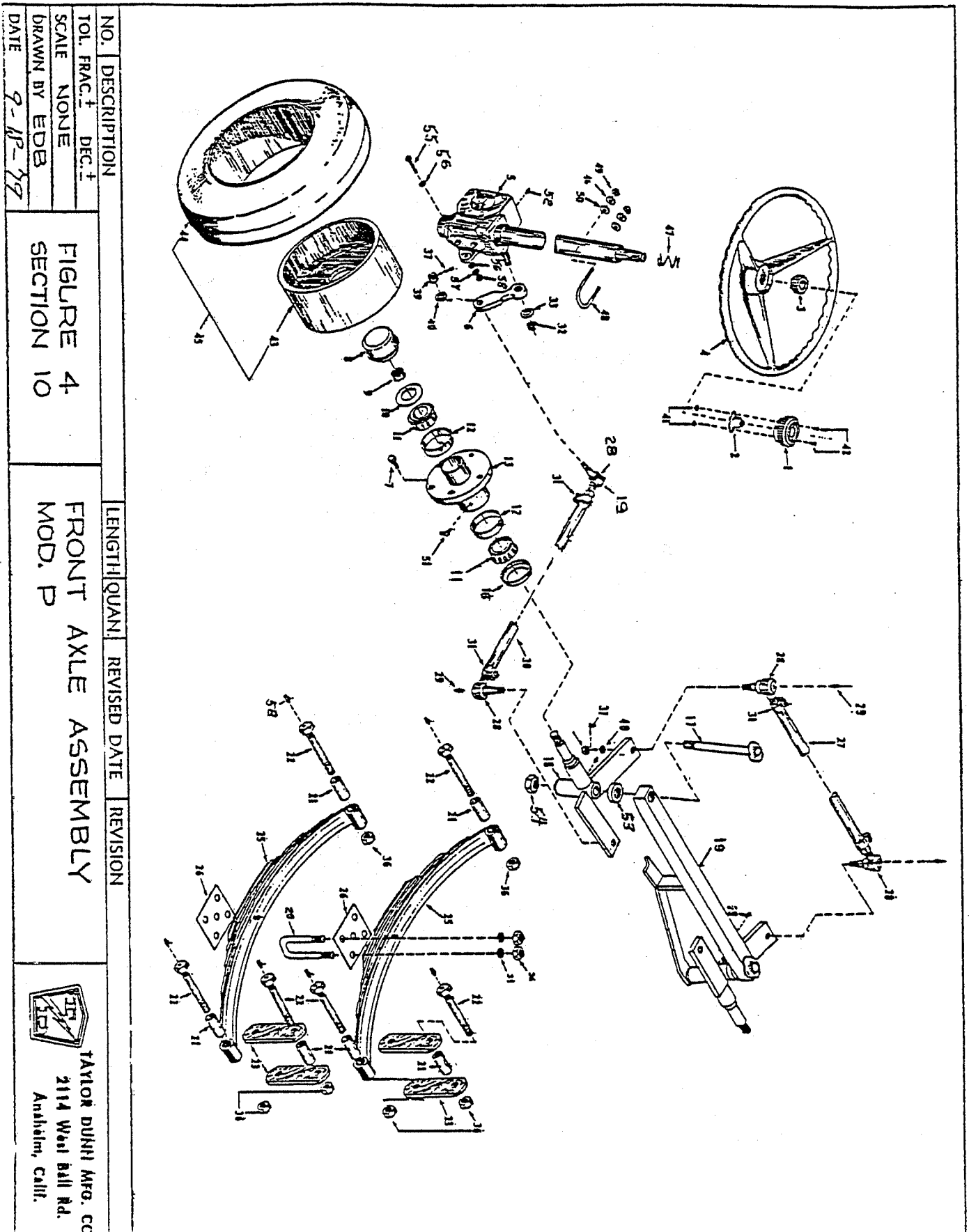
1. Remove cotter pin and nut.
2. Loosen sleeve clamp.
3. Rap ball joint stud sharply with soft hammer or soft block and regular hammer, to loosen tapered stud from steering arm.
4. Either measure position of ball joint or count number of threads exposed from sleeve. Remove ball joint by unscrewing from sleeve. Note that one end will be left hand thread and the other ball joint will be right hand thread.
5. Install new ball joint and position same as the one removed.

REMOVAL OF STEERING WORM

1. Pry steering wheel cap up to expose locknuts holding horn button in place.
2. Remove 2 horn button screws.
3. Remove wiring from horn button and slide out of steering tube through bottom.
4. Remove lock nut. With suitable puller, remove steering wheel.
5. Remove "U" bolt on steering tube.
6. Remove ball joint at pitman arm.
7. Remove 2 steering worm holding bolts and slide steering worm assembly from bottom of vehicle.
8. Remove lock nut holding pitman arm on shaft.
9. Mark position of pitman arm and remove from worm shaft.

INSTALL STEERING ARM

1. If installing new steering worm it is important to place the pitman arm in the same relative position on the new unit as it was on the old unit. Failure to do this will result in a misalignment of the steering linkage and a loss of steering in one direction.
2. Install steering worm in the reverse manner to which it was removed outlined in steps 1 through 8.
3. When installing steering wheel, rotate the steering shaft until the front wheels are in a straight ahead position. Place the steering wheel on the shaft aligning it in a central position.
4. Adjust any minor misalignment by loosening the steering link sleeve clamps. Adjust the steering link until the front wheel and steering wheel are both in position. DO NOT apply excessive tension to chain as undue bearing and chain wear will result.
5. Check that you will be able to turn the steering mechanism equally, in both directions. If you cannot it means the pitman arm was not properly installed. It will be necessary to install it in the proper position.
6. Lubricate steering worm through a zerk fitting located on worm housing. Refer to Lubrication Diagram and Maintenance Guide sections.



TAYLOR DUNN MFG. CO.
2114 West Hill Rd.
Anaheim, Calif.

FRONT AXLE, STEERING AND TIRES
REFER TO FIGURE 4

FIG. I.D.	T-D PART NO.	DESCRIPTION	QTY.
4-1	19-004-10	CAP WITH HORN BUTTON HOLE (STEERING WHEEL)	1
4-2	71-501-00	HORN BUTTON STANDARD	1
4-3	88-259-82	JAM NUT 13/16" NF (HEX)	1
4-4	19-003-00	STEERING WHEEL	1
4-5	18-307-13	STEERING WORM ASSEMBLY, INCLUDING WORM, SHAFT AND JACKET TUBE ASSEMBLY	1
4-5	18-307-51	STEERING COLUMN SHAFT AND WORM ASSEMBLY	1
4-5	18-307-52	STEERING COLUMN JACKET TUBE ASSEMBLY	1
4-6	18-107-00	LEVER, STEERING	1
4-7	97-236-00	NUT, 1/2" TAPERED LUG	10
4-8	92-104-00	DUST CAP WITH GREASE FITTING	2
4-9	88-239-85	NUT, CASTLE, 3/4" NF (HEX)	2
4-10	88-228-00	WASHER, 3/4" SAE	2
4-11	80-017-00	BEARING, TAPERED ROLLER	4
4-12	80-103-00	BEARING, RACE, TAPERED	4
4-13	12-124-00	HUB, FRONT, WITH BEARING RACES - FIVE 1/2" NC HOLES ON 4-1/2" BOLT CIRCLE	2
4-16	45-338-00	OIL SEAL	2
4-17	21-015-00	KING PIN WITH FORMED WASHER	2
4-18	14-161-98	SPINDLE, FRONT WHEEL ONLY (LEFT)	1
4-18	14-161-99	SPINDLE, FRONT WHEEL ONLY (RIGHT)	1
4-19	15-067-11	FRONT AXLE BAR, YOKE AND YOKE ANCHOR	1
4-20	96-121-00	U BOLT - FRONT AXLE	4
4-21	32-313-00	BUSHING (NYLON)	6
4-22	96-244-00	SHACKLE BOLT WITH GREASE FITTING	6
4-23	16-870-10	SHACKLE STRAP	4
4-25	85-503-00	LEAF SPRING UNIT (21-3/4" CENTERS) 9 LEAF	2
4-26	16-867-00	SPRING PAD	2
4-27	18-053-10	STEERING ADJUSTMENT SLEEVE ASSEMBLY WITH BALL JOINTS AND CLAMPS (18" LONG)	1
4-28	86-501-98	BALL JOINT (LEFT HAND THREAD)	2
4-28	86-501-99	BALL JOINT (RIGHT HAND THREAD)	2
4-29	87-074-00	GREASE FITTING 1/4-28 THREAD (STRAIGHT)	4
4-30	18-041-00	STEERING ADJUSTMENT SLEEVE	1
4-31	86-510-00	BALL JOINT CLAMP	4
4-32	88-279-82	JAM NUT 7/8" NF HEX	1
4-33	88-268-62	LOCK WASHER 7/8"	1
4-34	88-168-62	LOCK WASHER 9/16"	8
4-36	88-169-81	LOCK NUT 9/16" NC HEX	14
4-37	88-527-11	COTTER PIN 1/8" X 1"	5
4-39	88-159-85	CASTLE NUT 1/2" NF (HEX)	5
4-40	88-188-61	WASHER 5/8" SAE	6
4-41	88-029-81	LOCK NUT 8-32 (HEX)	2
4-42	88-025-08	TRUSS HEAD MACHINE SCREW 8-32 X 5/8	2
4-43	12-050-00	WHEEL FOR 16 X 4 X 12-1/8 SOLID CUSHION TIRE (FIVE 1/2" HOLES ON 4-1/2" BOLT CIRCLE)	2
4-44	10-250-00	TIRE - SOLID CUSHION 16 X 4 X 12-1/8	2
4-45	13-952-10	TIRE & DEMOUNTABLE CAST IRON WHEEL, 16 X 4 X 12-1/8 SOLID CUSHION TIRE	2
4-46	88-088-62	LOCK WASHER 5/16"	2
4-47	85-122-00	SPRING COMPRESSION (STEERING COLUMN) 1-1/8" OD X 1"	1
4-48	96-102-00	"U" BOLT FOR STEERING COLUMN SHAFT	1
4-49	88-089-80	NUT 5/16" NC (HEX)	2
4-50	88-088-60	WASHER 5/16" FLAT	2
4-51	87-075-00	GREASE FITTING 1/4" DRIVE (65 DEGREE ANGLE)	2

FRONT AXLE, STEERING AND TIRES CONTINUED
REFER TO FIGURE 4

FIG. I.D.	T-D PART NO.	DESCRIPTION	QTY.
4-52	87-071-00	GREASE FITTING (3/16 DRIVE) STRAIGHT	9
4-53	80-309-00	THRUST BEARING	2
4-54	88-279-81	7/8 LOCK NUT	2
4-55	88-120-15	HEX HEAD CAP SCREW 7/16 X 1-3/4 NC	2
4-56	88-128-60	WASHER 7/16" FLAT	4
4-57	88-128-62	LOCK WASHER 7/16"	2
4-58	88-129-80	NUT 7/16" NC (HEX)	2

MAINTENANCE PROCEDURES
REFER TO FIGURE 5
"FULL FLOATING" REAR AXLE, MOTOR AND BRAKES

Your "Full Floating" direct drive assembly is a highly efficient unit. Great care was taken in its design to promote long life with a minimum of maintenance. It employs an automotive type differential unit which operates within an enclosed housing. The gears, bearings, etc. are lubricated from within by oil which when maintained at its proper level insures complete coverage of all moving parts. This oil level should be checked on a regular basis as outlined in the Maintenance Guide and Lubrication Diagrams of this manual. If the oil level is allowed to drop below normal limits serious damage to the differential and drive unit will result.

Although little or no adjustment of this unit will normally be required, refer to Service and Adjustment Section of this manual if the need arises.

The electric motor will provide many hours of trouble free service. It is provided with sealed ball bearings which are pre-lubricated for their lifetime.

Periodically, the motor brushes should be inspected and cleaned. The carbon dust should be blown out of motor. When brushes are worn they should be replaced. Approximately 3000 hours operating life may be expected from a new set of brushes. To determine when to replace worn brushes, proceed as follows:

1. For motors equipped with brushes having end pigtails and side hooks, replace brush when hook is within 1/16" from bottom of hook slot.
2. For motors equipped with brushes having side pigtails only, replace brush when pigtail is within 1/16" from bottom of pigtail slot.

NOTE: When one brush is replaced in a motor, it is considered good maintenance practice to replace all brushes.

Inspect commutator for roughness or undue wear as arcing and shortened brush life will result from this condition.

Check wiring terminals for cleanliness and tightness. A loose connection will cause burning of the respective terminal and can induce motor failure.

Refer to Maintenance Guide (Section 4) and Service and Adjustment (Section 11) for further recommendations on motor care.

The mechanical brake assembly located on the motor shaft will require a periodic inspection for lining wear and consequently periodic adjustment. Refer to the Service and Adjustment section of this manual for proper procedures.

A few drops of oil on the clevis pin and pivot pins of the mechanical linkage is recommended on a monthly basis. Great care must be taken that no oil is allowed to contact the brake band or drum as it will seriously impair the braking ability. If the braking surfaces become oily or contaminated for any reason it will be necessary to remove the brake band and clean all parts thoroughly. Refer to the appropriate section of this manual for the correct procedure to follow.

A periodic tightening of all bolts and nuts, especially the spring mounting "U" bolts should be made.

SERVICE AND ADJUSTMENTS
REFER TO FIGURE 5
"FULL FLOATING" REAR AXLE, MOTOR AND BRAKES

Removal of "Full Floating" rear axle and drive assembly from chassis.

1. Disconnect battery connector to prevent accidental engagement of power while servicing unit.
2. Clearly mark motor leads to ensure their proper location when reassembling.
3. Remove motor leads.
4. Pull clevis pin and disconnect brake rod from brake arm.
5. Loosen locknut and release spring tension by unscrewing turn buckle.
6. Disconnect hydraulic brake line at hose end.
7. Remove shackle bolts and nuts attaching spring to frame.
8. Remove spring eye anchor bolts.
9. Remove axle and drive assembly from chassis.
10. Install axle and drive assembly in the reverse order of removal, taking care that shackles and bushings are in good condition. (Replace if worn or damaged.)
11. Check brake adjustments following procedures outlined in brake section of this manual.
12. On models equipped with hydraulic brakes, it will be necessary to bleed the air from brake system. Follow procedure outlined in Hydraulic Brake section of this manual.

DISASSEMBLY OF "FULL FLOATING" REAR AXLE

AXLE SHAFT, REMOVAL -

- Raise vehicle and place stands under housing.
- Remove axle shaft stud nuts and lockwashers.
- Strike the center of the axle shaft flange with a hammer and drift to loosen the tapered dowels, remove the dowels.
- Remove the axle shaft from the housing.

BEARING OR OIL SEAL, REPLACE

1. Remove the outer seal from the axle shaft flange studs.
2. Bend the lockwasher tab away from the locknut and remove locknut, lockwasher and adjusting nut.
3. With a wheel jack, raise the wheel to the point that all wheel weight is removed from the wheel bearings.
4. Remove the outer bearing cone and pull the wheel straight off the axle.
5. With a piece of hard wood which will just clear the outer bearing cup drive the inner bearing cone and inner seal out of the wheel hub.
6. Clean all the old grease or axle lubricant out of the wheel hub.

NOTE: If axle lubricant is found in a wheel hub that has an outer seal, it means the seal or sealing has failed and should be replaced.

7. Inspect the bearing races and rollers for pitting, galling and erratic wear pattern. Inspect the rollers for end wear.
8. If bearing cups are to be replaced, drive them out with a drift.
9. Check for proper seating of new cups by trying to insert a .0015 inch feeler gauge between the cup and the hub.
10. A ring of wheel bearing grease as high as the cup should be placed in the hub on each side of both cups. These rings form a dam which prevents thinned grease from flowing out of the bearing.
11. Pack each bearing cone and roller assembly.
12. Place the inner bearing in the wheel hub and install a new hub inner seal.
13. Adjust the wheel jack so the wheel can be installed straight on the housing without damaging the inner seal.
14. Install the outer bearing and start the bearing adjuster nut.
15. Turn the adjuster nut in and torque the nut to 50 to 80 ft. lbs. while rotating the wheel.
16. With the bearing rollers firmly seated, back off the nut 3/8 of a turn and install the lockwasher.
17. If the adjusting nut is equipped with a locking dowel, make sure that the dowel enters the lockwasher hole which closely aligns with the dowel.

SERVICE AND ADJUSTMENTS

REFER TO FIGURE 5

"FULL FLOATING" REAR AXLE, MOTOR AND BRAKES

18. If the lockwasher is equipped with tabs, run the locknut against the lockwasher and bend a tab over the adjusting nut.
19. Torque the locknut to 100-150 ft. lbs.

AXLE SHAFT, INSTALL

1. Install the seal and gaskets on the axle shaft studs.
2. Install the axle shaft, tapered dowels, lockwashers and axle shaft flange nuts.
3. Adjust the brakes.

REAR AXLE ASSEMBLY, REPLACE

Inasmuch as the axle tubes are pressed into the differential carrier to form a one-piece housing; the rear axle assembly must be removed from the chassis when it becomes necessary to overhaul the unit.

1. Raise vehicle from floor and support with stand jacks under frame side rails.
2. Remove rear axle unit from chassis as previously outlined.

NOTE: When replacing rear axle unit in vehicle it will be necessary to bleed air from hydraulic brake system.

DIFFERENTIAL CARRIER, DISASSEMBLE

1. Remove axle shafts as outlined previously, axle shafts may be pulled out only far enough to clear differential side gears.
2. Drain lubricant and rear cover.
3. Make sure differential side bearing caps and axle housing are marked, then remove the side bearing caps.
4. Pry differential from housing.
5. Remove side bearing cups.
6. Pull off side bearing and adjusting shims, tagging shims for identification on reassembly.
7. Unfasten ring gear from case.
8. Drive out differential pinion shaft pin and pull out the shaft, pinions, and side gears.
9. Hold companion flange from turning and remove flange nut.
10. Remove motor and gear case plate.
11. Remove driven gear from pinion shaft.
12. Remove pinion from carrier by tapping on front end with soft hammer.
13. Remove pinion shaft bearings from carrier, keeping separate the shim pack at each bearing.

PINION AND BEARINGS, REPLACE.

If the original ring gear and pinions are being used in the original carrier, use the original shim packs at each bearing. If a new pinion or differential carrier is installed, note the markings on the end of the pinion gear and on the differential carrier to obtain the correct thickness of shimming to be used with these parts. The shims behind the rear bearing establishes the correct pinion depth.

1. Press the rear pinion bearing cup to the housing with the proper thickness of shims. Press the rear pinion bearings on the shaft.
2. Install the front bearing cup and shims and front bearing.
3. Install the companion flange and, while holding the flange from turning, tighten nut to torque load of 200-220 lb. ft.
4. Check the pinion bearing pre-load with a spring scale and heavy cord wrapped around the companion flange. Pull on the spring scale. The torque required to rotate the pinion is 2-5 inch lbs. If not within these limits, add or remove shims from behind the front bearing to obtain the proper pre-load.
5. Remove the companion flange and install a new oil seal (well soaked). Reinstall the companion flange and tighten the nut to a torque load of 200-220 lb. ft.

SERVICE AND ADJUSTMENTS
"FULL FLOATING" REAR AXLE - continued

INION AND BEARINGS, REPLACE continued

- Replace driven gear on pinion flange and replace motor and gear case plate with gear case bolts.

ING GEAR, REPLACE

- Install guide pins in every other hole in the ring gear. These pins can be made from 1-1/2" long cap screws with heads cutt off and ends slotted. replaced as needed.
- Make sure back face of ring gear and face of cases are free of dirt and burrs and slip gear over pilot diameter of case.
- Install every other ring gear bolt. Draw them up evenly and snugly so ring gear face is flush with face of case.
- Remove guide pins and install remaining bolts.

IFFERENTIAL CARRIER, ASSEMBLE

The differential bearings are adjusted by shims. These shims also establish the ring gear position with the pinion. Therefore, backlash must be checked whenever a bearing adjustment is made.

The correct bearing adjustment is one which will provide a .001-.002" pinch fit when the differential unit is assembled into the carrier. To make the adjustment, install the bearing cones without shims and place the assembly in the housing with the bearing cups. Force the unit to one side and check the clearance between the bearing cup and differential case with a feeler gauge. When the clearance is determined, select shims of this amount plus .001-.002" extra to establish the proper load. Remove the differential bearings again and divide the shims into two packs of equal thickness and install on each side and replace bearings. Reinstall the unit in the tractor. This operation is made easier by cocking the bearing cups slightly when the differential is placed in the housing and then tapping them lightly with a mallet. However, when installing the differential in the housing, be sure the ring gear teeth mesh with the pinion teeth before tapping the bearings in place. After the bearing cups are firmly in place, install the bearing caps. The bearing caps and gasket surface of the housing are marked with a horizontal numeral and on the other side by a vertical numeral. The position of the numerals should correspond when reinstalling the bearing caps.

ING GEAR AND PINION BACKLASH, ADJUST

Mount a backlash gauge indicator on the carrier and start checking for the correct backlash between the right gear and pinion. If the backlash is not within the limits of .004" to .011", it will be necessary to change the arrangement of the shims back of the bearings. Make correction in backlash bearing in mind that shims removed from one side must be installed on opposite side so that the total shim thickness of the right and left side will remain unchanged, and the bearing adjustment undisturbed.

EAR REPLACEMENT (SPUR GEAR REDUCTION)

Remove five 5/16 bolts and nuts and the three 3/8 bolts. This will allow the gear case to come aprar. To remove the pinion gear, remove nut and use gear puller to pull gear. Replace new gear and lock down with nut. To replace driven gear, remove bolt and slide off splined shaft. To replace new gear slip over spline and lock nut down.

MOTOR REPAIRS: Unless the maintenance man is properly qualified, it is advisable that the repair work be done at a qualified service station. When ordering replacement parts, give complete name plate data.

DISASSEMBLY OF MOTOR FOR MINOR REPAIRS

1. Remove motor from vehicle as previously outlined.
2. Remove cover exposing brush assembly.
3. Lift brushes out of brush holder.
4. Remove bolts holding end bells and remove end bell and rotor. (Pull from shaft extension end). Take care not to damage any coils or armature wires when handling motor parts.
5. Press or pull old bearings off by using bearing or bearing puller. Do not damage shaft while removing bearings.
6. Install new bearings onto shaft by gentle pressure or tapping with proper tool on inner race only. Bearing will be damaged if pressed or driven by outer race or seals.
7. On "Full Floating" model replace motor seal in shaft extension end bell housing.
8. If the commutator is worn or "burned" it should be turned, the mica undercut, and the commutator polished.
9. Oil bearing housing lightly to aid in re-assembly.
10. Re-assemble motor taking care that all parts are kept clean.
11. Install brushes and seat in with fine sandpaper.
12. Be sure brushes work freely, replace covers, and re-install motor into drive assembly.
13. Connect motor leads as follows: (IMPORTANT)
 - a. Check that each motor terminal stud nut is tightened securely but not over-tightened as this could bend or twist the terminal post and cause an electrical short within the motor.
 - b. Install motor leads on correct motor terminal post.
 - c. Install a second nut on each terminal post and finger tighten.
 - d. To avoid bending, twisting or breaking-off a terminal post, use a thin pattern 9/16" wrench to hold the bottom nut from moving while tightening the top nut. Carefully tighten the top nut so as to make a good connection between the terminal post and motor lead.

DEADMAN MECHANICAL BRAKE ASSEMBLY
REFER TO FIGURE 7

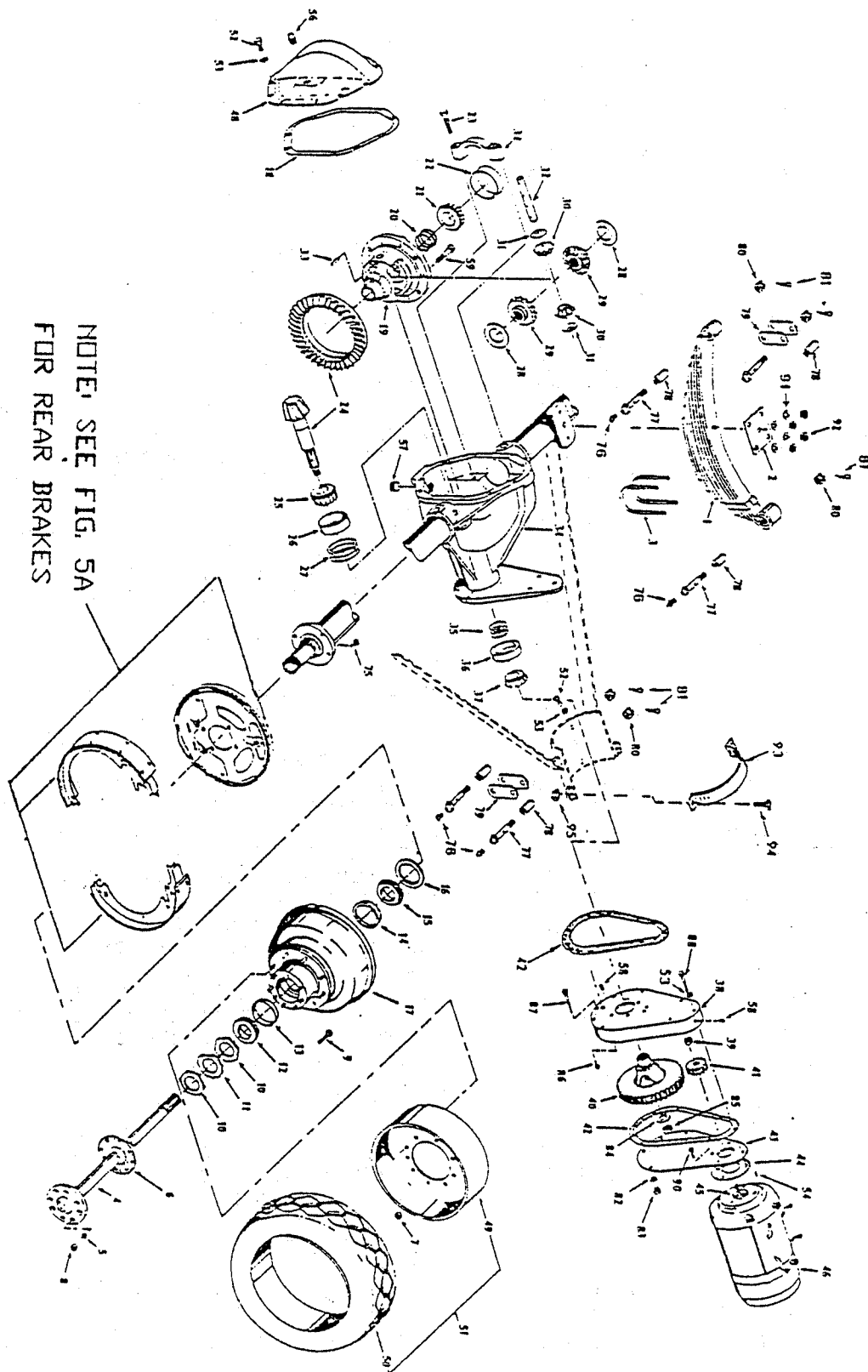
REMOVAL OF BRAKE ASSEMBLY AND DRUM

1. Remove cotter pin and clevis pin, disconnecting brake rod from brake lever arm. (Note location of clevis.)
2. Remove spring tension by unscrewing turnbuckle.
3. Remove bolts and cotter pin holding brake band assembly, and slide assembly off drum.
4. Band and drum may not be cleaned, inspected and if necessary parts may be replaced as needed.
5. Brake band lining is bonded to the band for long dependable service. When it wears to approximately 1/16" thickness the band should be replaced.
6. If the brake drum is scored it should be removed and turned. It is recommended that a brake drum that has been severely scored or damaged should be replaced with a new drum.
7. To remove drum, unscrew nut, and pull drum from motor shaft.
8. Re-assemble drum on motor shaft and tighten.
9. Replace brake assembly in the reverse order to which it was removed.
10. Adjust brake band anchor bolt and nut, tightening it until the lever arm is within 1 to 2 degrees of being vertical.
11. Adjust turnbuckle or eyebolt to attain a spring length of 9-1/2" measured between spring loops at their point of contact with hooks.
12. Adjust seat brake rod using clevis adjustment until there is 5" measured between seat stop and seat deck.

NOTE: As brake lining wears the spring will contract in length and the seat will rise in position. Compensate for lining wear by adjusting brake band anchor bolt.
13. If vehicle is equipped with hydraulic wheel brakes, refer to Section 13 for service and adjustment.
14. Once a month lubricate four (4) bushings on seat hinge assembly.

REAR AXLE, MOTOR AND BRAKES

REAR AXLE, MOTOR AND BRAKES—MODEL P



"FULL FLOATING" REAR AXLE - MOTOR AND BRAKES
FIGURE 5

FIG. I.D.	T-D PART NO.	DESCRIPTION	QTY.
5-1	85-503-00	9 LEAF SPRING ASSEMBLY	2
5-2	16-867-00	SPRING PLATE	2
5-3	96-111-00	U-BOLT	4
5-4A	41-150-00	AXLE, REAR, 16 TOOTH SPLINE	2
5-4B	41-150-50	AXLE, REAR, 30 TOOTH SPLINE	2
5-5	95-450-00	7/16 ID TAPERED DOWEL	16
5-6	45-043-00	GASKET, AXLE TO HUB	2
5-7	97-236-00	1/2 NF LUG NUT	16
5-8	88-139-81	7/16 NF LOCK NUT	24
5-9	96-332-00	WHEEL STUD	16
5-10	41-870-00	HUB OUTER BEARING LOCK NUT	4
5-11	41-871-00	HUB OUTER BEARING LOCK WASHER	2
5-12	80-529-00	HUB OUTER BEARING	2
5-13	80-134-00	HUB OUTER BEARING RACE	2
5-14	80-135-00	HUB INNER BEARING RACE	2
5-15	80-530-00	HUB INNER BEARING	2
5-16	45-337-00	HUB SEAL	2
5-17	12-225-00	HUB ASSEMBLY WITH DRUM BEARING RACE AND STUDS	2
5-18	45-041-00	GASKET	1
5-19	41-873-52	DIFFERENTIAL CARRIER ASSEMBLY	1
5-20	41-874-51	SHIM (.003 THICK) CARRIER BEARING	1 TO 5
5-20	41-874-52	SHIM (.005 THICK) CARRIER BEARING	1 TO 5
5-21	80-531-00	TAPERED ROLLER BEARING (CARRIER)	2
5-22	80-136-00	BEARING RACE (CARRIER)	2
5-23	88-140-17	1/2 X 2-1/4 NC HEX HEAD CAP SCREW	4
5-24A	31-243-00	RING AND PINION GEAR SET 6.17 RATIO 10 TOOTH SPLINE	1
5-24B	31-243-10	RING AND PINION GEAR SET, 6.17 RATIO 29 TOOTH SPLINE	1
5-25	80-532-00	TAPERED ROLLER BEARING (REAR PINION)	1
5-26	80-137-00	BEARING RACE (REAR PINION)	1
5-27	41-876-51	PINION BEARING SHIM (.003 THICK)	1 TO 5
5-27	41-876-52	PINION BEARING SHIM (.005 THICK)	1 TO 5
5-28	41-877-00	DIFFERENTIAL GEAR WASHER (AXLE)	2
5-29A	41-878-00	DIFFERENTIAL GEAR (AXLE), 16 TOOTH SPLINE	2
5-29B	41-878-10	DIFFERENTIAL GEAR (AXLE), 30 TOOTH SPLINE	2
5-30	41-879-00	DIFFERENTIAL GEAR (PINION)	2
5-31	41-880-00	DIFFERENTIAL GEAR WASHER (PINION)	2
5-32	41-881-00	DIFFERENTIAL GEAR SHAFT	1
5-33	88-707-14	PIN (DIFFERENTIAL SHAFT LOCK)	1
5-34	41-883-12	HOUSING, COMPLETE WITH GEARS LESS AXLES AND BRAKES	1
5-35	41-884-51	SHIM (.003 THICK)(PINION BEARING SHAFT)	1
5-35	41-884-52	SHIM (.005 THICK)(PINION BEARING SHAFT)	1
5-36	80-138-00	FRONT PINION BEARING RACE	1
5-37	80-533-00	FRONT PINION BEARING	1
5-38	43-200-51	GEAR CASE	1
5-39	97-241-00	3/4 NF HEX HEAD JAM NUT	1
5-40	31-206-12	67 TOOTH SPUR GEAR, 29 TOOTH HUB SPL.	1
5-41	31-229-00	17 TOOTH GEAR (GOES W/84 TOOTH GEAR)	1
5-41	31-232-00	17 TOOTH GEAR (GOES W/67 TOOTH GEAR)	1
5-42	45-000-00	GEAR CASE GASKET	2
5-43	44-350-00	GEAR CASE COVER	1
5-44	45-010-00	MOTOR GASKET	1
5-45	45-507-00	SHAFT OIL SEAL	1
5-46	70-061-00	MOTOR, 5HP 2800 RPM, 36 VOLT GE	1
5-48	41-872-00	CARRIER COVER	1
5-49	12-055-00	CAST WHEEL FOR 21X5X15 SOLID CUSHION TIRE	2

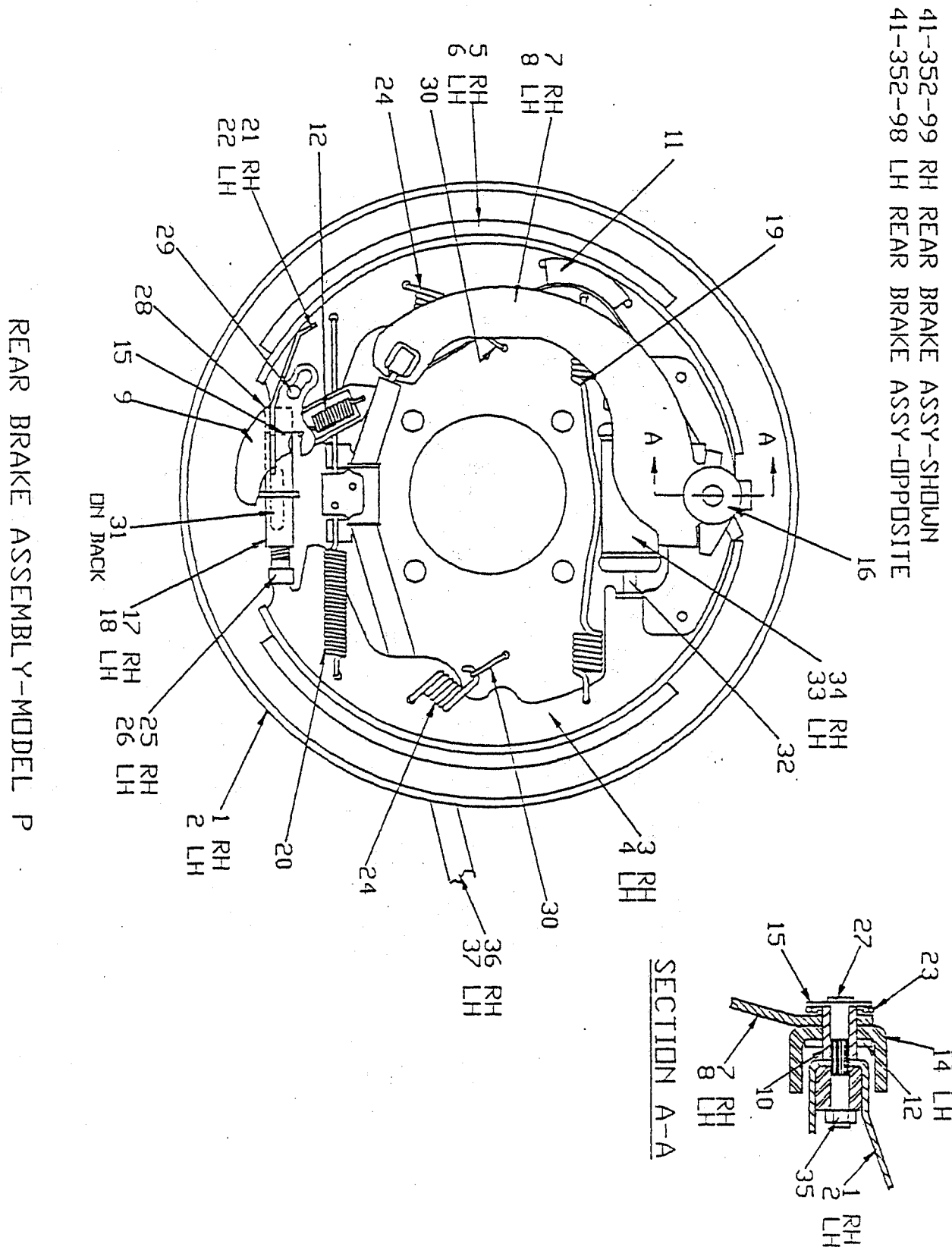
"FULL FLOATING" REAR AXLE - MOTOR AND BRAKES
FIGURE 5

FIG. I.D.	T-D PART NO.	DESCRIPTION	QTY.
5-50	10-262-00	TIRE, SOLID CUSHION 18 X 5 X 14 (SMOOTH)	2
5-50	10-263-00	TIRE, SOLID EXTRA CUSHION 21 X 5 X 15 (A.W.)	2
5-51	13-957-10	TIRE AND DEMOUNTABLE WHEEL 18 X 5 X 14 SOLID CUSHION TIRE	2
5-52	88-100-08	3/8 X 5/8 NC HEX HEAD CAP SCREW	1
5-53	88-108-62	3/8 LOCK WASHER	1
5-54	97-100-00	3/16 WOODRUFF KEY	1
5-55	88-080-09	5/16 X 3/4 NC HEX HEAD CAP SCREW	4
5-56	41-994-00	FILL AND DRAIN PLUG-SQUARE HEAD	1
5-57	41-885-00	FILL AND DRAIN PLUG-RECESSED HEAD-MAGNETIC	1
5-58	41-997-00	FILL AND DRAIN PLUG	2
5-59	88-150-12	1/2 X 1-1/8 NF HARDENED HEX HEAD CAP SCREW	12
5-75	41-682-00	BACKING PLATE MOUNTING BOLT	8
5-76	87-071-00	GREASE FITTING - 3/16 DRIVE TYPE	8
5-77	96-244-00	SHACKLE BOLT	8
5-78	32-213-00	NYLON BUSHING	8
5-79	16-870-10	SHACKLE STRAP WITH 21 X 5 X 15 TIRE	4
5-79	16-871-00	SHACKLE STRAP WITH 18 X 5 X 14 TIRE	4
5-79	16-873-00	SHACKLE STRAP	6
5-80	88-169-81	LOCK NUT - 9/16 IN NC (HEX)	8
5-81	88-527-11	COTTER PIN - 1/8 IN X 1 IN	8
5-82	88-088-62	5/16 LOCK WASHER	5
5-83	88-089-80	5/16 NC HEX HEAD NUT	5
5-84	88-268-61	7/8 SAE WASHER	1
5-85	88-279-81	7/8 NF HEX HEAD LOCK NUT	1
5-86	88-167-09	3/8 X 3/4 DOWEL PIN	2
5-87	88-080-20	5/16 X 3 NC HEX HEAD CAP SCREW	5
5-88	88-100-20	3/8 X 3 NC HEX HEAD CAP SCREW	3
5-89	88-108-62	3/8 LOCK WASHER	3
5-90	88-103-09	3/8 X 3/4 NC SOCKET, FLAT HEAD CAP SCREW	1
5-91	88-168-62	9/16 LOCK WASHER	8
5-92	88-179-81	9/16 NF HEX HEAD NUT	8
5-93	50-457-00	MOTOR ANCHOR STRAP - GE	1

"FULL FLOATING" REAR AXLE
SUGGESTED SPARE PARTS LIST

FIG. I.D.	T-D PART NO.	DESCRIPTION	QUANTITY OF 1-20 UNITS
5-4	41-150-00	AXLE, REAR	2
5-5	95-450-00	7/16 ID TAPERED DOWEL	16
5-6	45-043-00	GASKET, AXLE TO HUB	2
5-7	97-236-00	1/2 NF LUG NUT	16
5-16	45-337-00	HUB SEAL	2
5-17	12-225-10	HUB ASSEMBLY WITH DRUM BEARING RACE AND STUDS	1
5-18	45-041-00	GASKET	1
5-42	45-000-00	GEAR CASE GASKET	2
5-44	45-010-00	MOTOR GASKET	1
5-45	45-502-00	SHAFT OIL SEAL	1
5-46	70-061-00	MOTOR, 5 H.P., 2600 RPM, 36 VOLT	1
5-51	13-957-10	TIRE AND DEMOUNTABLE WHEEL 18 X 5 X 14	2
		SOLID CUSHION TIRE (TRACTOR WITH 18" ONLY)	
5-51	13-958910	TIRE AND DEMOUNTABLE WHEEL 21 X 5 X 15	2
		SOLID XTRA CUSHION TIRE (TRACTOR WITH 21" TIRE ONLY)	
5-56	41-885-00	FILL AND DRAIN PLUG-SQUARE HEAD	1
5-57	41-886-00	FILL AND DRAIN PLUG-RECESSED HEAD	1
5-58	41-997-00	FILL PLUG	2
5-61	41-669-00	SHOE, BRAKE, SET FOR TWO WHEELS	1
5-62	41-864-00	BRAKE ADJUSTMENT HOLE COVER	2
5-63	41-676-00	ANCHOR ROD BRAKE SHOE BACKING PLATE	4
5-64	41-677-00	RETAINER WASHER, BRAKE SHOE BACKING PLATE ANCHOR	8
5-65	85-070-00	SPRING BRAKE BACKING PLATE ANCHOR (FUCHSIA COLOR)	4
5-70	41-683-10	WHEEL CYLINDER PUSH ROD	4
5-71	99-502-99	WHEEL CYLINDER RIGHT SIDE	1
5-72	99-502-98	WHEEL CYLINDER LEFT SIDE	1
5-73	85-209-00	BOTTOM SHOE SPRING (BROWN COLOR)	2
5-74	85-211-10	TOP SHOE SPRING (RED COLOR)	4

FIGURE 5A REAR BRAKE ASSY - R.H. SHOWN



REAR BRAKE ASSEMBLY
41-352-98 LH, 41-352-99 RH
FIGURE 5A

FIG. I.D.	T-D PART NO.	DESCRIPTION	QTY.
5A-1	41-351-99	PLATE, BACK BRAKE 13 IN RH AXLE 60	1
5A-2	41-351-98	PLATE, BACK BRAKE 13 IN LH AXLE 60	1
5A-3	42-352-99	SHOE, BRAKE, PRI. RH AXLE 60	1
5A-4	42-352-98	SHOE, BRAKE, PRI. LH AXLE 60	1
5A-5	42-352-89	SHOE, BRAKE, SEC. RH AXLE 60	1
5A-6	42-352-88	SHOE, BRAKE, SEC. LH AXLE 60	1
5A-7	51-352-99	LEVER, PK. BRAKE RH, BENDIX AXLE 60	1
5A-8	51-352-98	LEVER, PK. BRAKE LH, BENDIX AXLE 60	1
5A-9	51-352-00	LEVER, BRAKE ADJ. BENDIX, AXLE 60	2
5A-10	32-352-00	BUSHING, BRAKE ANCHOR, AXLE 60	2
5A-11	27-352-00	GUIDE, CABLE, BENDIX, AXLE 60	2
5A-12	96-828-00	CABLE ASSEMBLY, 13 IN, AXLE 60	2
5A-13	42-351-99	CAM, PK. BRAKE, RH, BENDIX, AXLE 60	1
5A-14	42-351-98	CAM, PK. BRAKE, LH, BENDIX, AXLE 60	1
5A-15	97-352-00	WASHER, BRAKE ADJ., BENDIX, AXLE 60	2
5A-16	97-352-10	WASHER, BRAKE ANCHOR, AXLE 60	2
5A-17	97-352-99	NUT, BRAKE ADJ., RH, BENDIX, AXLE 60	1
5A-18	97-352-98	NUT, BRAKE ADJ., LH, BENDIX, AXLE 60	2
5A-19	85-211-10	SPRING, EXT., TOP, BROWN, AXLE 60	2
5A-20	85-209-10	SPRING, EXT., BOTTOM, BROWN, AXLE 60	2
5A-21	85-352-00	SPRING, TORSION, BLACK, AXLE 60	1
5A-22	85-352-10	SPRING, TORSION, YELLOW, AXLE 60	1
5A-23	85-352-20	SPRING, COMPRESSION, BLACK, AXLE 60	1
5A-24	85-352-30	SPRING, TORSION, RED, AXLE 60	4
5A-25	96-352-99	SCREW, BRAKE ADJ., RH, BENDIX, AXLE 60	1
5A-26	96-352-98	SCREW, BRAKE ADJ., LH, BENDIX, AXLE 60	1
5A-27	96-000-10	BOLT, BRAKE ANCHOR, AXLE 60	2
5A-28	41-678-10	SOCKET, BRAKE ADJ., BENDIX, AXLE 60	2
5A-29	41-352-00	PIN, BRAKE ADJUSTER, BENDIX, AXLE 60	1
5A-30	41-352-10	PIN, BRAKE SHOE HOLD DOWN, AXLE 60	4
5A-31	41-684-10	COVER, ADJ. HOLE, BENDIX, AXLE 60	2
5A-32	41-683-10	ROD, WHEEL CYLINDER, BENDIX, AXLE 60	4
5A-33	99-502-98	WHEEL CYLINDER, LH, BENDIX, AXLE 60	1
5A-34	99-502-99	WHEEL CYLINDER, RH, BENDIX, AXLE 60	1
5A-35	88-079-85	1/4 NF LOCK NUT	2
5A-36	96-286-13	CABLE, HAND PARK BRAKE, RH	1
5A-37	96-827-13	CABLE, HAND PARK BRAKE, LH	1

MOTOR MAINTENANCE, SERVICE AND ADJUSTMENT
ELECTRIC MOTORS
REFER TO FIGURE 5H

Detailed service procedures covering maintenance of bearing brushes and commutator are covered in this section. DO NOT PERFORM THIS WHILE BATTERIES ARE BEING CHARGED.

Maintenance of electric motors should be referred to personnel with experience and equipment. Should it be necessary for you to order replacement parts for your motor, IT IS NECESSARY TO INCLUDE COMPLETE NAMEPLATE DATA WITH ORDER.

MOTOR MAINTENANCE - BRUSH INSPECTION AND REPLACEMENT

1. Remove cover, exposing brush assemblies. Lift brush from holder for inspection.
2. If brushes are worn, remove, install new brushes. Use fine sandpaper to "Seat in" new brushes to commutator. To determine when to replace worn brushes, proceed as follows:
 - a. For motors equipped with brushes having end pigtails and side hooks, replace brush when hook is within 1/16" from bottom of hook slot.
 - b. For motors equipped with brushes having side pigtails only, replace brush when pigtail is within 1/16" from bottom of pigtail slot.

NOTE: When one brush is replaced in a motor, it is considered good maintenance practice to replace all brushes.

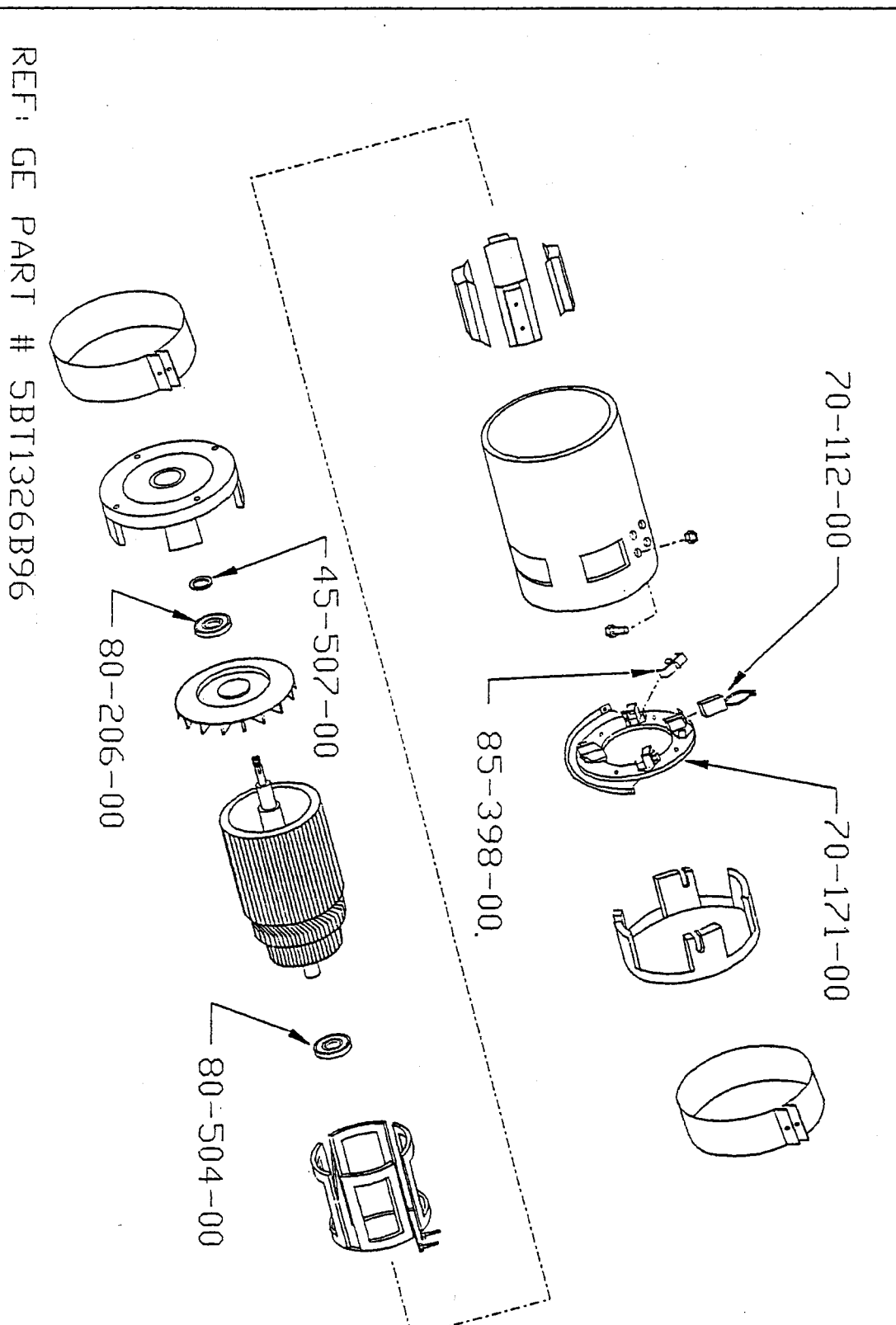
3. Check operation of each brush to assure that brush slides freely and does not bind in holder.
4. Replace cover.

MOTOR DISASSEMBLY AND REASSEMBLY

1. Remove motor from vehicle as described in Section 11.
2. Determine if witness marks on end bell and stator housing are present. If not, mark end bell and housing to assure proper relation of brushes and commutator when reassembling.
3. Remove cover, exposing brush assemblies. Lift brushes from brush holder.
4. Remove bolts holding end bells and remove end bell and rotor. (Pull from shaft extension end). Take care not to damage any coils or armature wires when handling motor parts.
5. Press or pull old bearings off by using bearing press or bearing puller. Do not damage shaft while removing bearings.
6. Install new bearings on to shaft by gentle pressure or tapping with proper tool on inner race only. Bearing will be damaged if pressed or driven by outer race or seals.
7. If the commutator is worn or "burned" it should be turned, the mica undercut and the commutator polished.
8. Oil bearing housing lightly to aid in reassembly.
9. Reassemble motor taking care that all parts are kept clean.
10. Install brushes and "seat in" with fine sandpaper.
11. Check operation of each brush to assure that brush slides freely in holder.
12. Replace cover.
13. Reassemble to vehicle as described in preceding subsection.

NOTE: If motor terminal studs were removed for inspection, refer to Section 11, Disassembly of Motor for Minor Repairs, Item 13, for correct procedure to avoid damaging studs.

DRAWING - MOTOR PARTS - GE MOTORS



ELECTRIC MOTORS

For D.C motor replacement parts, IT IS NECESSARY TO INCLUDE COMPLETE MOTOR NAME PLATE DATA WITH THE ORDER.

FIG. I.D.	PART NO.	DESCRIPTION	QTY.
		REPLACEMENT PARTS FOR 70-061-00, G.E. MOTOR 5BT1326B96	
		10/15 HP 24/36 VOLTS 1800/2800 RPM	
	80-504-00	BALL BEARING COMMUTATOR END	1
	80-206-00	BALL BEARING, SHAFT END	1
	70-171-00	BRUSH HOLDER ASSEMBLY	1
	70-112-00	DUAL MOTOR BRUSH, ONE TERMINAL	4
	85-398-00	BRUSH SPRING	8
	45-507-00	OIL SEAL	1

MAINTENANCE PROCEDURES
REFER TO FIGURE 6 AND 7
HYDRAULIC BRAKE SYSTEM

Your hydraulic brake system consists of an automotive master cylinder, located under the left front floorboard. It is operated by the brake foot pedal and control linkage.

Each rear wheel is fitted with a 12" brake assembly; and rugged brake drum. On 4 wheel brake models the front wheels are equipped with 7" brake assembly.

Refer to Maintenance Guide Section 4 and Lubrication Diagram Section 5 for proper lubrication and frequency of inspection.

Master cylinder fluid level should be checked monthly. Add fluid as needed to maintain level $3/8$ " to $1/2$ " from top of fill port. Use only approved hydraulic brake fluid.

A visual inspection of the hydraulic system is recommended on a monthly basis to detect any signs of leakage. Repairs should be made immediately if leakage is discovered.

A spongy action on brake pedal or a low engagement point on pedal usually indicates air entrapment or the need of shoe adjustment. Refer to Service and Adjustment Section 13 of this manual for proper procedures to follow.

SERVICE AND ADJUSTMENT
REFER TO FIGURE 6
HYDRAULIC BRAKE SYSTEM

The loss of brake pedal action may be due to a defective master cylinder. It can usually be detected by signs of fluid leakage at the master cylinder or by the action of the brake pedal. When foot pedal pressure is applied you will feel the brakes engage, yet, the pedal will continue to travel downward. A ruptured hydraulic line or a defective wheel cylinder will product the same action. You can determine the cause by the location of brake fluid leakage.

MASTER CYLINDER REPAIR OR REPLACE

1. Remove cotter pin, clevis pin, and remove push rod. (It will slide out of master cylinder socket.)
2. Disconnect hydraulic line at cylinder (There will be 2 lines of 4 wheel brake system).
3. Remove 2 holding bolts and lift master cylinder out of chassis.
4. Cylinder should be thoroughly cleaned.
5. Remove boot and locking ring.
NOTE: Piston parts are under spring pressure, take care that they do not pop out when you remove lock ring.
6. Remove piston and cup assembly.
7. Inspect cylinder wall. If scoring or roughness is present it must be removed with a fine hone.
8. Taking care that all parts are kept clean, install new piston and cup assembly kit. A diagram is furnished with each kit. It is also recommended that parts are coated with a small amount of brake fluid prior to assembly.
9. Replace lock ring and boot.
10. Install cylinder in chassis in reverse order to which it was removed.
11. **ADJUST** push rod by loosening and shortening or lengthening the rod so that when brake pedal is fully raised the push rod should be within 1/16" of contacting piston socket. A good way to be certain is to remove clevis pin. While lightly holding rod against socket (DO NOT PUSH HARD ENOUGH TO MOVE PISTON) observe the alignment of clevis and hole. When correct you will have to pull rod approximately 1/16" out of socket to insert clevis pin.
12. Tighten locknut and install cotter pin.

BLEED AIR FROM BRAKE SYSTEM

NOTE: Anytime that any part of the hydraulic system is disconnected or replaced, it is necessary to bleed air from system.

If fluid level is allowed to fall to low in master cylinder reservoir, air will be pumped into system. Consequently the system will have to be bled to remove air. To bleed air from system, follow procedure outlined next.

1. For the best results brake shoes should be properly adjusted prior to bleeding system. Refer to Adjustment Section 13 of this manual.
2. Fill master cylinder to top with approved brake fluid or, if available, attach brake bleeder tank to master cylinder.
3. When using bleeder tank, loosen air bleeder valve (located at each wheel cylinder), one at a time. Allow fluid to flow until air pockets and bubbles stop and a clear stream appears.

SERVICE AND ADJUSTMENT
REFER TO FIGURE 6

BLEED AIR FROM BRAKE SYSTEM continued

3. Alternate: It is necessary to utilize 2 people to bleed brake system when bleeder tank is not available. One person will operate brake pedal and add fluid to master cylinder as needed. The other person will operate bleeder valves. While one person applies brake pedal pressure, loosen bleeder valve. Fluid and air will be forced out on the downward stroke of the pedal. Person operating pedal must hold it down at the end of its stroke while the other person closes bleeder valve. If pedal is raised while bleeder valve is open, air will be drawn back into the system. By coordinating the movements of the 2 people, air will be bled out on each downward stroke of the pedal. It is wise to refill master cylinder after every 3 or 4 strokes to insure against any air being drawn in because of the reservoir level being too low. Usually 2 to 4 strokes per wheel cylinder is sufficient to remove air from system.
4. Remove brake bleeder tank if used. Fill master cylinder $3/8$ " to $1/2$ " of top and replace cover.

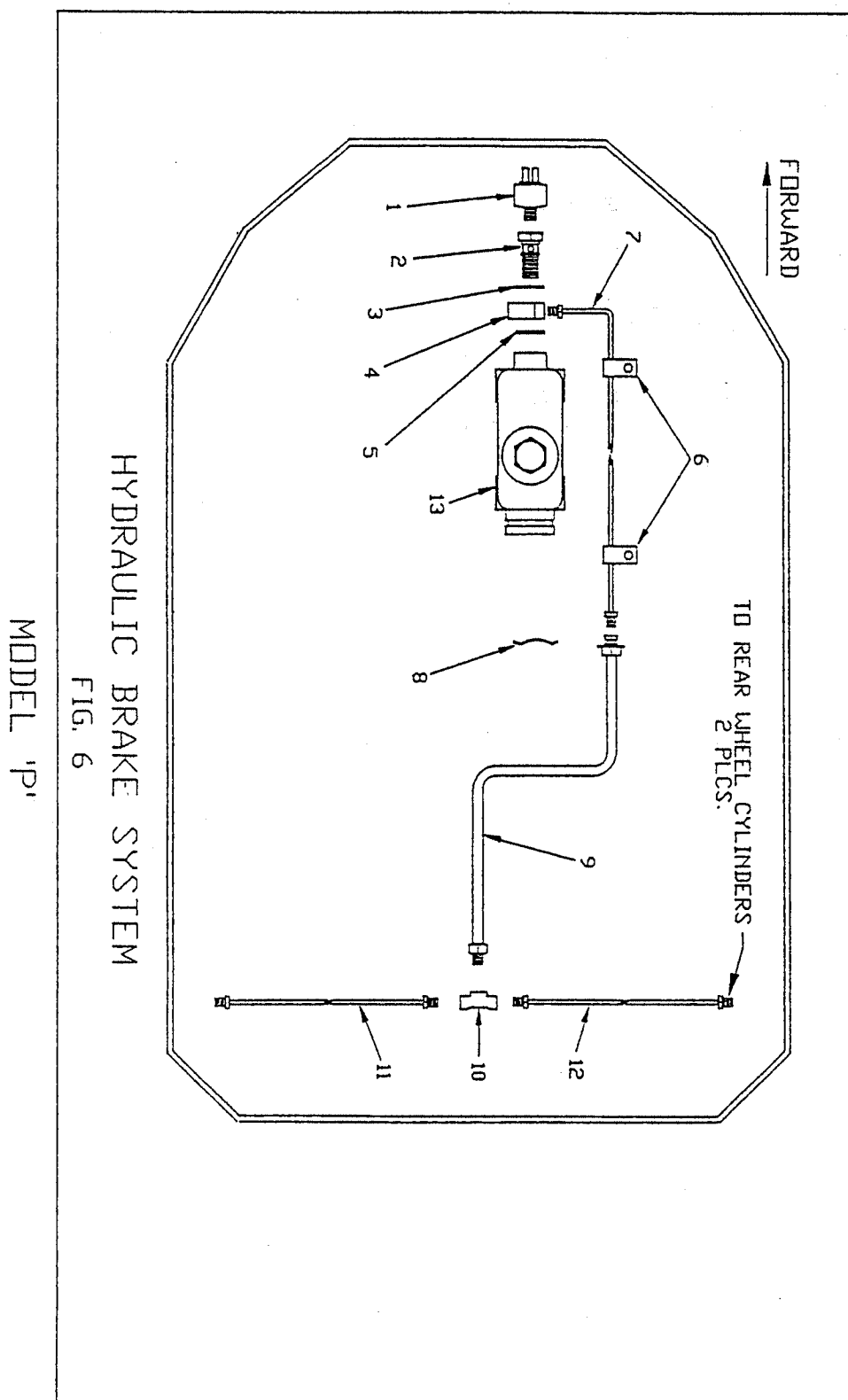
REPLACING WHEEL CYLINDERS OR BRAKE SHOES

1. Remove wheel lugs, wheel and brake drum.
2. Unhook springs and remove brake shoes. Brake shoes should be replaced when lining is worn to rivet heads.
3. To remove wheel cylinder, disconnect hydraulic line.
4. Remove 2 wheel cylinder bolts from backing plate and remove wheel cylinder.
5. If installing replacement kit, clean wheel cylinder thoroughly.
6. Remove dust caps and piston parts.
7. Examine cylinder walls. If scored or rough, remove with fine hone.
8. Install new kit assembly.
9. Replace wheel cylinder and brake shoes in reverse order to which they were removed.
10. Replace brake drum. (If brake drum is badly scored, replace with new one).
11. Replace wheel.
12. Adjust brake shoes and bleed hydraulic system.

ADJUST BRAKE SHOES (REFER TO FIGURE 5A)

1. Jack wheels clear of floor.
2. Remove adjusting hole covers.
3. Insert screwdriver or special adjusting tool in slot of backing plate to engage star wheel adjusting screw.
4. Move outer end of tool toward axle, expanding brake shoes to a point where the wheel drags heavily.
5. Then back off by turning adjustment star in opposite direction slightly until wheel is just free of drag.
6. Repeat procedure on opposite wheel.
7. Depress brake pedal several times and check to be sure wheel still revolves free of drag and desired pedal travel is obtained.
8. If wheel drags, repeat adjustments as previously outlined, until satisfactory results are obtained.
9. If wheel (or wheels) are free of drag, but pedal has too much travel, check adjustments as previously outlined. If necessary, bleed hydraulic system.

DRAWING - HYDRAULIC BRAKE SYSTEM - MODEL P



HYDRAULIC BRAKE SYSTEM
REFER TO FIGURE 6

FIG. I.D.	PART NO.	DESCRIPTION	QTY.
6-1	71-110-00	SWITCH, BRAKE LIGHT, HYDRAULIC	1
6-2	99-578-00	BOLT, STOP LIGHT	1
6-3	99-572-00	WASHER, WAGNER FC 603	1
6-4	99-566-00	FITTING, STRAIGHT	1
6-5	99-571-00	WASHER, WAGNER FC 602	1
6-6	96-624-00	CLAMP, WIRE 1/4"	2
6-7	99-609-00	BRAKE LINE, STL 3/16" X 72"	1
6-8	99-576-00	CLIP, WAGNER FC 3052	1
6-9	99-580-00	HOSE, FLEXIBLE	1
6-10	99-563-00	FITTING	1
6-11	99-605-62	BRAKE LINE, STL 3/16" LH	1
6-12	99-605-63	BRAKE LINE, STL 3/16" RH	1
6-13	99-510-00	MASTER CYLINDER	1
6-14	99-510-61	KIT, MASTER CYLINDER REPAIR, NOT SHOWN	1

MAINTENANCE PROCEDURES
REFER TO FIGURE 7
MECHANICAL CONTROL LINKAGE

The mechanical control linkage operates the various controls and mechanisms located throughout your vehicle.

The accelerator system consists of the operating pedal and pivot shaft assembly, the connecting rods and adjusters and the return spring. All wear points should be lubricated monthly for normal service. Refer to Maintenance Guide Section 4 and Lubrication Diagram Section 5 for proper application of lubricants.

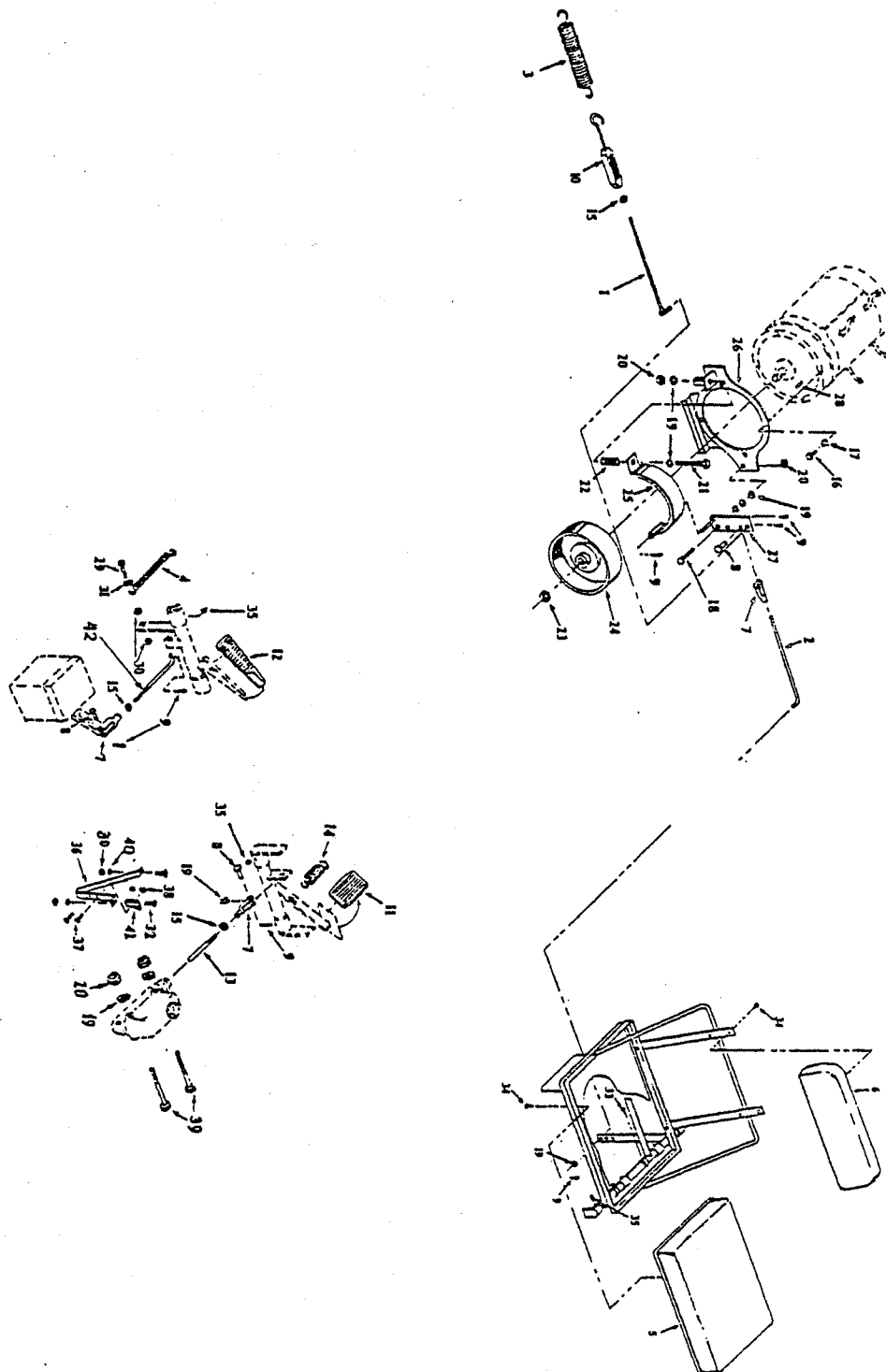
The footbrake system consists of the foot pedal, pivot shaft, the return spring, and the master cylinder and push rod assembly.

The automatic deadman brake system consists of the pivoted seat assembly. The operating cable or rods. The brake apply spring, adjustable tension device and its connecting linkage.

All wear points should be lubricated monthly. Refer to Maintenance Guide Section 4 and Lubrication Diagram Section 5 for proper application of lubricants.

For service and adjustments refer to the following sections:

- SECTION 11 - For mechanical brake or "deadman" brake service and adjustments.
- SECTION 12 - For Master cylinder and push rod adjustments and service.
- SECTION 15 - For accelerator service and adjustments.



MECHANICAL CONTROL LINKAGE
FIG. 7
MODEL 'P'

MECHANICAL CONTROL LINKAGE
FIGURE 7

FIG. I.D.	PART NO.	DESCRIPTION	QTY.
7-1	50-024-00	3/8 ROD WITH SPECIAL PIN 8-1/2" LONG	1
7-2	50-023-00	3/8 ROD 11-1/2" LONG PLUS 1" BEND	1
7-3	85-280-00	SPRING DEADMAN BRAKE RETURN	1
7-4	85-295-00	SPRING ACCELERATOR RETURN	1
7-5	90-001-00	SEAT CUSHION	1
7-6	90-000-00	SEAT BACKREST	1
7-7	96-762-00	3/8 CLEVICE	3
7-8	96-772-00	3/8 CLEVICE PIN	3
7-9	88-527-11	1/8 X 1 COTTER PIN	7
7-10	96-926-00	TURNBUCKLE	1
7-11	98-200-00	PAD, RUBBER BRAKE PEDAL	1
7-12	98-254-00	PAD, ACCELERATOR PEDAL	1
7-13	50-009-00	MASTER CYLINDER PUSH ROD	1
7-14	85-270-00	BRAKE RETURN SPRING	1
7-15	88-119-80	3/8 NF HEX HEAD NUT	3
7-16	88-100-11	3/8 X 1 NC HEX HEAD CAP SCREW	4
7-17	88-108-62	3/8 LOCK WASHER	4
7-18	88-100-13	3/8 X 1-1/4 NC HEX HEAD CAP SCREW	1
7-19	88-108-60	3/8 CUT WASHER	10
7-20	88-109-81	3/8 NC LOCK NUT	4
7-21	88-100-24	3/8 X 4 NC HEX HEAD CAP SCREW	1
7-22	85-060-00	SPRING	1
7-23	88-239-82	3/4 NF JAM NUT	1
7-24	41-250-10	BRAKE DRUM	1
7-25	41-650-00	BRAKE BAND	1
7-26	01-202-80	BRAKE MOUNTING PLATE	1
7-27	42-001-51	BRAKE CAM	1
7-28	97-100-00	3/16 WOODRUFF KEY	1
7-29	88-060-11	1/4 X 1 NC HEX HEAD CAP SCREW	2
7-30	88-069-80	1/4 NC HEX HEAD NUT	4
7-31	88-068-60	1/4 CUT WASHER	3
7-32	88-065-09	1/4 X 3/4 MACHINE SCREW TRUSS HEAD	2
7-33	88-067-11	1/4 X 1 THUMB SCREW	2
7-34	88-837-09	#14 X 3/4 PHILLIPS PAN HEAD SHEET METAL SCREW	8
7-35	87-071-00	ZERK GREASE FITTING	8
7-36	71-609-00	BRACKET - MICRO SWITCH BRAKE PEDAL INTELOCK	1
7-37	88-014-13	ROUND HEAD MACHINE SCREW 6-32 X 1-1/4	2
7-38	88-019-80	NUT 6-32 (HEX)	2
7-39	88-100-20	HEX HEAD CAP SCREW 3/8" NC X 3	2
7-40	88-068-62	LOCK WASHER 1/4"	2
7-41	71-130-00	MICRO SWITCH (STANDARD)	1
7-42	50-015-00	ACCELERATOR ROD - 3/8" X 3-3/4" LONG PLUS BEND	1

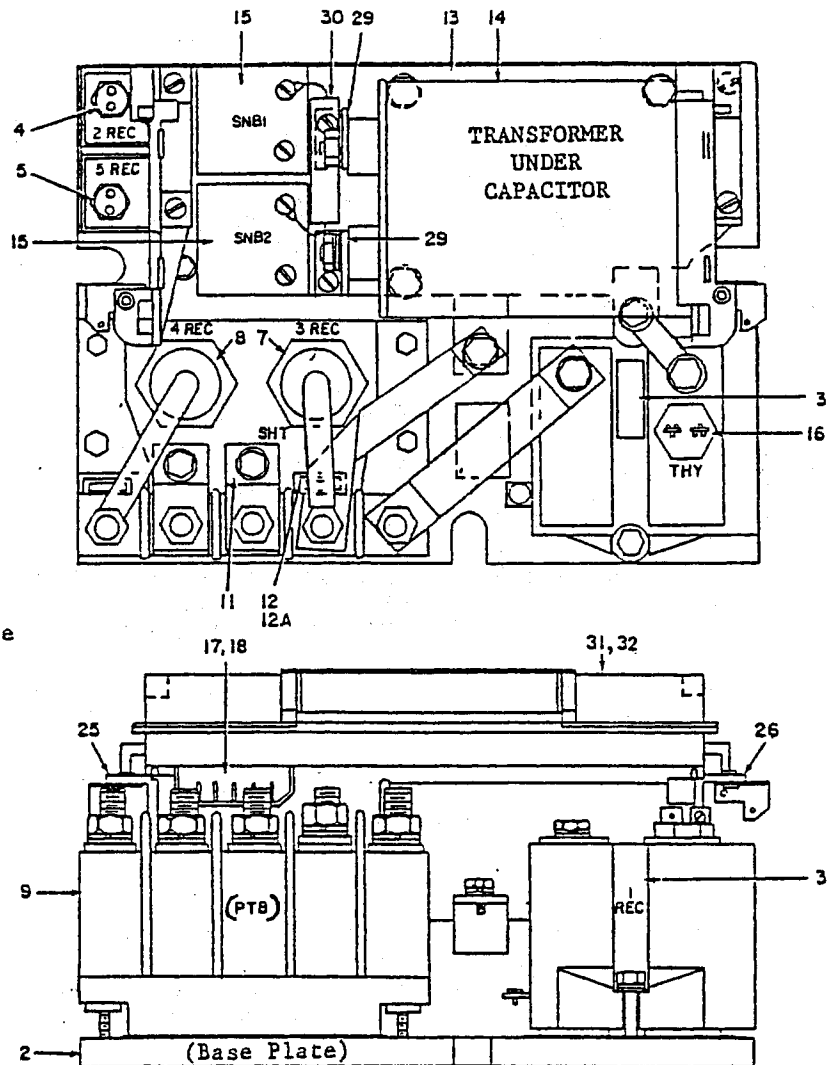
EV-1 SYSTEM AND INSTRUMENT PANEL

GENERAL:

The EV-1 is a General Electric speed control system. It consists of an SCR control, contactor panel and accelerator switch. This vehicle is furnished with an EV-1B system. A General Electric service booklet "EV-1 SCR CONTROL FOR ELECTRIC VEHICLES" is furnished as an enclosure to this chapter.

1. The control unit (part no. 62-011-00) is located at the rear of the vehicle.
2. The contactor panel (part no. 71-305-00) is located next to the control unit, at the rear of the vehicle.
3. The accelerator switch (part no. 61-912-00) is located under the floor board.
4. All circuit breakers (100 AMP, double pole, part no. 79-843-00, 1 required, 79-843-11, 100 AMP, triple pole, 1 required, and part no. 79-842-00, 10 AMP, single pole, 5 required) are at the rear of the vehicle.

DRAWING EV-1B SCR CONTROL MODULE
FIGURE 1



NOTE: Use heat conductive grease, T-D Part #94-422-00, under all mated assemblies that mount to the base except the power block (PTB).

NOTE: Apply a thin coating of heat conductive grease T-D Part #94-422-00 to the bottom of the Control Module (Base Plate) before mounting Module on vehicle.

EV-1 SCR CONTROL MODULE "B"
REFER TO FIGURE 1

FIG. I.D.	T-D PART	DESCRIPTION	QTY.
	62-011-00	EV-1 SCR CONTROL MODULE - "B"	1
1-3	62-011-51	RECTIFIER ASSEMBLY, (1 REC)	1
1-4	62-011-52	RECTIFIER ASSEMBLY, (2 REC)	1
1-5	62-002-54	RECTIFIER ASSEMBLY, (5 REC)	1
1-7	62-011-53	RECTIFIER ASSEMBLY, (3 REC)	1
1-8	62-011-54	RECTIFIER ASSEMBLY, (4 REC)	1
1-9	62-002-58	TERMINAL BLOCK ASSEMBLY	1
1-11	62-011-55	SHUNT ASSEMBLY	1
1-12, 12A	62-002-60	CAPACITOR	1
1-13	62-011-56	TRANSFORMER	1
1-14	62-002-62	CAPACITOR, COMMUTATING 200 VOLT	1
1-15	62-002-63	SNUBBER ASSEMBLY	2
1-16	62-002-64	THERMAL PROTECTOR	1
1-17	62-002-65	CONTROL THERMAL BLOCK	1
1-18	62-002-66	COVER, TERMINAL BLOCK	1
1-25	62-002-67	SUPPORT, CARD BOX (LEFT HAND)	1
1-26	62-002-68	SUPPORT, CARD BOX (RIGHT HAND)	1
1-29	62-002-69	BUS	2
1-30	62-002-70	RESISTOR	1
1-32	62-002-52	CARD ASSEMBLY W/O FIELD WEAKENING SERIAL #IC36450SCC1D3	1
	94-422-00	GREASE, HEAT SINK	

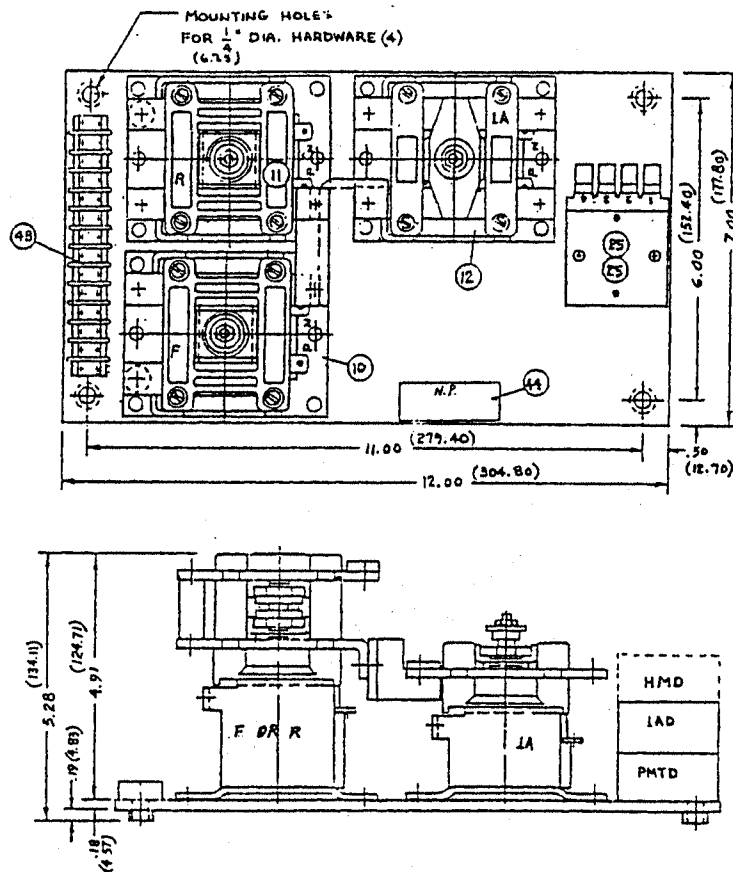
NOTE: When installing the EV-1B control module (part no. 62-011-00) it is necessary to fine tune the pot settings:

CREEP	C/A	C/L	1A TIME	1A DO	PLUG	FW PU	FW DO
5.5	5	9	5	3.8	4.4	5	5

(See Table 6 on page 22 of EV-1 handbook)

Refer to EV-1 handbook in this chapter for functional description and trouble shooting of your control module.

EV-1 SYSTEM AND INSTRUMENT PANEL



NOTE: MOUNTING HARDWARE
MUST NOT PROTRUDE
MORE THAN .19" (4.83)
BEYOND BACK OF PANEL.

DIMENSIONS IN ()
ARE MILLIMETERS.

FIGURE 2
EV-1 SCR 150 AMP 24/36/48 VOLT
CONTACTOR PANEL

FIG. I.D.	PART NO.	DESCRIPTION	QTY.
2-0	71-305-00	CONTACTOR PANEL ASSEMBLY	1
2-10	71-305-70	CONTACTOR, FWD., SINGLE POLE, DOUBLE THROW	1
2-11	71-305-80	CONTACTOR, REV., SINGLE POLE, DOUBLE THROW	1
2-12	71-305-90	CONTACTOR, 1A., SINGLE POLE, SINGLE THROW	1
2-25	71-305-54	CONTACTOR DRIVER	2
NOT SHOWN	79-731-00	HOURLY METER DIODE BLOCK (OPTIONAL)	1
2-44	71-305-55	NAMEPLATE (SPECIAL ORDER ITEM)	1
2-48	71-305-56	TERMINAL BOARD, 12 POSITION	1

EV-1 SYSTEM AND INSTRUMENT PANEL

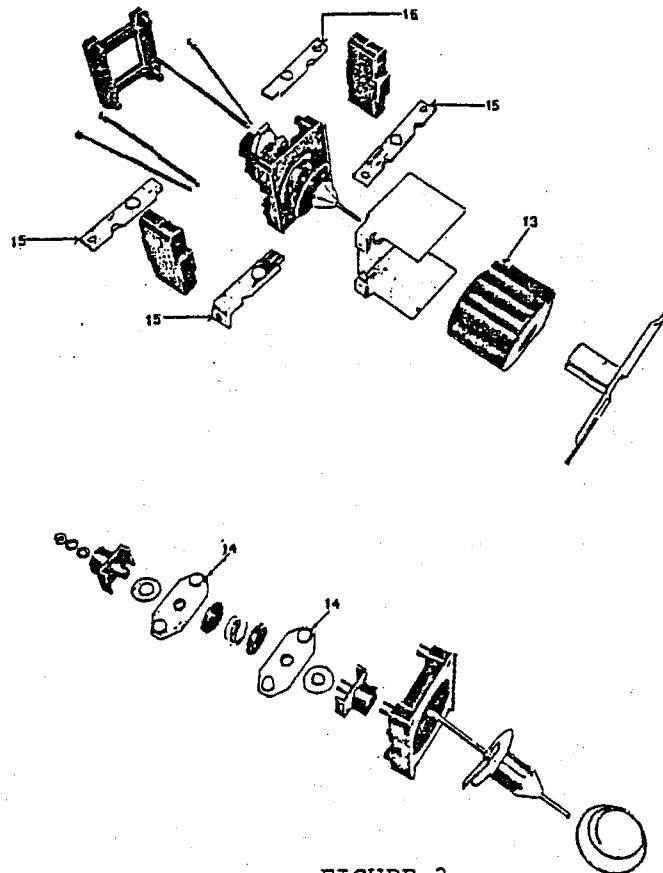


FIGURE 3

EV-1 SCR 150 AMP-24/36/48 VOLT CONTACTOR UNIT

FIG. I.D.	PART NO.	DESCRIPTION	QTY.
FWD/REV CONTACTOR COMMON PARTS (EXCEPT AS NOTED)			
3-13	71-305-71	COIL, 36/48 VOLT, FWD/REV CONTACTORS	2
3-13	71-305-72	COIL, 24 VOLT, FWD/REV CONTACTORS (OPTIONAL)	2
3-14	71-305-73	MOVING TIP ASSEMBLY, FWD/REV CONTACTORS	2
NOT SHOWN	71-305-79	SPACER, FWD/REV CONTACTORS	2
NOT SHOWN	71-305-78	MOUNTING BOLT, SPACER, FWD/REV CONTACTORS	2
FORWARD CONTACTOR			
3-15	71-305-74	TERMINAL, L.H. TOP, FWD CONTACTOR	1
3-15	71-305-75	TERMINAL, R.H. TOP, FWD CONTACTOR	1
3-15	71-305-76	TERMINAL, L.H. BOTTOM, FWD. CONTACTOR	1
3-15	71-305-77	TERMINAL, R.H. BOTTOM, FWD. CONTACTOR	1
REVERSE CONTACTOR			
3-15	71-305-75	TERMINAL, L.H. TOP, REVERSE CONTACTOR	1
3-15	71-305-81	TERMINAL, R.H. TOP, REVERSE CONTACTOR	1
3-15	71-305-82	TERMINAL, L.H. BOTTOM, REVERSE CONTACTOR	1
3-15	71-305-83	TERMIANL, R.H. BOTTOM, REVERSE CONTACTOR	1
1A CONTACTOR			
3-13	71-305-91	COIL, 36/48 VOLT, 1A CONTACTOR	1
3-13	71-305-92	COIL, 24 VOLT, 1A CONTACTOR (OPTIONAL)	1
3-15	71-305-93	TERMINAL, L.H., 1A CONTACTOR	1
3-15	71-305-94	TERMINAL, R.H., 1A CONTACTOR	1
3-14	71-305-95	MOVING TIP ASSEMBLY, FWD/REV CONTACTOR	1

SERVICE AND ADJUSTMENT
EV-1 FORWARD/REVERSE SWITCH (LOCATED ON STEERING COLUMN)
REFER TO FIGURE 3A

CAUTION: Whenever service work is to be conducted on the switch or any part of the vehicle wiring system, disconnect the positive lead at the battery or unplug power leads on vehicles so equipped.

REPLACEMENT OF MICROSWITCHES

1. Remove (1) screw from center of handle and hub assembly. Remove handle and hub assembly from cover.
2. Remove (2) screws attaching cover to frame. Remove cover from frame.
3. Carefully note the position of wires and mark their respective locations.
4. Remove switch terminal screws and wires.
5. Remove (2) screws attaching switch to frame assembly.
6. Install new switch, replacing screws and wires in reverse order. Switch position retaining screws should be snug, not tight, for the moment.
7. With switch roller riding on top of cam lobe, insure that .010" clearance exist between roller arms and switch body, and tighten switch retaining screws.
8. Ensure that replaced switch operates correctly in "NC" and "NO" positions.
9. Check adjoining switch for correct adjustment.
10. Replace cover and handle assembly in reverse order.
11. Check for proper operation.

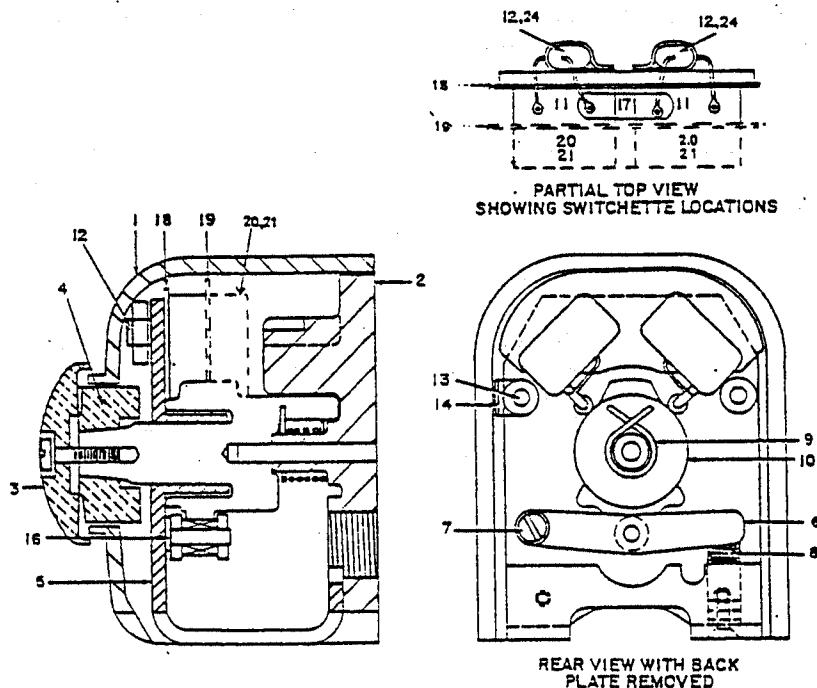


FIGURE 3A

FORWARD/REVERSE SWITCH
EV-1 SCR CONTROL
REFER TO FIGURE 3A

FIG. I.D.	PART NO.	DESCRIPTION	QTY.
3-0	71-091-00	FORWARD / REVERSE SWITCH	1
3-1	71-091-51	COVER	1
3-2	71-091-52	BACK PLATE	1
3-3	71-091-53	HANDLE AND HUB ASSEMBLY	1
3-4	71-091-54	STOP	1
3-6	71-091-56	CAM FOLLOWER	1
3-7	71-091-57	SPACER	1
3-8	71-091-58	SPRING FOR CAM FOLLOWER	1
3-10	71-091-59	STAR WHEEL CAM	1
3-11	71-091-60	SWITCH, FORWARD & REVERSE	2
3-12	71-091-61	CAPACITOR ASSEMBLY	2
3-13	71-091-62	SPACER	2
3-14	71-091-63	WIRE CLIP	1
3-16	71-091-65	WASHER	1
3-17	71-091-66	JUMPER	1
3-18	71-091-67	INSULATION	1
3-19	71-091-68	INSULATION (OPTIONAL)	1
3-20	71-091-60	SWITCH (OPTIONAL), FOR SPECIAL ORDER ACCESSORIES	1
3-21	71-091-70	SWITCH (OPTIONAL), FOR SPECIAL ORDER ACCESSORIES	1
NOT SHOWN	71-091-71	STEERING COLUMN MOUNTING CLAMP	1
3-24	71-091-72	CAPACITOR CLAMP	2

NOTE: Standard hardware items listed below are not normally stocked by Taylor-Dunn but can be purchased locally.

SCREWS

10-32 5/8 flat head	4-40, 1/4" pan head
4-40, 3/4" pan head	4-40, 1-1/4" pan head
4-40, 1-3/4" pan head	6-32, 3/4" pan head
8-32, 3/4" pan head	8-32, 7/8" pan head
10-32, 1/2" pan head	10-32, 2-1/2" pan head

LOCK WASHERS

PLAIN WASHERS

NUTS

For #4 screw
For #8 screw
For #10 screw

For #4 screw
For #8 screw

4-40 hex
10-32 hex

EV-1 SYSTEM AND INSTRUMENT PANEL

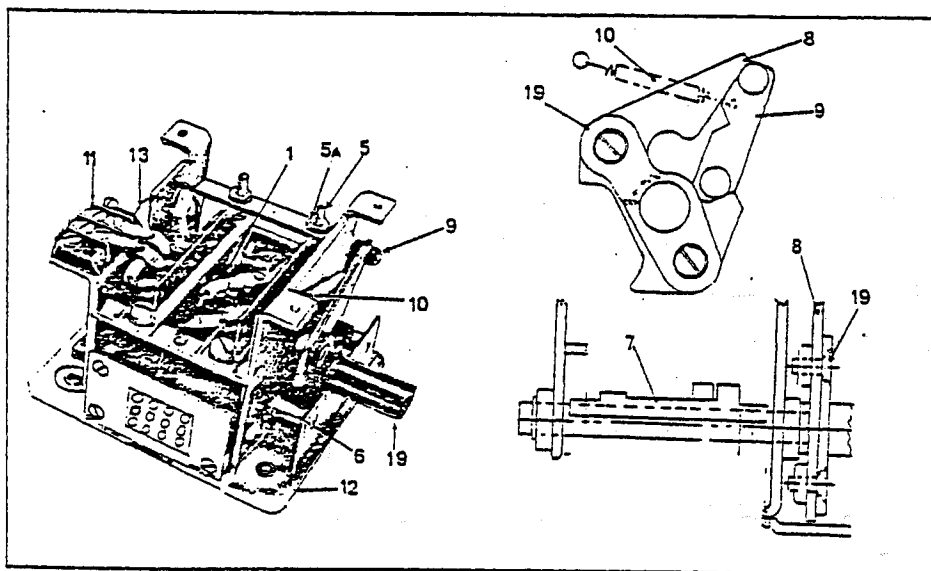


FIGURE 4, EV-1 ACCELERATOR SWITCH

FIG. I.D.	T-D PART	DESCRIPTION	QTY.
4-0	61-912-00	ACCELERATOR SWITCH COMPLETE	1
4-1	61-912-51	SWITCH ASSEMBLY	2
4-5	61-912-55	SCREW, ADJUSTING FOR SWITCH	2
4-5A	88-049-80	NUT, HEX 10-32	2
4-6	61-912-57	STOP	1
4-7	61-912-58	CAM	1
4-8	61-912-59	CAM SHAFT ASSEMBLY	1
4-9	61-912-60	POTENTIOMETER OPERATING ARM & SHAFT	1
4-10	61-912-61	SPRING, RETURN	1
4-11	61-912-62	TERMINAL BOARD	1
4-12	61-912-63	SWITCH SUPPORT BASE	1
4-13	61-912-64	POTENTIOMETER 5K, W/MOUNTING BRACKET	1
4-19	61-912-71	SHAFT ASSEMBLY	1

NOT SHOWN

61-912-66	HOSE	1
61-912-67	CLAMPS, HOSE	2
61-912-68	COVER	1
61-912-69	PLATE, COVER	1
61-912-70	PLUG, RUBBER (FITS IN COVER PLATE)	1

NOTE: The standard hardware items listed below are not normally stocked by Taylor-Dunn but can be purchased locally.

SCREW WITH SPRING LOCK WASHER

6-32, 1/2" PAN HEAD
8-32, 3/8" PAN HEAD

AIN WASHERS

SCREW
CREW
SCREW

SCREWS

6-32, 3/8" FLAT HEAD
10-32, 1/2" FLAT HEAD

FLAT HEAD LOCK WASHER

10-32 SCREW

RETAINING RING

EXTERNAL "E" RING FOR 1/4" DIAMETER SHAFT
EXTERNAL "E" RING FOR 3/8" DIAMETER SHAFT

EV-1 SYSTEM AND INSTRUMENT PANEL

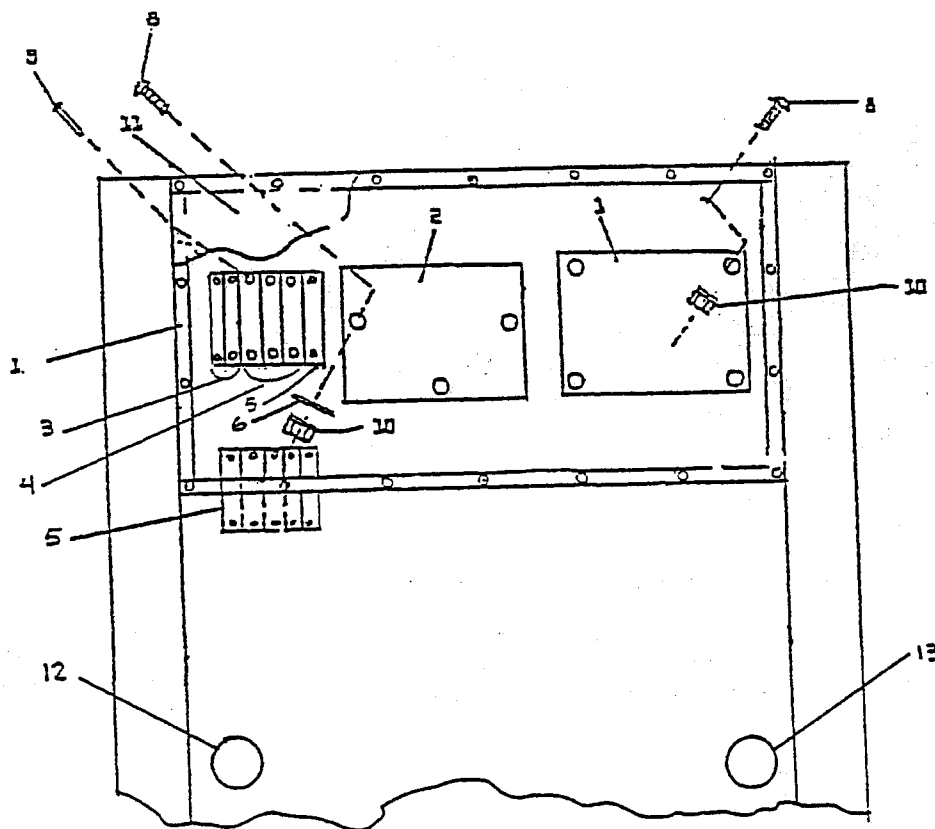


FIGURE 5

EV-1 COMPARTMENT

REAR OF VEHICLE WITH INSPECTION PANEL (ITEM 11) REMOVED

ITEM NO.	PART NO.	DESCRIPTION	QTY.
5-1	71-305-00	CONT. PNL. ASSY, 150A 36/48V 171CZ41562	1
5-2	62-011-00	EVB-1C3645SCRIH3BOXAAE PANEL	1
5-3	79-843-00	BREAKER, CIRCUIT 100 AMP DP	1
5-4	79-843-11	BREAKER, CIRCUIT 100 AMP TP	1
5-5	79-842-00	BREAKER, CIRCUIT 10 AMP	5
5-6	88-068-62	WASHER, 1/4 INCH LOCK	18
5-7	88-060-06	SCREW, 1/4 X 1/2 INCH HEX HEAD	18
5-8	88-065-13	SCREW, 1/4 X 1-1/4 INCH TRUSS HEAD	7
5-9	88-737-08	RIVET, 3/16 X 5/8	20
5-10	88-069-87	NUT 1/4 INCH FASTITE	21
5-11	74-623-10	PANEL, INSPECTION REAR	1
5-12	72-034-00	LIGHT, TAIL (RED) 36V	1
5-13	72-007-00	LIGHT, REVERSE (FLASHING) 36V	1
5-14	76-028-61	GASKET, REAR PANEL (NOT SHOWN)	1

EV-1 SCR CONTROL FOR ELECTRIC VEHICLES

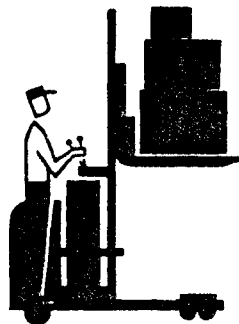
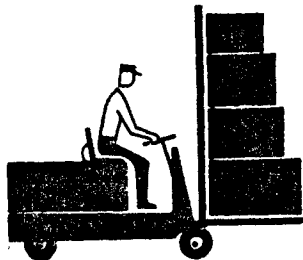


OPERATING & MAINTENANCE
INSTRUCTIONS

GEK-40724C

MODELS EV-1A, EV-1B, EV-1C, EV-1D
VOLTS 24-48, 48-84

EV-1* SCR CONTROL FOR ELECTRIC VEHICLES



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What is an SCR?	2
Photos of Control	2
Elementary Diagram	3
Circuit Operation	4
Control Features	5
General Maintenance	8
Trouble-shooting Instructions	9
Arrangement and Identification of Components	23
Wiring Diagrams	24

*Trademark of General Electric Company

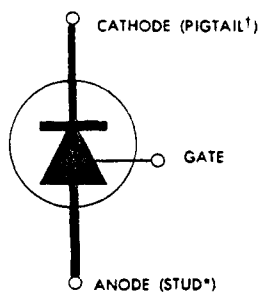
The information contained herein is intended to assist truck users and dealers in the servicing of SCR control furnished by the General Electric Company. It does not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the truck manufacturer through his normal service channels, not directly to General Electric Company.

GEK-40724 EV-1 SCR Control

WHAT IS AN SCR?

Since the heart of the control is a silicon controlled rectifier (SCR), a general understanding of the characteristics of the device will be helpful. The SCR is a semi-conductor rectifier used as a latching switch; i.e., it may assume either a conducting or nonconducting state (On or Off).



The SCR can be turned On by a momentary application of control current to the gate. To turn it Off, it is necessary in addition to removing the turn-on signal from the gate, either to remove all power from the SCR or to apply momentary reverse voltage between cathode and anode.

† Typical of SCR as used in GE control for electric vehicles.

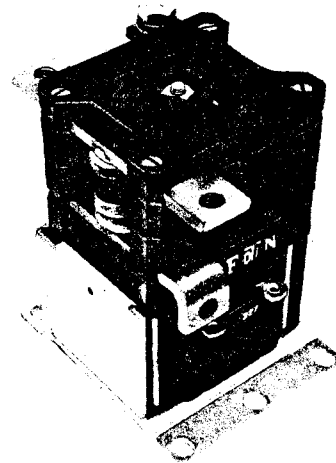


Fig. 2. Typical contactor

PHOTOS OF CONTROL

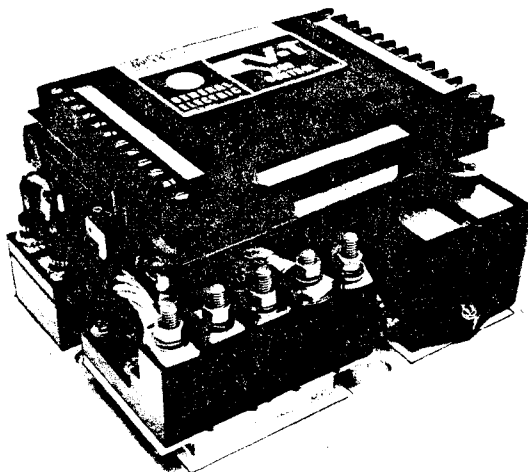


Fig. 1. Typical SCR static panel

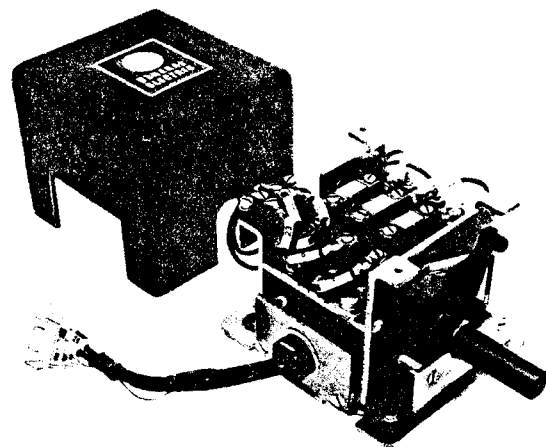


Fig. 3. Typical accelerator switch with cover removed

ELEMENTARY DIAGRAM

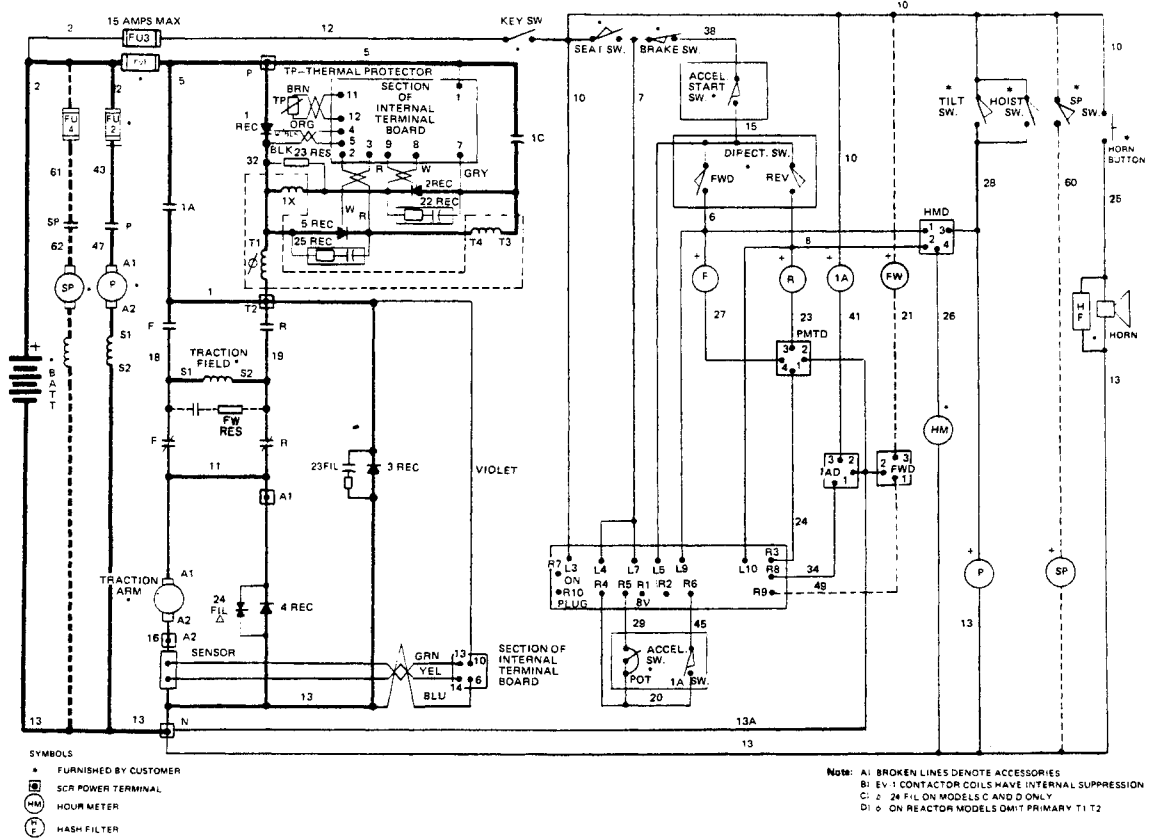


Fig. 4. Elementary diagram, General Electric EV-1 control for typical sit-down truck.
Refer to the manufacturer's instruction book for diagram for your specific truck.

GEK-40724 EV-1 SCR Control

CIRCUIT OPERATION (SEE FIG. 4)

The control circuit is energized by closing the Key switch, Seat switch, and moving the Forward or Reverse lever to either position and then depressing the accelerator, thus closing the Start switch. This applies power to the control card and, if the static return to OFF and pulse monitor trip requirements are satisfied, turns on the PMT driver, which will close the selected directional contactor, completing the circuit to the traction motor.

The control card supplies a gate pulse to 2 REC, turning it on to a conducting state, allowing current to flow from the battery through 1C, 2 REC, 1X, motor field, motor armature, current sensor, and back to the battery. After 1C charges, 2 REC shuts OFF due to lack of current. The control card checks that 1C is charged and unlocks the gates to 1 REC and 5 REC.

The control card then supplies a gate pulse to 1 REC, turning it ON to a conducting state, allowing current to flow from the battery through 1 REC, motor field, motor armature, sensor, and back to the battery. 5 REC turns ON and allows current to flow T4-T3, 1C, 1 REC, 5 REC back to T4-T3. This current charges 1C positive (card terminal 7 is now positive). This charge is now stored on the capacitor until it is time to turn OFF 1 REC. This charging cycle occurs in less than 1 millisecond (0.001 seconds) and 5 REC shuts OFF.

Current continues to flow in 1 REC until the control card turns ON 2 REC. When 2 REC conducts, capacitor 1C discharges around the circuit composed of 1C, 2 REC, 1X and 1 REC. This discharge current opposes the battery current through 1 REC until the resultant current is zero.

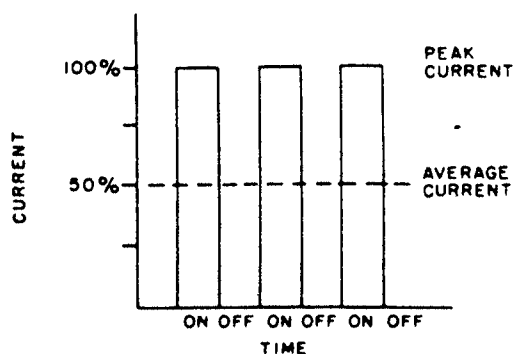


Fig. 5. Battery current

EV-1 SCR Control GEK-40724

With reverse voltage across 1 REC, 1 REC is turned OFF. Current continues to flow in 1C, 2 REC, motor and the battery loop until the capacitor (card terminal 7) is fully charged negative. This charge exceeds battery voltage by an amount which is a function of motor current, and 2 REC turns OFF. Figure 5 illustrates the pulsing of current from the battery.

During the OFF time, the energy stored in the motor, by virtue of its inductance, will cause current to circulate through the motor around the loop formed by 3 REC, thus providing what is called "flyback current". Figure 6 shows the nature of the motor current, which is composed of both battery current and the inductive flyback current. It should be noted that the average motor current measured will be greater than the average battery current. The SCR control, in effect, converts battery current at battery volts into a higher motor current and a lower motor volts.

The time for the next On and Off cycle to start is determined by the time that the control card takes to oscillate. The oscillation times are controlled by the potentiometer in the accelerator. Slow speed is obtained by having maximum ohms in the potentiometer. As the resistance in the potentiometer decreases, the speed of the motor increases. With level operation, the SCR circuit is capable of delivering approximately 85 to 90 percent speed. For full-speed operation, the 1A contactor is closed to apply full battery voltage across the motor.

CONTROL FEATURES

- **OSCILLATOR** — The oscillator section of the card has two adjustable features, creep speed and controlled acceleration, and one fixed feature, top speed.

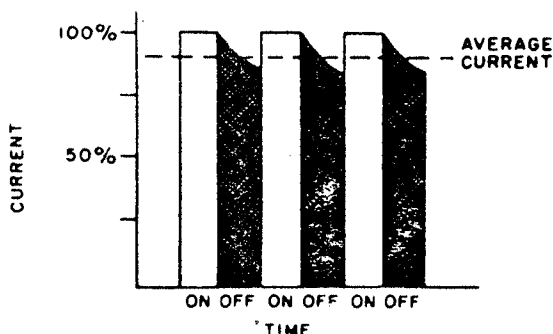


Fig. 6. Motor current

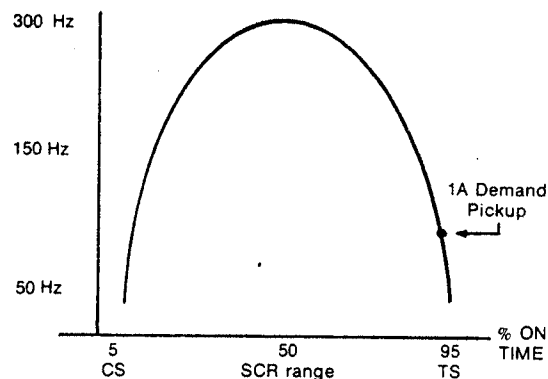


Fig. 7. Oscillator frequency curve

With the accelerator potentiometer at maximum ohms, the creep speed can be adjusted with a trimpot on the card. Top speed is fixed by card design, and is obtained with the accelerator potentiometer at minimum ohms.

The rate at which the oscillator may increase its % ON time is limited by "Controlled Acceleration". The minimum time required to go from creep speed to the 1A pickup point may be varied by an indexed trimpot (C/A) on the card, adjustable from approximately 0.5 seconds to 1.0 seconds.

The % ON time has a range of approximately 5 to 95 percent. The center operating condition of the oscillator is at 50 percent ON time with a nominal 1.7 milliseconds ON time and 1.7 millisecond OFF time. This corresponds to a maximum operating frequency of about 300 hertz. At creep the ON time will decrease to approximately 0.8 milliseconds while OFF time will become in the order of 20 milliseconds. At full SCR operation, this condition will be reversed (short OFF time, long ON time). This variation of ON and OFF time of the oscillator produces the optimum frequencies through the SCR range. See Fig. 7.

- **CURRENT LIMIT** — This circuit monitors motor current by utilizing a sensor in series with the armature. The information detected across the sensor is fed back to the card so current may be limited to a maximum safe value. If heavy load currents are detected, this circuit overrides the oscillator and limits the average current. An indexed trimpot for the current limit (C/L) adjustment is provided to maintain the peak voltage on the capacitor within its rating when

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used on high source inductance and/or low motor resistance applications. Because of the flyback current through 3 REC, the motor current usually runs 2 to 3 times the battery current. The (C/L) trimpot adjustment will produce little or no variation of battery current when used with high resistance motors.

- **PLUGGING** — Slowdown is accomplished when reversing by providing a small amount of retarding torque for deceleration. If the vehicle is moving and the directional lever is moved from forward to reverse, the motor field is reversed, the motor armature is driven by the inertia of the vehicle and acts as generator. This generated current passes through 4 REC and the current sensor. When the plug signal is initiated, the oscillator circuit regulates at a plug current limit level as set by the Plug trimpot on the control card. This controls the pulse rate of 1 REC to regulate the generated motor current and bring the truck to a smooth stop and reversal.
- **RAMP START** — This feature provides SCR torque to restart a vehicle on an incline. The memory for this function is the directional logic in the card. When stopping on an incline, the Directional switch must be left in its original or OFF position to allow the control to assume full power when restarting in the same direction. The "C/L" trimpot affects this torque.
- **FULL-POWER TRANSITION** — This built-in feature provides smooth transition from SCR to 1A bypass. This is accomplished by the SCR continuing to pulse until the 1A contactor power tips close.
- **1A CONTROL** — The 1A contactor has 6 modes of control:
 1. **DEMAND PICKUP** (fixed feature of the card) — If the oscillator has attained a % ON time equivalent to a motor voltage of 80 to 85 percent of the available battery volts, the 1A contactor will automatically pick up. The 1A switch in the accelerator is not necessary for this function. On "H3" cards, this feature may be eliminated by adding a jumper from R9 to R4.
 2. **TIMED PICKUP** — This feature works with the 1A switch in the accelerator. The time-delay pickup of 1A is provided by a circuit in the card. This feature allows 1A to be picked up after a time delay without reaching the demand point, and is normally used to apply full power at near stall

conditions. This time delay is adjustable by means of a 1A time trimpot on the card.

3. **1A THERMAL HOLDOFF** — This feature prevents the 1A contactor from closing as a function of time when the truck is in severe thermal cutback to avoid torque jumps. When a truck starts to go into thermal cutback, the 1A time will rapidly increase to infinity as the control goes deeper into thermal cutback. On "E" and later cards, this feature may be eliminated by adding a jumper from R2 to R4.
 4. **1A CURRENT HOLDOFF** — This feature is obtained by not wiring in the 1A switch in the accelerator. 1A will not pick up until the vehicle can accelerate to a point where the demand pickup will close the 1A contactor.
 5. **1A PLUGGING HOLDOFF** — This built-in feature is designed to prevent 1A closure anytime during plugging.
 6. **1A DROPOUT (1A DO)** — This adjustable feature can be set to open the 1A contactor if the traction motor is subjected to excessive currents. The dropout is adjustable with the (1A DO) trimpot. The directional or Accelerator switch must be returned to NEUTRAL to unlock the dropout circuit. Using this feature will reduce the 1A contactor tip life, thus it should be used only where needed to protect the motor.
- **PULSE MONITOR TRIP** — This function contains three features: The look ahead, the look again, and the automatic look again reset.

If 1 REC is shorted or 1A is welded, PMT will look ahead and prevent F or R from closing if either condition exists.

If 1 REC fails to commutate, or if 1A power tips remain closed when they should be open, the control will open F or R contactor. PMT will then look again by testing for a fault and, if none, reclose F or R. If the fault still exists, the F or R will reopen and remain open.

If 1A closes before a second commutation failure, the look again counter will automatically reset. This eliminates the inconvenience of resetting the PMT with the key switch if the tripping is due to random noise.

When the PMT circuit prevents F or R from closing, the PMT circuit can be reset only by opening the Key switch.

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- **STATIC RETURN TO OFF** — This built-in feature of the control requires the operator to return the directional lever to NEUTRAL any-time he leaves the vehicle and returns. If the Seat switch or Key switch is opened, the control will shut off and cannot be restarted until the Directional switch is returned to NEUTRAL. A time delay (0.5 seconds) is built into the Seat switch input to allow momentary opening of the Seat switch. This same delay requires the Directional switch not be closed until both the Key switch and the Seat switch have been closed for 0.5 seconds.
- **TIP BOUNCE TIMER** — After F or R are closed or 1A opens, the oscillator card checks that the capacitor has been charged by 2 REC, the battery volts appear across 1 REC, and an interval of time has elapsed before 1 REC and 5 REC can be gated.
- **COIL DRIVE MODULES** — These modules are typically located on the contactor portion of the control. They are the power devices that operate F, R, 1A and FW contactor coils. These modules pick up or drop out these coils on command from the control card. All modules are equipped with reverse battery protection so that if the battery is connected incorrectly, none of the contactors controlled can be closed electrically.
- **THERMAL PROTECTOR (TP)** — This temperature-sensitive device is mounted in the 1 REC heat sink. If the 1 REC temperature exceeds design limits, the thermal protector will lower the maximum current limit and not allow 1 REC to exceed its temperature limits. Even at a reduced current limit, the vehicle will normally be able to reach sufficient speed for full 1A operation, thereby allowing the panel to cool. As the panel cools, the thermal protector will automatically return the control to full power.
- **FIELD WEAKENING (optional)** — If the vehicle is supplied with a field weakening circuit, the FW PU and FW DO trimpot adjustments will be on the SCR control card. Field weakening is a method of attaining higher running speed for the vehicle in level operation. The normal settings for this feature are: pickup of FW contactor from 125 to 150 percent of normal full-load running current (1A), and dropout of FW contactor from 275 to 300 percent current. The dropout puts the motor back to the 1A range to climb ramps and inclines.
- **FW WITH 1A CURRENT HOLDOFF** — The 1A switch in the accelerator has to close to allow the FW circuit to operate. To allow the two

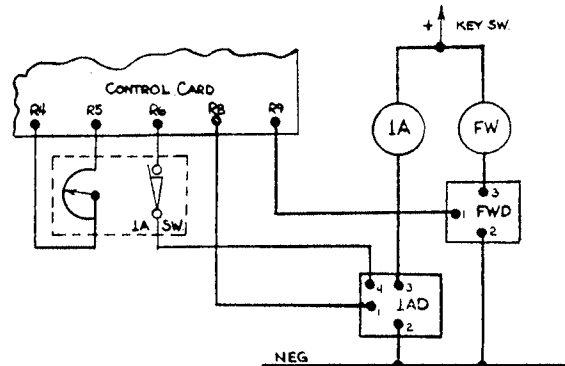


Fig. 8. FW with current 1A holdoff

functions to operate, the 1A switch has to be rewired per Fig. 8.

- **LOW VOLTAGE** — Batteries under load, particularly if undersized or more than 80 percent discharged, will produce low voltages at the SCR control terminals. The EV-1* control is designed for use down to 50 percent of the nominal battery volts. Low battery volts may cause the control to not operate correctly but the PMT should open the F or R contactor in the event of a commutation failure.
- **ACCESSORIES** — Other functions and equipment available with SCR control for electric vehicles and their instruction references are:
 IC3645 System Analyzer GEK-40725
 IC3645 Pump Time Delay GEK-73400
 IC4482 Contactors GEH-4469
 IC4484 Auxiliary Plugging Control GEK-64881
 IC4484 Battery Discharge Indicator GEK-73401
 IC4484 Dual Motor Control GEK-64882
 IC4485 Accelerator Switch GEH-4470

• OSCILLATOR CARD CHANGES

Card	Volts	FW	Features (Described on page 8)						
			1	2	3	4	5	6	7
IC3645									
OSC1A3	24-48	Yes	X	X	X		X	X	
A4	48-84	Yes		X	X	X	X	X	
B3	24-48	No	X	X	X		X	X	
B4	48-84	No		X	X	X	X	X	
C3	24-48	Yes					X*	X	
D3	24-48	No					X*	X	
E3	24-48	Yes							
E4	48-84	Yes							
F4	48-84	No							
H3	24-48	No							X

*Only on cards up to Rev. B-2 (see card name-plate)

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• OSCILLATOR CARD CHANGE FEATURES

1. Optional reduced current limit.
Adding a connector from R1 to R2 will reduce motor current (by about 50 amperes when used with the EV-1B control.)
2. Low thermal cutback.
Reduction in current limit is adequate only when the panel is mounted on a good heat sink. 1A thermal holdoff occurs at a low temperature. The low temperature thermal protector (group 1) must be used with this card.
3. No PMT look again reset.
The PMT look again counter will not reset when 1A closes.

4. Motor current output signal location.
IM Output is located at R2 instead of L6.
5. 1 REC synch circuit.
1 REC synchronizing circuit shuts off 1 REC gate pulse causing failure to gate 1 REC with certain motors.
6. Non-optional 1A thermal holdoff.
The provisions for disabling 1A thermal hold-off by adding a connector from R2 to R4 is not available.
7. Optional no 1A on demand and soft ramp start. Adding a connector from R9 to R4 softens the initial torque on ramp start on some applications, and also prevents 1A from picking up on demand.

GENERAL MAINTENANCE INSTRUCTIONS

The SCR control, like all electrical apparatus, does have some thermal losses. The semiconductor junctions have finite temperature limits above which these devices may be damaged. For these reasons, normal maintenance should guard against any action which will expose the components to excessive heat, such as steam cleaning; or which will reduce the heat dissipating ability of the control, such as restricting air flow.

The following DO'S and DON'TS should be observed:

- Any controls that will be used in ambients of 100 F (40 C) or over should be brought to the attention of the truck manufacturer.
- All external components having inductive coils must be filtered. Refer to vehicle manufacturer for specifications.
- The control should not be steam cleaned. In dusty areas, use low-pressure air to blow off the control. In oily or greasy areas, a mild solution of detergent or denatured alcohol can be used to wash off the control and then blow completely dry with low-pressure air. The control can also be cleaned with Freon TF† degreaser.

- For the SCR panel to be most effective, it must be mounted against the frame of the truck. The truck frame, acting as an additional heat sink, will give improved truck performance by keeping the SCR control package cooler. The use of a heat-transfer grease (Dow Corning 340) is recommended.
- Terminal boards and other exposed SCR control parts should be kept free of dirt and paint that might change the effective resistance between points.

CAUTION: The truck should not be plugged when the truck is jacked up and the drive wheels are in a free wheeling position. The higher motor speeds can create excessive voltages that can be harmful to the control.

- Do not hipot (or megger) the control. Unless the terminals of each semiconductor and card are connected together, the control may be damaged. Refer to control manufacturer before hipotting.
- Use a lead-acid battery with the voltage and ampere hour rating specified for the vehicle. Follow normal battery maintenance procedures, recharging before 80 percent discharged and with periodic equalizing charges.

†Registered trademark of the E.I. duPont de Nemours & Company

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TROUBLE-SHOOTING INSTRUCTIONS

The pulsing of the main SCR is too fast for conventional instruments to measure. When the control is functioning properly, a low hum can be heard.

Malfunctions of the SCR will generally fall into one of two categories. They are either no power (Table 1) or full power (Table 2), when operating in the SCR control range.

These simple and easy-to-follow tables outline the various symptoms and the corrective action to be taken.

The same device designations have been maintained on different controls but the wire numbers may vary. Refer to the elementary and wiring diagrams for your specific control. The wire numbers shown on the elementary diagram will have identical numbers on the corresponding wiring diagrams for a specific truck, but these numbers may be different from the numbers referenced in this publication.

WARNING: Before trouble-shooting, jack up wheels, disconnect the battery and discharge capacitor 1C. Reconnect the battery as needed for the specific check.

If capacitor 1C terminals are not accessible, discharge capacitor by connecting from SCR POS terminal to 2 REC anode. Check resistance on RX1000 scale from frame to SCR power and control terminals. A resistance of less than 20,000 ohms can cause misleading symptoms. Resistance less than 1000 ohms should be corrected first.

Before proceeding, visually check for loose wiring, maladjusted linkage to accelerator switch, signs of overheating of components, etc.

Tools and test equipment required are: (a) 6-volt lamp, 6-volt battery, two A14 diodes (1 Amp 400V), clip leads, volt-ohm meter (20,000 ohms per volt) and general hand tools, or (b) EV-1 System Analyzer, volt-ohm meter (20,000 ohms per volt) and general hand tools. If the system analyzer is used, refer to the analyzer instruction book.

Note: To test an EV-1 Model D, 1 REC, use a 12-volt battery and test lamp.

FUNCTION OF EV-1 CARD TERMINALS FOR IC3645OSCIE3 AND E4 CARDS

TERMINAL (Voltage measurements with respect to negative, SCR power terminal.)	DESCRIPTION	CONDITION	VOLTS		
			NOMINAL	THRESHOLD †	
				E3	E4
L1	Not presently used				
L2	Not presently used				
L3	Card power supply input must be low to satisfy PMT reset.	Key open Key closed	0 BV	4.1	4.1
L4	SRO Input. When used ignores open switch between L4 and L5.	Key or seat open Key and seat closed	0 BV		
L5	Accelerator Start and Brake switch input. Must be high after L3 and L7 are at battery volts for over 0.5 seconds and while L9 and L10 are low to complete SRO logic.	Key, seat, brake, or start open.	0		
		Key, seat, brake, and start closed.	BV		
		Key, seat, and direction closed.	0.07 BV (E3) 0.17 BV (E4)	4.1	18
		Key and seat closed, start and direction open.	0.9 BV (E3) 0.5 BV (E4)	4.1	18

†Threshold is the voltage ± approx. 5% below which the logic is the same as for zero volts.

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TERMINAL	DESCRIPTION	CONDITION	VOLTS		
			NOMINAL	THRESHOLD †	
				E3	E4
L6	Motor current sensor output	No current	1.8		
		500 Amps average motor current model "B"	3.3		
L7	Seat switch input	Key open	0	8.2	19
		Key and seat closed.	BV		
L8	Not presently used				
L9	Direction switch input from positive side of "F" coil.	Key open	0		
		Key, seat, start, brake and direction "F" closed.	BV	8.2	19
L10	Direction switch input from positive side of "R" coil.	Key open	0		
		Key, seat, start, brake and direction "R" closed.	BV	8.2	19
R1	Card power supply	Key off	0		
		Key on	8.2		
R2	1A thermal holdoff control jumper to R4 to disable 1A thermal holdoff.	Key on, cold T/P	0		
		Key on, thermal cutback	0.66 or more		
R3	Output to PMT Driver	Key off	0 Volts		
		Key, seat, start, brake and direction selected. See Note 1.	5-10 milliamps		
R4	Common return to card for accelerator pot and 1A switch	Key off, use VOM and read from TBR4 to "Neg."	Less than 1 ohm		
R5	Accelerator pot input	Key on and accelerator at "creep".	3-4		
		Key on and accelerator at top speed.	0-2		
R6	1A switch input	Key on, 1A switch open	8		
		Key on, 1A switch closed	0	2.0	2.0
R7	% ON time output. See Note 2.	Creep speed	2.2		
		Top speed	6.2		
R8	1A driver output	1A contactor open	0 Volts		
		Top SCR Speed. See Note 1.	5-10 milliamps		
R9	FW driver output	FW contactor open	0 Volts		
		1A closed high speed. See Note 1.	5-10 milliamps		
R10	Plugging output logic	Not plugging mode.	0 Volts		
		Plugging mode.	8 Volts		

NOTE 1: Connect milliammeter from terminal to R4. If contactor picks up during this test replace driver. If zero milliamps open lead and recheck to eliminate possible driver short from terminal 1 to 2.

NOTE 2: If B card is used, remove wire to R7 when checking voltage.

†Threshold is the voltage \pm approx. 5% below which the logic is the same as for zero volts.

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ALL TESTING SHOULD BE DONE WITH TRUCK JACKED UP.

**TABLE 1
FAILURES WHICH CAUSE REDUCED OR NO MOTOR TORQUE
WITH SCR CONTROL**

Trouble-shooting is based on using the voltmeter to determine if the proper voltages are available to permit the control to operate properly. Refer to

table pages 9 and 10 for threshold voltages. Check for leakage in switches if voltage is close to the threshold.

SYMPTOM	PROBABLE CAUSE
1A. Contactors do not pickup. No control voltage from positive to negative.	<ul style="list-style-type: none"> • Check power and control fuses. • Check battery for low specific gravity and connections for looseness or broken fittings.
1B. Contactors do not pickup. Control volts present from positive to negative with proper polarity.	<ul style="list-style-type: none"> • Plug in battery with Key switch OFF. Volts on L3 should be less than 4 volts. • Close Key switch. Check volts at T2 (pin 10). Should be about 50% of battery volts. Above 70% locks out 1 REC. (Control card contains a 10 K bridge from pin 5 to L3 and pin 6). If near battery volts, check for shorted 1A tips or a shorted 1 REC. If near zero volts, check for shorted 3 REC. (4G). • Close Brake, Start switches (all switches needed to close F or R contactor except the Direction switch). Volts on L3, L5, L7 should be battery volts. Volts on L9 and L10 should be near zero. Wait for one second, then close FORWARD Direction switch. Volts at L10 should remain near zero. Volts at L9 and L9 side of F coil should be battery volts. If not, check wiring and switches. • Connect milliammeter (10 ma scale) from R3 to R4. Should read 5-10 milliamps. If not, open Key switch, open lead from R3 to PMT driver, reclose all switches except Direction switch, wait over one second and close FORWARD Direction switch. If reading is not 5-10 milliamps, replace control card. If reading is good, the coil or wiring to the PMT driver is open or the PMT driver is defective. Check driver. (4E)
1C. Contactors close. NO power and NO SCR hum with accelerator in SCR range.	<ul style="list-style-type: none"> • Check volts at SCR positive. Should be battery volts. If not, check power fuse. • Check volts at T2. Should be zero. If not, check volts at S1, S2, A1, and A2 to locate open circuit.

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SYMPTOM	PROBABLE CAUSE
1C. Contactors close. NO power and NO SCR hum with accelerator in SCR range. (Cont'd.)	<ul style="list-style-type: none"> • Check volts at R5. Should be 3-4 at creep reducing to 0.2 or less at top speed. If R5 remains about 4 volts, check accelerator. If R5 is zero, check volts at R1. Should be 8-8.5 volts. If R1 is above 10 or near zero and L3 is battery volts, replace control card and check PMT driver for short. (4E) • Check volts at R7. Should be 2-2.5 when Key switch closed. When F or R contactor is closed and accelerator depressed, should increase to about 6.2 volts. If remains near 2 volts, check volts at 1C (grey wire or 2 REC anode). If more than 0.125 BV, check if 2 REC will gate on. (4G) If less than 0.125 BV, check if 1 REC will gate on. (4G) Check current sensor green lead to card input pin 13. • Check 23 FIL for shorted resistor. • Replace control card. (4A)
1D. Contactors close. Little or no power. Normal SCR hum.	<ul style="list-style-type: none"> • Check 3 REC for open circuit. (4H) • Check 4 REC for short. (4H) • Check for open thermal protector. (4J)
1E. Contactors close. Little or no power. Abnormal SCR hum.	<ul style="list-style-type: none"> • Check 2 REC for short. (4G) • Check 5 REC for short. (4G) • Check 22 REC and 25 REC. (4M) <p>Note: A 25 REC which checks good with an ohmmeter can cause a misoperation of 5 REC under load, and can cause 1A to close on demand at lower than normal motor volts.</p>
1F. Contactors close. Little power. No SCR hum.	<ul style="list-style-type: none"> • Check 1C for low resistance (4B).
1G. One contactor closes with normal operation but opposite contactor will not close.	<ul style="list-style-type: none"> • Close Key, Brake, Start switches (all switches needed to close F or R contactor except the direction switch.) Volts on L9 and L10 should be near zero. Wait for one second, then close Direction switch in the direction that contactor will not close. Volts at other direction input (L9 or L10) should remain near zero. Volts at non-closing direction (L9 or L10) and top of coil should be battery volts. If not, check wiring and switches. • Close switches as above. Check volts at negative side of coil or corresponding terminal of PMT driver. Zero volts indicates open coil, battery volts indicates open driver. (4E) • Replace control card. (4A)
1H. PMT trips after operating in 1A and acceleration is returned to SCR range.	<ul style="list-style-type: none"> • Check for cause of long 1A dropout time, i.e., defective 1A driver, low resistance in 1A filter, shorted turns in 1A coil, or low voltage coil.

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TABLE 2
FAILURES WHICH CAUSE FULL MOTOR TORQUE WITH SCR CONTROL

SYMPTOM	PROBABLE CAUSE
2A. Contactors close. Full SCR speed immediately with audible hum. NO PMT trip.	<ul style="list-style-type: none"> • Key switch on. Check volts at R5. Should be 3-4 volts at creep position. If near zero, check Accelerator potentiometer. (4D) • Replace control card. (4A)
2B. Contactors close once or twice and then remain open. PMT trips.	<ul style="list-style-type: none"> • Check 5 REC for open circuit or open gate. (4G) • Check 1C for open and connections. (4B) • Check 1C for dead short. (4B) • Check 5 REC for short. • Check 2 REC for short. • Check 1X choke and transformer T3-T4. (4N) • Replace control card. (4A)
2C. Contactors close. Stall currents, under SCR operation, higher than normal and uncontrollable with C/L trimpot. Contactors may open once or twice and then remain open.	<ul style="list-style-type: none"> • Check current sensor yellow lead from negative end of sensor to card input pin 14. • Replace control card. (4A)

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TABLE 3
MISOPERATION OF OTHER FEATURES

SYMPTOM	PROBABLE CAUSE
3A. 1A or FW contactors close with Key switch.	<ul style="list-style-type: none"> • Check drivers for short from terminals 2 to 3 by disconnecting wires to terminal 1 on the driver. (4E) • Check resistance from R4 to SCR negative. If not zero, the control card has been damaged, probably by a high-current input to R4 burning open a run on the card. Check for possible shorts and improper leads being connected to this terminal. Normally only the accelerator pot, 1A switch from R6, and B card use R4 as a negative. • Replace control card. (4A)
3B. F or R will close without returning Direction switch to OFF.	<ul style="list-style-type: none"> • Check location of L5. Any open switch between L5 and Direction switch will satisfy SRO. • Open lead from R3 to driver. Close switches normally used to close F or R. If F or R close, replace driver. • Reconnect lead from R3. Close Key switch only. Volts at L3 should be BV, volts at L5, L7, L9, L10 should be near zero. Close Seat, Brake and Direction switches. Volts at L7 should be BV. Volts at L5 should be about 0.07 BV (0.17 BV on E4 card). If near 4.1 volts, (18 on E4 card) check Start switch leakage. Close Start switch. If contactor picks up, replace control card. (4A)
3C. PMT does not open F or R contactor.	<ul style="list-style-type: none"> • Operate traction drive. Jumper R3 to R4. If contactor does not drop out, replace PMTD driver. • Operate traction motor in low speed SCR range. Be sure wheels are turning freely. Push 1A tips closed manually. F or R should open. If not, replace control card. (4A)
3D. 1A will not close at run (percent pickup).	<ul style="list-style-type: none"> • Connect a milliammeter from R8 to R4. Should read 5-10 milliamps when 1A should be closed. If near zero, see later steps for improper inputs or control card. Check volts at terminal 3 of 1A driver. Should be battery volts decreasing to about 2 volts when 1A should be closed. If near zero, check coil and wiring to terminal 3. If remains battery volts, check wiring from R8 to terminal 1 and terminal 2 to negative, then replace 1AD driver.

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SYMPTOM	PROBABLE CAUSE
<p>3D. 1A will not close at run (percent pickup). (Cont'd.)</p>	<ul style="list-style-type: none"> ● If milliamps from R8 to R4 are near zero when 1A should be closed, open lead from R8 to 1A driver and recheck. If now good, there is a wiring short to negative in the lead from R8 or defective driver. (4E) ● Check volts at R7. Should be greater than 6 at top speed. If less than 5.7 volts, 1A will not close on demand. Check volts at R5, should reduce to less than 0.2 volts at top speed. If over 0.2 volts, check accelerator. If less than 0.2 volts, check that creep trimpot is not turned too far CCW. ● Check continuity of violet wire from T2 to pin 10. ● Replace control card. (4A)
<p>3E. 1A will not close at SCR stall (time pickup). (Check truck diagram to see if 1A switch closes card circuit R4 to R6.)</p>	<ul style="list-style-type: none"> ● Check 1A switch circuit. Key switch on. Volts at R6 should drop to less than 2 volts when 1A switch is closed. ● Check volts at orange lead to TP. If volts are above 1.6 (0.06 on OSC1A and OSC1B cards), control is in thermal cutback. Allow to cool, and recheck 1A function. ● Turn 1A trimpot fully CCW and recheck. ● Check continuity of violet wire from T2 to pin 10. ● Replace control card. (4A)
<p>3F. 1A will not open until start switch is opened.</p>	<ul style="list-style-type: none"> ● Check volts at R6. Should be near 8 volts when 1A switch is open. If not, check wiring and 1A switch.
<p>3G. FW contactor will not close after 1A pickup.</p>	<ul style="list-style-type: none"> ● Check volts at R6. After 1A contactor closes, this point must be less than 2 volts. If not, check 1A switch and wiring. ● Open lead to R9 and connect milliammeter from R9 to R4. When control signals FW to pick up, should read 5-10 milliamps. If remains at zero, turn FW PU trimpot fully CW and recheck. If remains zero, replace control card. (4A) If reads 5-10 ma, reset FW PU trimpot. (6)

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SYMPTOM	PROBABLE CAUSE
3G. FW contactor will not close after 1A pickup. (Cont'd.)	<ul style="list-style-type: none"> ● Reconnect lead to R9 and check volts at R9 when FW should pick up. If near 8 volts, check lead from R9 to terminal 1 of FW driver and R2 to negative for open, then replace driver. If about 2 volts, check volts at terminal 3 of FW driver. Should be battery volts dropping to 2 volts or less when FW should pick up. If volts are near zero, check wiring from positive to FW coil, FW coil, and wiring to terminal 3 of FW driver. If volts remain greater than four volts, replace driver.
3H. FW contactor will not drop out with increasing load.	<ul style="list-style-type: none"> ● Check dropout setting on card. (6) ● Replace control card. (4A)
3J. Stiff plug. Severe reversal.	<ul style="list-style-type: none"> ● Check plug adjustment setting on card. (6) ● Check 4 REC for open circuit. (4H) ● Replace control card. (4A)
3K. Very soft reversal.	<ul style="list-style-type: none"> ● Check plug adjustment setting on card. (6) ● Replace control card. (4A)
3L. Blown power fuse. Very hot power cables.	<ul style="list-style-type: none"> ● Check 3 REC for short. (4H) (Possible damage also to 1 REC and transformer module.)
3M. Hourmeter feeder faults: (1) Pump contactor closes when either F or R direction is selected. (2) One direction okay; opposite direction picks up <i>both</i> F and R. (3) Either direction selected picks up <i>both</i> F and R.	<ul style="list-style-type: none"> ● Diode shorted 3 to 4. (4H) Replace hourmeter block. ● Diode shorted 1 to 4 or 2 to 4. (4H) Replace hourmeter block. ● Diode shorted 1 to 4 and 2 to 4. (4H) Replace hourmeter block.

TABLE 4
CHECKING COMPONENTS

4A. Main SCR Control Card

All trouble-shooting is written to check all outside devices and eliminate them as the source of symptoms. The conclusion being then that the card is faulty.

1. Instructions for Removal of Card
 - a. Remove the four (4) screws shown in Fig. 9.
 - b. Jack out the right- and left-hand terminal board, using a screwdriver in the slots, (leaving the wires intact) as shown in Fig. 10.
 - c. Pry open the latches carefully with a screwdriver as shown in Fig. 11.
 - d. Jack out the bottom plug with a screwdriver as shown in Fig. 12.

The card can be removed by hinging 10 degrees and pulling out, or, if panel components (not related to card hinge mountings) are to be replaced, disregard all instructions above except "C" and the card will hinge up to 90 degrees.

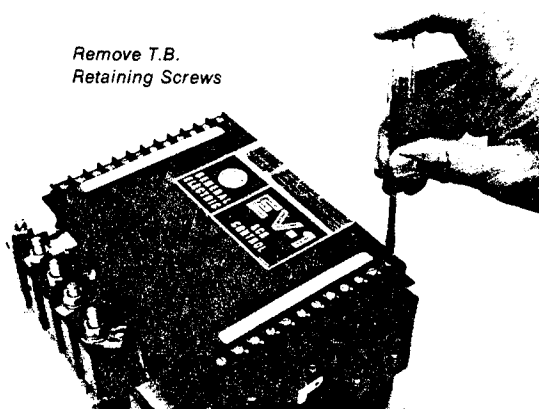


Fig. 9.

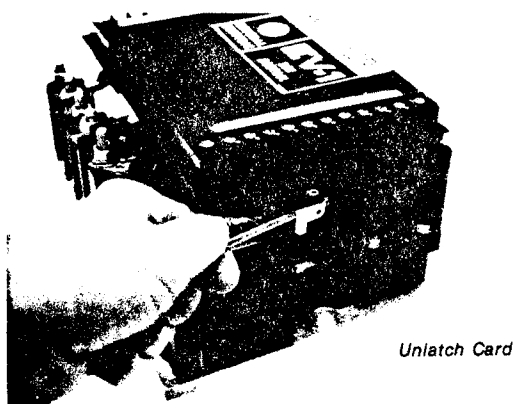


Fig. 11.

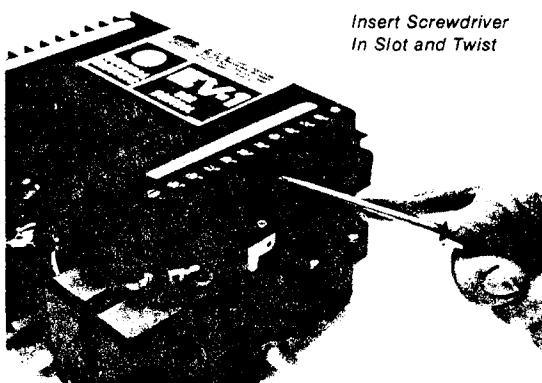


Fig. 10.

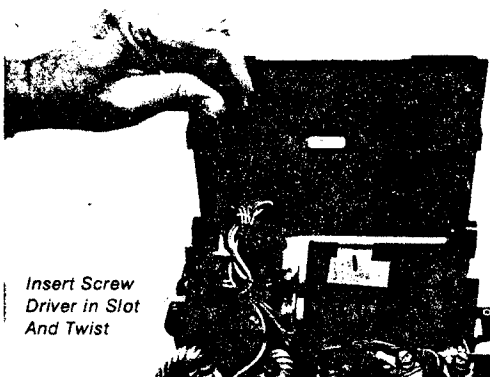


Fig. 12.

GEK-40724 EV-1 SCR Control

4B. Capacitor 1C

Disconnect battery and discharge capacitor. Measure ohms through the capacitor using the R x 10,000 scale. Meter should read zero and then swing slowly to above 100,000 ohms. Replace capacitor if above reading is not obtained.

4C. Contactors F, R, 1A, and P

75-ampere contactors (see GEH-3099)
150-ampere contactors (see GEH-4469)
300-ampere contactors (see GEH-4469)

NOTE 1. Control is arranged so that F and R do not break current. Check to see that 1A drops out ahead of F or R.

NOTE 2. Most contactor coils are polarity sensitive. The left-hand terminal must be connected to positive.

4D. Potentiometer in Accelerator

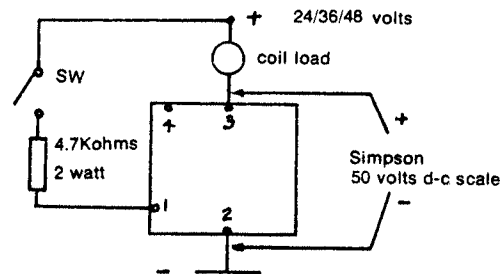
To check operation of the potentiometer, disconnect battery and disconnect wires at card terminal R4 and R5. Connect a VOM to wire removed with scale set to R x 100. With accelerator in creep speed position, the ohms reading should be 4800 to 6000 ohms. With accelerator in top speed position, reading should be 200 ohms or less. With wire disconnected as above, check for resistance of 1 megohm or higher from pot wires to truck frame.

4E. Driver Module

(IC3645CPM1RDA2 and IC3645CPMIRDB2)

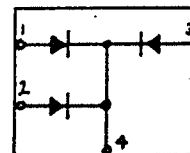
- Connect circuit as shown.
- Voltmeter should read battery volts with switch open.
- Close switch and meter reading should be 3 volts or less.
- Move load to terminal 4 and repeat steps (b) and (c).

NOTE: For 72 volt, use 8.2 Kohms 2-watt resistor.



4F. Hourmeter Module

Check individual diode circuits with trouble light or Simpson. (4H)



EV-1 SCR Control GEK-40724

4G. SCRs (1 REC, 2 REC, 5 REC)

These are silicon control rectifiers. Before checking, disconnect battery and discharge capacitor 1C. Disconnect one power connection on the rectifier. Disconnect gate leads of SCRs at the card plug.

To check an SCR, it is necessary to have a 6-volt battery, a 6-volt lamp and 2 A-14 diodes.

NOTE: Models C and D require 12-volt battery and 12-volt lamp.

Connect the positive lead to the anode (1), connect negative lead to the cathode (3) as shown in Figure 13.

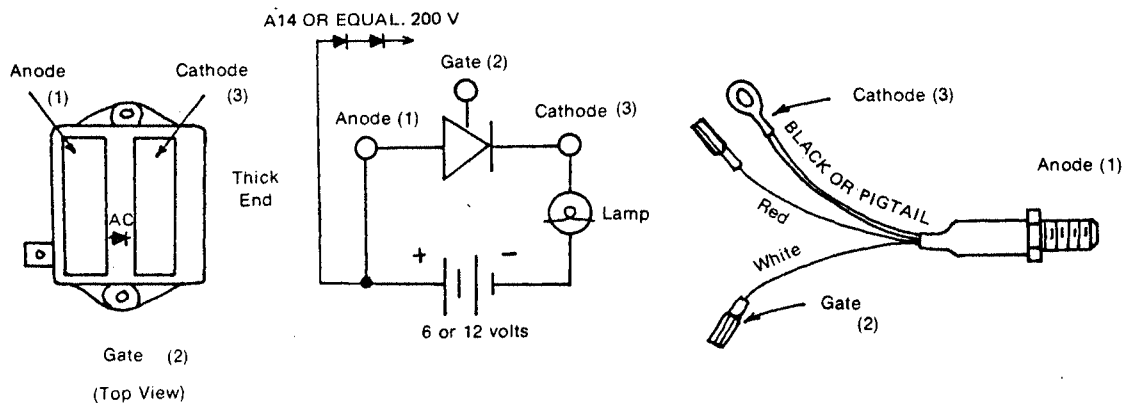


Fig. 13.

- The lamp should not light. If the lamp does light, the SCR is shorted and must be replaced.
- If check (a) was satisfactory, test the SCR for its ability to be turned on by the gate. Connect positive through two diodes to gate (point 2). If gate is operative, the lamp will come on and should remain on when the gate is removed. Some SCR's will operate correctly even if the lamp does not remain on, particularly with a weak battery.
- If lamp cannot be lit under step (b) the SCR is open and must be replaced.
- If the SCR is a stud-type device, check continuity between the red and black cathode leads.

NOTE: If you do not have a test light to check the SCRs as described above, they may be checked for shorts or opens by use of the VOM.

- Measure resistance from anode to cathode (R x 100 scale). If SCR is shorted (zero ohms), it must be replaced.
- Measure resistance from gate lead (white lead) to cathode and then from cathode to gate lead (R x 1 scale). If resistance reads either zero ohms (shorted) or infinity ohms (open), replace the SCR.

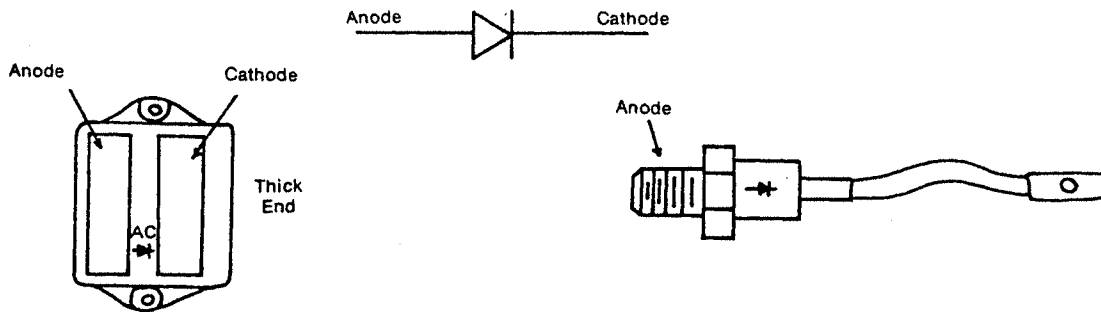
When reassembling SCRs, refer to TABLE 5.

4H. Rectifiers (3 REC, 4 REC, Diode Blocks)

When checking diodes, disconnect battery and discharge capacitor 1C to prevent burning out the ohmmeter. When replacing rectifiers, refer to TABLE 5. For 3 and 4 REC, disconnect one lead or

GEK-40724 EV-1 SCR Control

flexible connection. 3 and 4 REC are diodes with about 7 to 12 ohms in the conducting direction, (+ —————> —) measured on the R x 1 scale, and 10,000 ohms or higher, in the non-conducting direction (— —————> +) measured on the R x 10,000 scale.



4J. Thermal Protector (TP)

Remove both connections from TP and with a VOM read between 100 and 200 ohms terminal to terminal, if heat sink is at room temperature. Set VOM to highest ohm scale and check pins to heat sink, reading should be infinity.

4K. Filter Block (HF), 23 FIL, etc.

To check, disconnect all wires from filter block. With VOM on R x 10,000 scale, touch the lead to the filter terminals to charge the filter. After a few seconds, reverse the meter leads and touch the filter terminals. The VOM needle will deflect and return to infinity. If this capacitor action is not observed, replace the filter block.

4L. Filter Block — 23 RES, etc.

Should these filters fail, it will be evidenced visually by severe cracking.

4M. Filter Block — 22 REC, 25 REC.

The capacitor filter test, as in 4K, is valid for 22 REC and 25 REC only to detect an open or shorted filter. If control has symptoms as in 1E, interchange 22 REC and 25 REC and try again. If problem is corrected the old 25 REC is marginal. If problem is not corrected, replace both filters with known good filters.

4N. IX Choke — Transformer Secondary T3-T4

Refer to panel wiring diagrams, page 24 thru 27, to locate windings. With VOM on RX-1 scale, check choke winding or transformer secondary, reading should be zero ohms.

EV-1 SCR Control GEK-40724

TABLE 5
REPLACEMENT OF EV-1 COMPONENTS

When replacing stud semiconductors such as 2, 3, 4, or 5 REC, it is not necessary to torque these devices to a specific value. However, the device should be screwed into the heat sink and tightened to a snug fit. SCR gates, not screw connected, terminate inside card plug. Remove card connector for access to stab terminals.

The use of a heat-transfer grease (such as GE Versilube G-350-M or equivalent) is recommended.

- 5A. When replacing module semiconductors such as 1 REC (Models A and B), 1 REC and 3 REC (Model C), and 1 REC, 2 REC and 3 REC (Model D):

- (1) Remove all module connections.
- (2) Remove module by backing out the two screws at the device sides.
- (3) If a 1 REC, remove the thermal protector.
- (4) Clean the insulator surface with a clean rag and isopropyl alcohol.
- (5) Inspect insulator surface for tears or cracks. If defective, replace. Wipe a light layer of machine oil on base and smooth insulator into position.
- (6) Coat insulator with a light coat of heat-transfer grease similar to GE-350.
- (7) Install thermal protector in new module. Tighten until snug.
- (8) Set new module on insulation and start screws back into the base. Be sure to use original screws and washers. Run screws in to "finger tight."
Check to see the bottom of the heat sink is flat against the insulator.
Alternately tighten the two screws by 1/4 turn until firm.
- (9) Replace all connections removed in Step 1.

- 5B. Capacitor (EV-1A and B)

- (1) Remove card completely.
- (2) Remove card box right support.
- (3) Remove nuts from capacitor connections and slide capacitor to the right.
- (4) Reverse procedure to install new capacitor.

- 5C. 22 REC and 25 REC, 23 FIL (Models C and D)

When replacing these devices, use original hardware in the same holes, as the inserts are used for electrical connections to the transformer.

- 5D. Transformer/Choke

- (1) Remove card box and card supports.
- (2) Remove capacitor (Models A and B).
- (3) Disconnect all transformer leads.
- (4) Remove 2 REC, 5 REC, and snubbers as needed.
- (5) Remove 4 mounting bolts and lift transformer free.
- (6) Reverse procedure to reassemble.

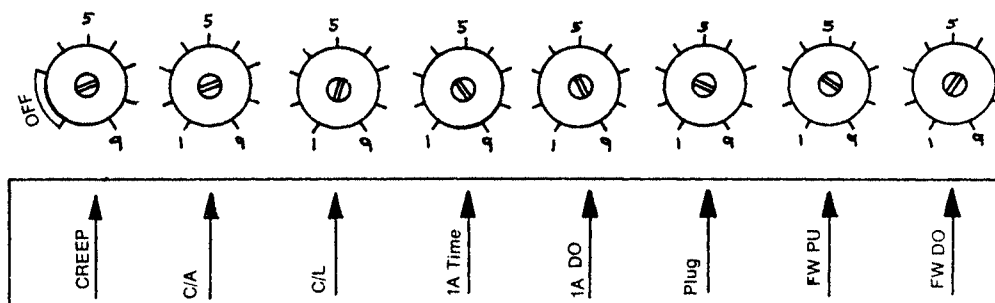
GEK-40724 EV-1 SCR Control

TABLE 6
TUNEUP FOR NEW OR MISTUNED CARD 1

Panels are factory adjusted for a particular motor and truck and should not need adjustment. The card is supplied with single turn potentiometer with internal stops and the box is marked with "dial" setting.

The truck manufacturer should supply the "combination" setting for the particular model truck. The following is for explanation only and should not be used for setting your control:

Creep 7, C/A 7, C/L 5-1/2, 1A Time 4, 1A DO 9, Plug 8, FW PU 3-1/2, FW DO 6



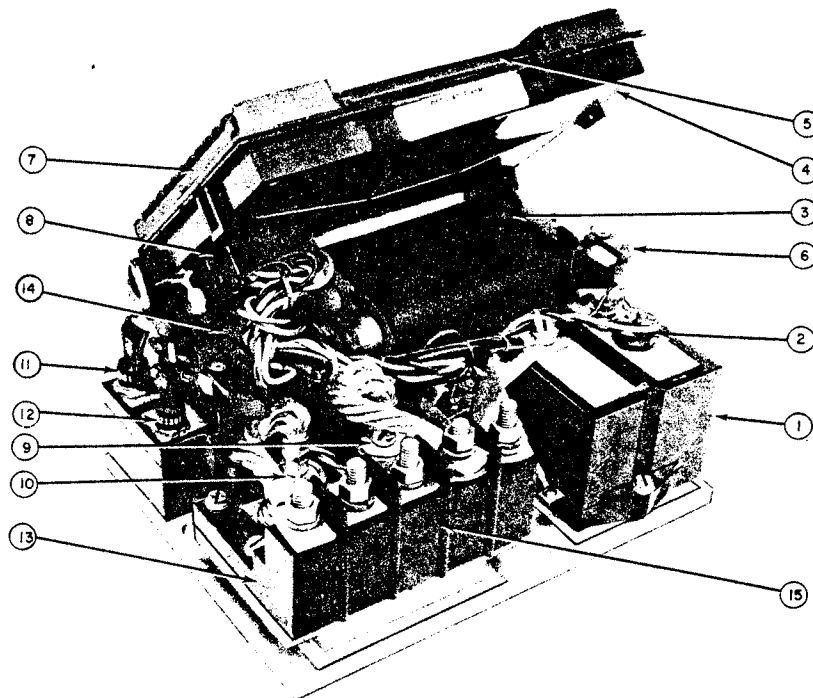
With a new card, turn all pots fully CCW to "1". Then set each pot to the setting for the particular truck.

Turning pots CW increases the particular function (i.e., CW adjustment increases creep speed, acceleration rate [C/A Pot], C/L, 1A Time, 1A DO, stiffness of plug, FW PU, FW DO).

EV-1 SCR Control GEK-40724

**TYPICAL PHYSICAL ARRANGEMENT
AND IDENTIFICATION OF COMPONENTS**

(Refer to wiring diagram furnished with truck for precise arrangement of components.)



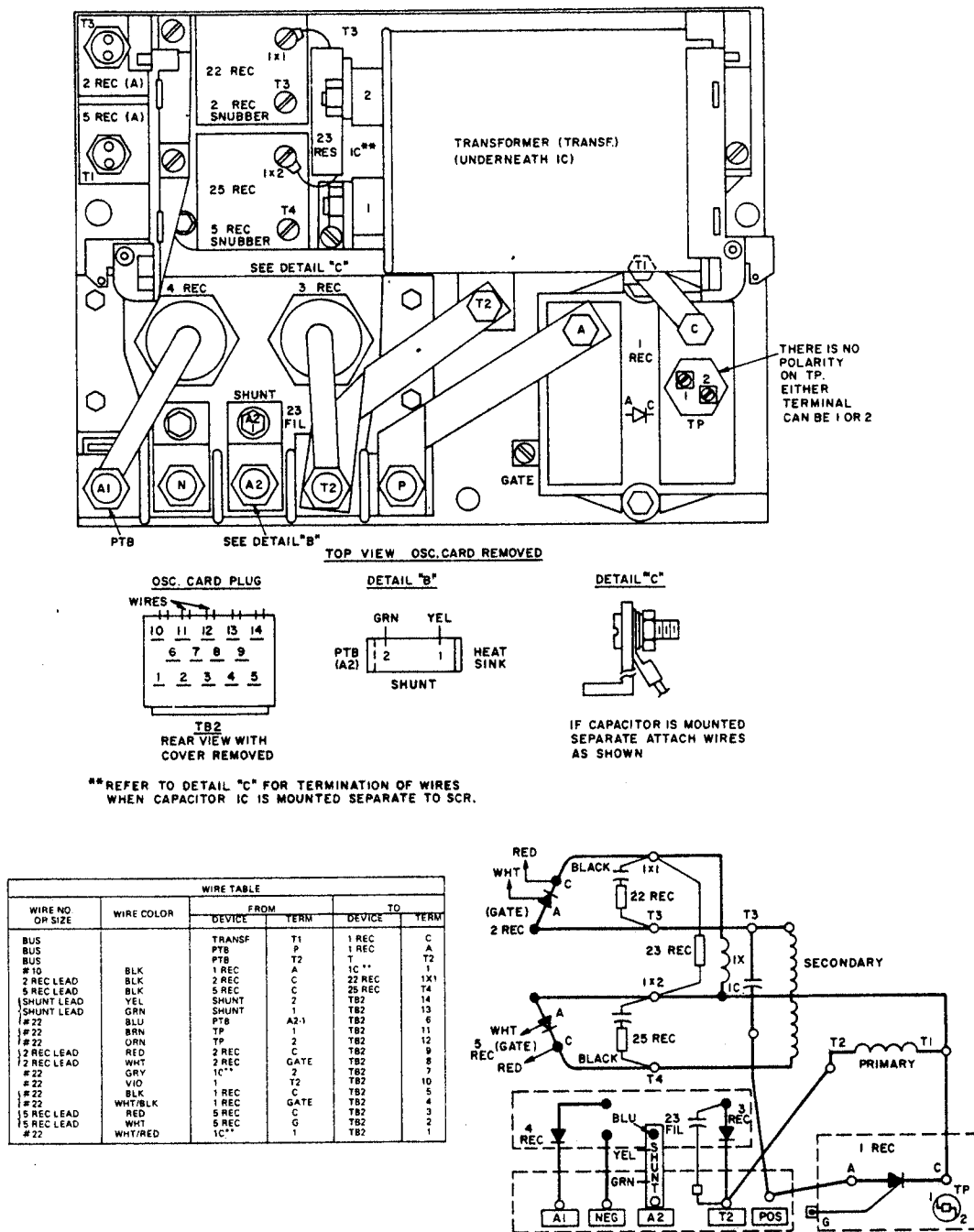
- (1) Main SCR (1 REC)
- (2) Thermal Protector
- (3) Commutating Capacitor
- (4) Oscillator Card
- (5) Card Adjustments
- (6) Quick Card Release
- (7) Card Connection Block
- (8) Card Connector

- (9) Flyback Diode (3 REC)
- (10) Plugging Diode (4 REC)
- (11) Turn-off SCR (2 REC)
- (12) Charging SCR (5 REC)
- (13) Power Connections
- (14) Filters for 2 and 5 REC
- (15) Motor Current Sensor
(Located behind middle power connector)

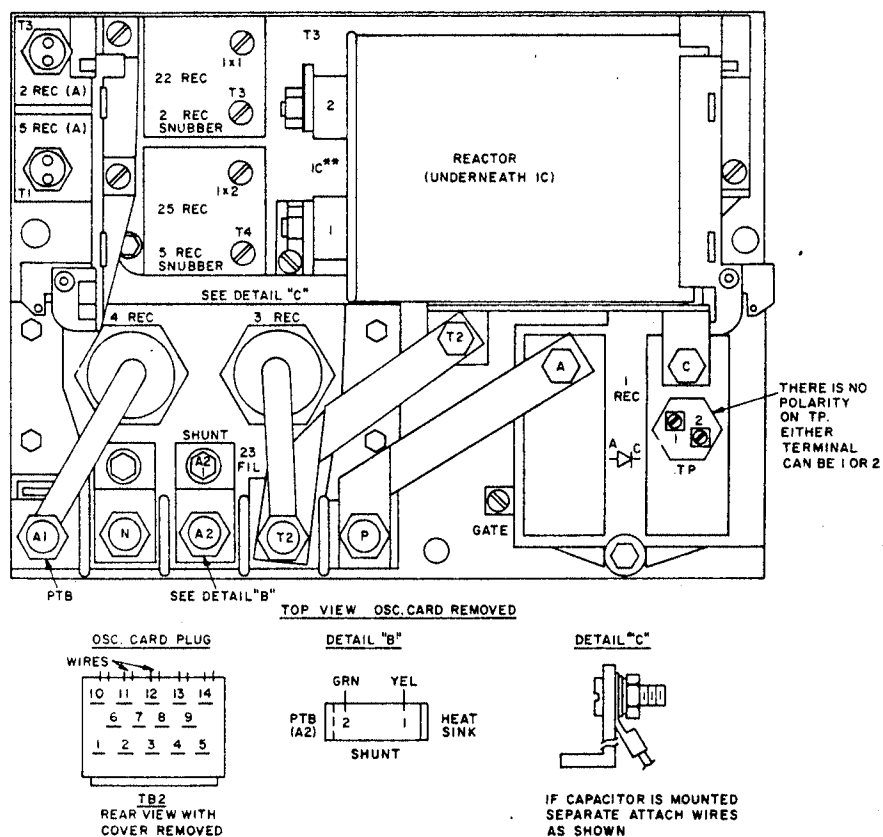
Transformer and choke (1X) located in encapsulated block under capacitor. 3 REC filter (23 FIL) located under pigtail of the diode.

Fig. 14. Typical EV-1 SCR panel (Model A or B)

GEK-40724 EV-1 SCR Control



EV-1 SCR Control GEK-40724



**REFER TO DETAIL "C" FOR TERMINATION OF WIRES
WHEN CAPACITOR IC IS MOUNTED SEPARATE TO SCR.

		WIRE TABLE					
WIRE NO. OR SIZE		WIRE COLOR	FROM		TO		
			DEVICE	TERM	DEVICE	TERM	
	BUS		REACTOR	T1	1 REC	C	
	BUS		PTB	T2	1 REC	A	
	BUS	PT2	T2	P		1	
	#10	BLK	1 REC	A	1C**	1	
	2 REC LEAD	BLK	2 REC	C	22 REC	1X1	
	5 REC LEAD	BLK	5 REC	C	25 REC	14	
	(SHUNT LEAD	SHLT	SHUNT			13	
	SHUNT LEAD	GRN	SHUNT	1	TB2	13	
	#22	BLU	PTB	A2-1	1	6	
	#22	TP	TP	1	TB2	11	
	#22	BRN	TP	2	TB2	12	
	2 REC LEAD	2 REC	C	TB2	9		
	2 REC LEAD	2 REC	GATE	TB2	8		
	#22	GRY	1C**	2	TB2	7	
	#22	VIO	1	T2	TB2	10	
	#22	BLK	1 REC	C	TB2	1	
	#22	WHT/BLK	1 REC	GATE	TB2	4	
	5 REC LEAD	RED	5 REC	C	TB2	3	
	5 REC LEAD	WHT	5 REC	G	TB2	2	
	#22	WHT	1C**	1	TB2	1	

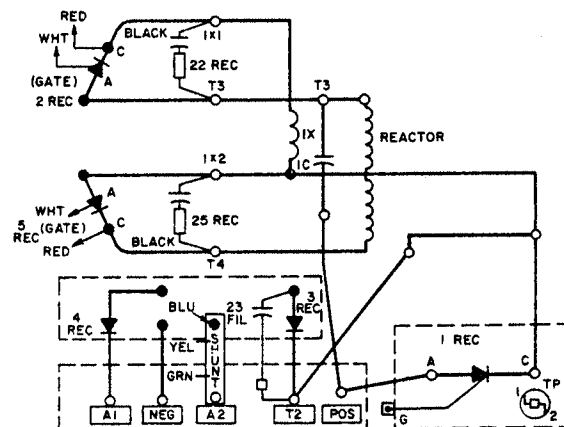
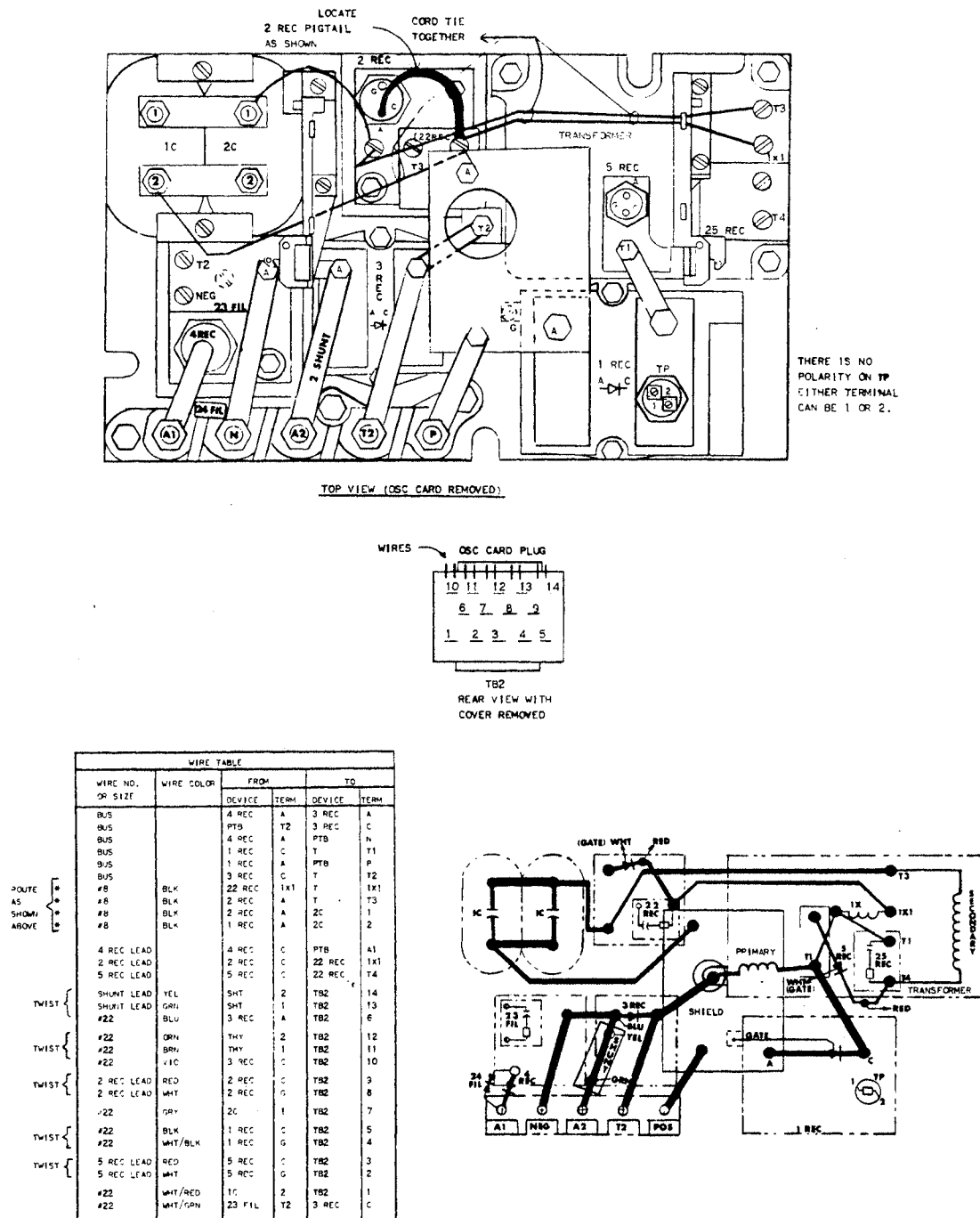
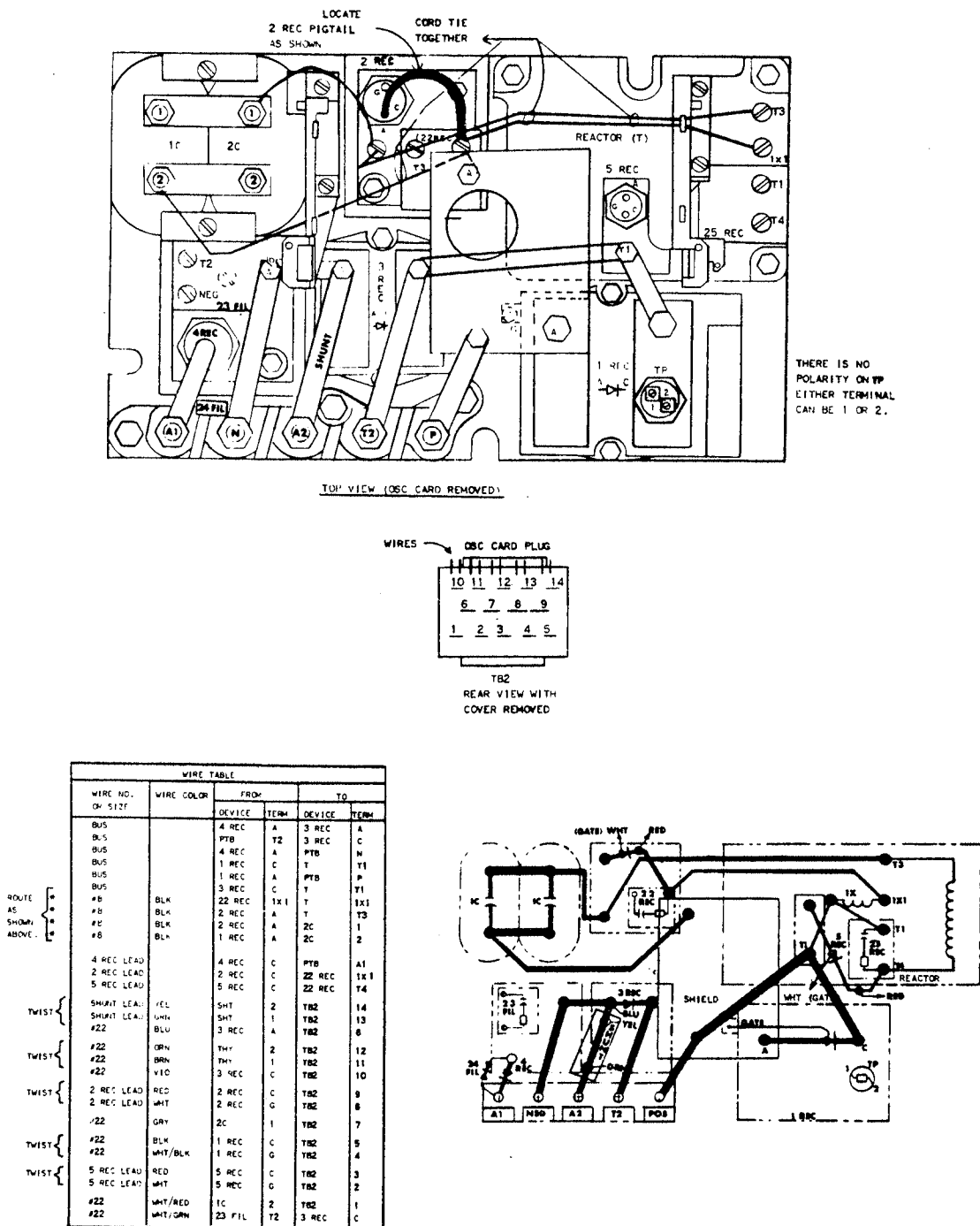


Fig. 16. Model A and B wiring diagram (reactor)

GEK-40724 EV-1 SCR Control



EV-1 SCR Control GEK-40724



GEK-40724 EV-1 SCR Control

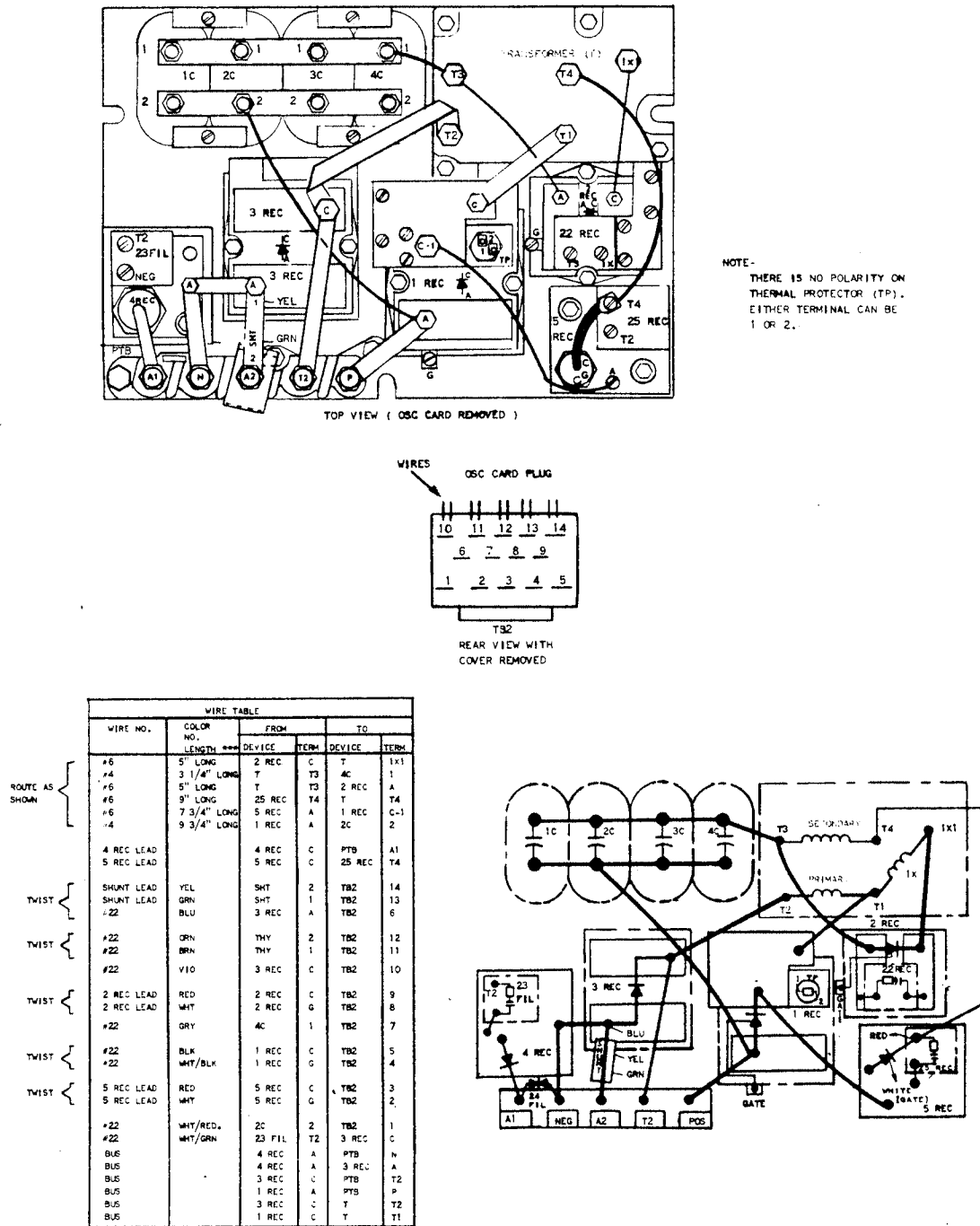


Fig. 19. Model D wiring diagram (transformer)

EV-1 SCR Control GEK-40724

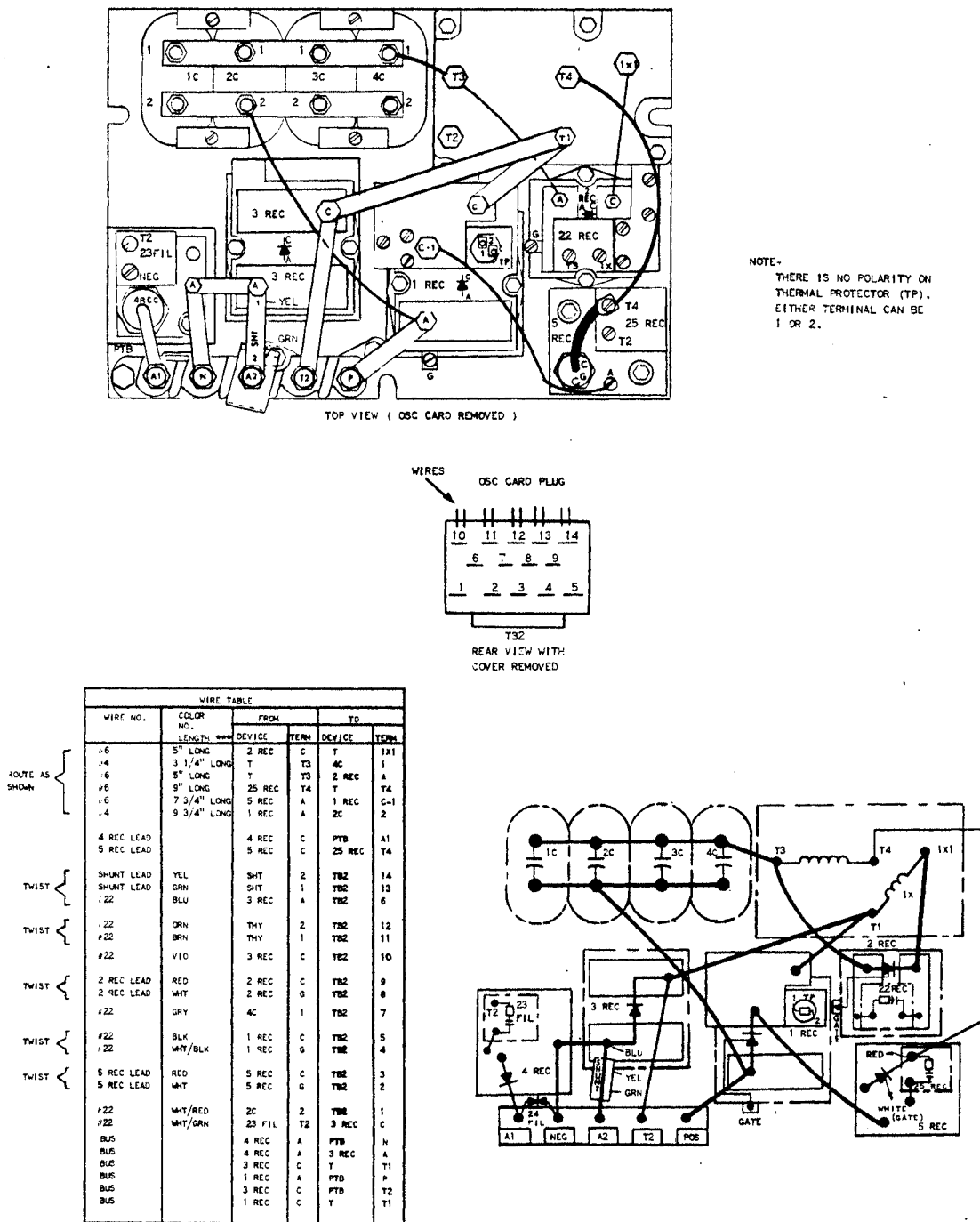



Fig. 20. Model D wiring diagram (reactor)

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SECTION 15
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GENERAL ELECTRIC COMPANY, U.S.A.
INDUSTRIAL CONTROL DEPARTMENT
CHARLOTTESVILLE, VA 22901

GENERAL  ELECTRIC

 GENERAL ELECTRIC	EV-1™ SCR CONTROL	SERVICE INFORMATION	
		Subject <u>EV-1 Card Damage</u>	
		Number <u>80-1</u>	Date <u>5/14/80</u>

As the number of EV-1 controls in use grows, so do the variety of application and maintenance procedures. This letter will list five specific situations which could cause damage to the EV-1 oscillator card. In all of these cases, the card should be replaced, the symptom confirmed and the cause eliminated.

1. Inadvertently apply battery positive to the R6 terminal of the oscillator card with the 1A switch open. This can easily be done by incorrect wiring of the 1A switch versus the start switch. This will cause internal damage to the card.

The SYMPTOM that would surface in this case is the bypass (1A) function will not operate.

2. Inadvertently apply battery positive to R4 or R5 or R6 terminals of the oscillator card with the 1A switch closed and/or the accelerator pot in the top speed position (min. ohms). This will cause internal damage to the card or the 15 amp control fuse will blow.

The SYMPTOM that will surface is the 1A/FW contactors pick up when the key switch is closed. If the control fuse opened, then the control will be inoperative.

3. Apply hi-pot voltage (500-1300 volts AC) with as low as 20 milliamps current draw to L3 on the EV-1 oscillator card. This is accomplished by Hi-Potting the vehicle with the oscillator plugged in and an existing short in the control circuit or the truck frame. Realize, that any short to frame in any of the control switches or wiring will cause this problem if the vehicle is Hi-Potted.

Certain components on the card will be damaged and also possibly the 5REC, 2REC, 1REC and 3REC.

The SYMPTOM in the case of damage to the 1, 2 or 5 REC's will be no output to the PMT driver and, therefore, no pickup of the Forward and Reverse contactor. If the 3REC is damaged, the power fuse should blow.

Should this situation occur (after Hi-Potting), the short should be eliminated. EV-1 controls are rated to withstand hi-pot voltages of 1300 volts A.C. The truck (or control) may be hi-potted without damage to the control, if the attached procedure on hi-potting is followed.

4. Forgetting to connect the 14 pin connector in the rear of the oscillator card and applying power will damage certain card components.

The SYMPTOM in this case will be no 1A function.

™Trademark of General Electric Company

The information contained herein is intended to assist truck users and dealers in the servicing of SCR control furnished by the General Electric Company. It does not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance.

Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purpose, the matter should be referred to the truck manufacturer through his normal service channels, not directly to General Electric Company.

5. Probably the most common of these five situations, plugging a working battery charger into the control and closing the key switch will damage the EV-1 card through terminal L3.

The SYMPTOM in this case is that the truck will not run and in many cases, the situation will be obvious as much smoke and fumes will be evident.

If the truck doesn't run with no visual evidence of card damage, confirm this situation by checking voltage at card terminal R1 (with respect to battery negative) and the key switch closed. Damage caused by a battery charger will cause a reading of 0 volts at this point.

The portion of the card damaged in this case is the power supply.

Other printed circuit cards such as the Battery Discharge Indicator can be damaged also.

Attached find a sketch of a suggested modification that can be made in order to prevent plugging the charger into the control.

It should be noted that all five of these conditions may invalidate warranty considerations.

Cosmo Mirra
Cosmo Mirra

Joe Nash/cm
Joe Nash

/gm

Tennis? [Signature]



EV-1 HIGH POTTING PRECAUTIONS

A. Protect the SCR panel components from ground fault paths by the following procedure:

- 1) Short all five SCR power terminals together; A1-NEG-A2-T2-POS
- 2) Short capacitor terminals together
- 3) Remove main control card and accessory cards

NOTE: It is important to remember that the practice of shorting SCR terminals/ capacitor and removing oscillator card is done to protect electronic components should a hi-pot failure exist anywhere on the truck.

B. Hi-pot positive and negative to frame using a hi-pot tester with 15 milliamps or better current capacity.

Hi-pot current draw can be broken down in three paths:

- 1) 3.5 to 5 MA is the typical draw for EV-1 SCR panel. The larger the panel size, the greater the current draw.
- 2) Current draw in a traction motor normally is in the 4 to 5 MA range.
- 3) The remainder of truck will make up the rest of current draw.

Clear any faults and continue testing until circuit will hold up hi-pot voltage in test B above.

C. This procedure is suitable for preparation for the U.L. dielectric test.

D. Warranty is voided unless this procedure is followed.

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<p>MADE BY</p> <p>JOYCE M. DUNBAR</p> <p>ISSUED</p>		<p>APPROVALS</p> <p><i>[Signature]</i></p> <p>INDUSTRIAL CONTROL DIV OR DEPT.</p> <p>CHARLOTTESVILLE, VA. LOCATION</p>	
<p>FF-803 WF (11-77)</p> <p>PRINTED IN U.S.A.</p>		<p>SKJMD82179-A1</p> <p>CONT ON SHEET FL. SH NO. 1</p> <p>CODE IDENT 1</p>	

MAINTENANCE PROCEDURES

GENERAL ELECTRICAL SYSTEMS

Your electrical system has been installed with care, utilizing quality materials for safe trouble free service. Proper fuses have been located where necessary to prevent unsafe overloads and protect the wiring from being damaged from short circuits.

Little care will be required, except for an occasional visual inspection for loose connections or some unusual condition causing the insulation to be rubbed off.

Normal replacement parts such as light bulbs, fuses, flashers, etc. have been arranged for simple changing by plug in devices or conveniently located terminals.

CAUTION: A blown fuse is usually indicative of a short circuit or faulty device. Care should be exercised to remove the faulty condition before replacing fuse. DO NOT place larger capacity fuses or "jumpers" to overcome the condition - as serious wiring damage can occur.

Refer to the following sections for more detailed information on the main power and electrical components:

- Section 7 - Wiring Diagram
- Section 12 - Motor
- Section 15 - Forward / Reverse Switch
- Section 17 - Batteries and Charger

BATTERIES AND CHARGERS

WARNING: Lead acid batteries continuously emit highly explosive gases. Flame or sparks must be kept away from the batteries at all times.

This emission is greatly increased during the charging process. Any area in which charging batteries are confined must be well ventilated, and flame or sparks must be kept out of the charging area and away from ventilator openings. DO NOT disturb battery connections while batteries are being charged.

The lead acid battery (or batteries) will furnish all power required by your vehicle. Two types are generally employed. The electric vehicle type battery pack, commonly used, can be expected to have a life of approximately 2 years, or 350 to 400 cycles. One cycle is the discharging and charging of the battery within proper limits. The heavy duty industrial type of battery has a life of approximately 7-1/2 years, or 1800 cycles, with appropriate use and care.

1. CORRECT CHARGING

Poor charging practices are responsible for more short battery life than any one other item. The charging equipment must be properly maintained and adjusted to give a charge which the battery will accept with maximum efficiency. Two things are involved in correct charging. These are the charging rate in amperes and the termination of the charge at the correct time. No amount of overcharging will increase the battery capacity or raise the specific gravity above its full charged condition.

2. DISCHARGING - CAPACITY

Batteries are commonly rated in ampere hours at the six hour discharge rate to final voltage of 1.75 per cell. They will deliver additional capacity in an emergency, but should not be required to do so regularly. The best way to avoid discharging is to prepare a rigid schedule for charging batteries which will ensure against discharging beyond the limits of capability.

3. WATERING

Water must be replaced from time to time. The frequency and quantity depends upon the watering space above the plates and the amount of gassing which the battery does on charge. Only approved or distilled water should be added to the battery. Water should be added after hydrometer or voltmeter readings have been taken. The liquid level within the battery raises as the gassing occurs. Thus filling after charging minimizes overfilling. However, the water level should cover the plates prior to charging.

4. CLEANING

Batteries pick up various kinds of dirt and dust, depending on their surroundings and the type of service to which they are subjected. This is usually dry dirt, which can readily be blown off with low pressure air or brushed off. However, if cells are overfilled and electrolyte collects on the covers, the top of the battery becomes wet and stays wet, since the acid in the electrolyte does not evaporate. This moist surface in combination with certain kinds of dirt becomes electrically conductive and permits stray currents to flow externally over the top of the battery. These currents cause corrosion of cell posts, nuts, connectors and steel trays, which eventually become troublesome and expensive to repair.

When wet dirt accumulates on top of the battery, remove it by washing the battery with a strong solution of baking soda and hot water (1 lb. of soda to 1/2 gallon of water). A convenient brush to use is one having flexible bristles like an old paint brush. Continue the application of the soda solution until all fizzing stops, which indicates that the acid has been neutralized. Then rinse thoroughly with clear water.

BATTERIES AND CHARGERS continued

4. CLEANING (continued)

Wet covers can be an indication of overfilling, leaky seals at posts and covers of excessive gassing during charge. When observed the cause should be determined and the abusive conditions corrected.

5. RECORDS

A battery record system is recommended for all vehicles. It is considered essential for large operations, and where minimum battery operating cost is desired. A properly supervised record system can be made to detect and call attention to such operating irregularities as:

- a. Overcharging
- b. Undercharging
- c. Overdischarging
- d. Excessive Water Consumption
- e. Cleanliness
- f. Worn Out Batteries
- g. Excessive Current Consumption on Trucks

It is not advisable to allow a battery to stand for a long period of time in a low state of charge. Doing so subjects the battery to excessive plate reosion and in cold climate conditions the electrolyte will freeze at a much higher temperature. For example, a fully charged battery will not freeze at temperatures near 60 degrees below zero. Yet a battery in a very low state of charge may freeze at temperatures around 10 to 15 degrees above zero.

A battery not in use maintains small amounts of chemical action which slowly tends to dissipate the charged condition. It is wise to re-charge a battery not in use every 1 to 2 months. If possible store the battery in a cool place, as the self discharge rate is increased with warmer temperatures.

BATTERY MAINTENANCE RECORD

VEHICLE NO.

Battery	Cell No.	Date			Date			Date		
		Water	Gravity	Gravity	Water	Gravity	Gravity	Water	Gravity	Gravity
		OK or Low	Before Charge	After Charge	OK or Low	Before Charge	After Charge	OK or Low	Before Charge	After Charge
	1									
	2									
	3									
	4									
	5									
	6									
	7									
	8									
	9									
	10									
	11									
	12									
	13									
	14									
	15									
	16									
	17									
	18									

1. CAUTION: Batteries emit explosive gases. During normal operation the concentration of these gases is rarely sufficient to be considered dangerous unless flame or sparks occur in the battery compartment close to the vent holes in the battery caps. It is important that this not be allowed to occur at anytime. During the charging process, emissions are greatly increased. Any area in which charging batteries are confined must be well ventilated, and flame, sparks or lighted cigarettes must be kept out of the charging area and away from ventilator openings associated with the charging area. Battery connections must not be disturbed while batteries are being charged.
2. Do not fill an uncharged battery. Bring water level up to just cover the plates, and complete filling after battery is fully charged. Use distilled water. Fill only to level indicated on battery.
3. Batteries which require unusually frequent watering may indicate overcharging. Review charging practices and/or adjustment of transformer taps in charger.
4. Gravity should be kept between 1175 (30% charged) and 1260 (100% charged), and gravity readings of all cells should be within 10 point range. When they are not, an equalizing charge should be applied. Refer to information under "Charging Time Chart" in Charger Handbook.
5. Periodically check for loose terminal posts or loose connections to terminal posts, but not while batteries are being charged.
6. Keep tops of batteries clean, and free of moisture, grease, and acid films. Any of these can cause current leakage.
7. Keep weekly (or oftener) record as shown in sample chart, for a new vehicle or when charging results seem unsatisfactory, until satisfactory charging continues for a four week period, then keep record on a monthly basis.

SERVICE AND ADJUSTMENTS
BATTERIES AND CHARGER

PARTS LIST, BATTERIES

T-D PART NO.	DESCRIPTION
77-067-00	36 VOLT, 680 AH INDUSTRIAL
77-064-00	36 VOLT, 450 AH INDUSTRIAL

NEW BATTERIES

1. Brand new batteries should be given a 12 hour charge before their first use, because it is difficult to know how long vehicle batteries have been in storage without a charge since new.
2. Limit use of brand new batteries between charges for first 5 cycles. New batteries and older batteries which have been in storage are not capable of their rated output until they have been discharged and charged a number of times.
3. During the first month of new batteries, particularly when night-time temperatures are below 60 F, give them an extra 12 hour charge once a week. The ampere-hours of energy that batteries can deliver and their charge acceptance varies directly with battery temperature.
4. All batteries that still taper down into the 1-4 amps area of the ammeter toward end of charge should be given the full 12 hours of charge. All cells in a set of batteries do not react identically to the same discharge and charge current. In a normal 12 hours charge the last 3 to 5 hours at low finish charge rate equalize the cells for better battery life.
5. When batteries age to the point where charge rate no longer tapers into the 1-4 amps area of the ammeter, reduce the hours of charge progressively to 10 hours, 8 hours, and finally down to 6 hours near the end of useful life. As batteries age, their on-charge voltage at end of charge period drops progressively, thereby causing a high finish charge rate in amperes and resultant higher water use rates.

VERIFY BATTERIES ARE CHARGED

1. Turn on the timer first thing in the morning and check to see if charger ammeter needle jumps smartly to 15 amps or more and then tapers into the 1-4 amps area within 15 minutes. This will provide a very simple means of verifying that the batteries were truly charged the night before. It also shows aging batteries whose finish charge rate will not taper into the ammeter 1-4 amps area.
2. Add water carefully to proper level in cells as required after they have been fully charged. Do not fill them so high that they bubble over while charging. New batteries require very little additional water, whereas very old batteries may need additional water two or three times a week. Water (electrolyte) level in battery cells settles when batteries are discharged and rises during charge. The probability of overfilling can be reduced by adding water when batteries are fully charged.

To determine whether or not a battery is properly charged, a measuring device known as a hydrometer should be used. A hydrometer consists of a glass tube or body with a rubber bulb at one end and a small spout at the other. Inside the tube is a graduated float.

The float will reach a point of equilibrium relative to the specific gravity of the fluid in which it floats.

BATTERIES AND CHARGER

VERIFY YOUR BATTERIES ARE CHARGED continued

The electrolyte within your battery becomes heavier as it is charged, therefore a higher specific gravity reading indicates a higher charge condition of your battery.

The specific gravity reading will range from 1100 for fully discharged condition to 1260 for fully charged condition on the electric vehicle type of battery.

On the heavy duty industrial type of battery, the specific gravity reading will be approximately 1275 to 1285 for fully charged condition.

NOTE: Because of the difference in the electrolyte the specific gravity will range slightly higher on the industrial type of battery. No amount of overcharging will raise the specific gravity above 1260 on the electric vehicle type of battery. Actually overcharging will only injure the plates and shorten battery life.

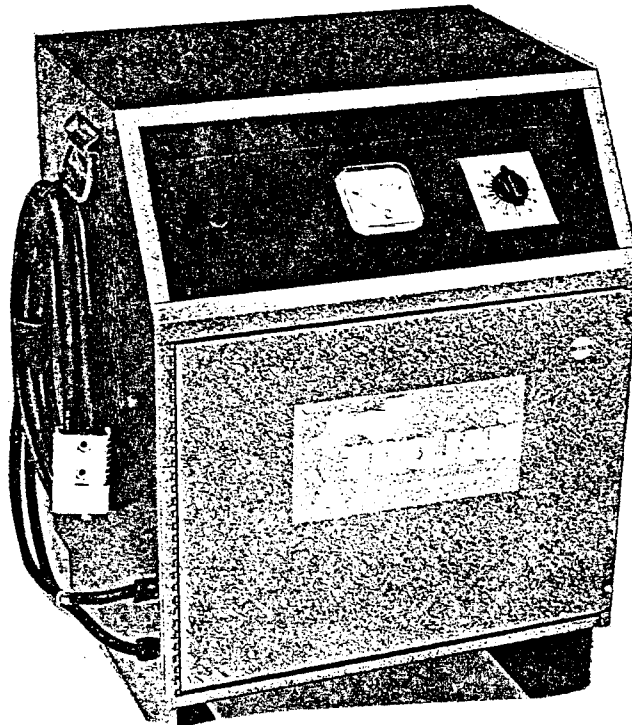
When testing battery charge condition with hydrometer, always return electrolyte solution to the same cell from which it was removed. DO NOT MIX electrolyte from one cell to another.

Refer to charger section for additional information on battery testing charging methods.

PREVENTIVE MAINTENANCE

1. When night air temperatures fall below 65 degrees F, batteries charged in unheated areas should be placed on charge as soon after use as possible. Under such condition a 4 hour equalize charge once a week in the early afternoon will improve state of charge and battery life.
2. Keep tops of batteries and battery hold-downs clean and dry. Tops of batteries and battery hold-downs must be kept clean at all times to prevent voltage leakage and flow of current between the batteries and the vehicle frame.

BATTERIES AND CHARGERS



Equipped with all solid state controls, these units automatically monitor the charge rate, protecting your batteries from undercharge or overcharge, thus allowing your batteries to achieve their maximum life while always operating at peak efficiency.

All units are constructed of the finest materials and carry a written guarantee.

CHARGERS

Trojan industrial type batteries are offered as an optional item for 12, 24 and 36 volt D.C. operation, the features are as follows:

Full Magnetic Control automatically allows for full taper charge from high rate to trickle.

Exact amount of Required Current is automatically replaced and completely equalized, thus bringing every cell up to a peak voltage at the end of each charge cycle.

Charging Rate is held below the gassing point to insure longer battery life and much less watering.

Automatic Cell Equalization maintains every plate in exact electrical and chemical balance. This means no hard sulphation, no unnecessary sluffing of active materials, and no over or undercharging.

Electric Timer serves as back-up to automatic solid state control system.

Circuit Protection-overload-short circuit-reverse battery connection-surge suppression on rectifiers.

Battery Compensation-Charging rate is easily readjusted to accomodate aging batteries or batteries with faulty cells.

BATTERIES AND CHARGERS
CHARGERS continued

INSTALLATION

The charger is designed for convection cooling, depending on a free circulation of air.

Locate the charger as near as possible to the main power source.

IMPORTANT procedures prior to initial operation. Disconnect charger from power line. Open front door, remove safety cover. Check connection to voltage tap; it should match power line. On dual voltage models AC contactor should match power line. Check that 240 line is not 208, if so connect to 208 voltage tap.

Your charger is fully automatic, requiring no other attention than turning the switch to 8-12 hours; 8 hours is normal. Use 12 hours for hard working applications. Set to 24 hours on weekends. **WARNING! DO NOT DISCONNECT BATTERY WITH SWITCH IN ON POSITION**

With the battery voltage controlling the rate of charge your charger will automatically replace current to bring your battery unit or units to full charge condition plus equalization of all cells during a normal charging cycle.

The following instructions should be adhered to in placing your charger in service:

1. Check name plate for AC (Alternating Current) voltage rating. Your charger is designed for 115, 240, 480 or 520 volts AC or dual combinations thereof. Proper line voltage adjustment assures maximum operating efficiency.
2. Your DC (Direct Current) voltage output should now be as follows: (charger turned on, battery NOT connected)

6 cell chargers (12 volts)	15 volts
12 cell chargers (24 volts)	30 volts
15 cell chargers (30 volts)	37.5 volts
16 cell chargers (32 volts)	40 volts
18 cell chargers (36 volts)	45 volts

3 Phase Chargers have proper voltage stamped on the control board

Above readings are approximate, do not exceed the suggested DC output. A lower reading than the suggested one is advisable if you cannot reach maximum.

DC voltage readings are determined on 2.5 volts per cell of battery to be charged.

Above readings are compiled by connecting the positive and negative leads to a DC volt meter to the corresponding terminals on the charger receptacle or same terminals on front panel.

Turn on charger switch. (Note that battery is not attached at this time.)

Read voltage on volt meter. If reading is not correct, adjust output on adjustment tap (upper part of control panel) left for lower, right for higher output.

BATTERIES AND CHARGERS
CHARGERS continued

Turn off switch, connect charger to battery and turn switch on. Observe charging current on ammeter. On a discharged battery (1.150 or less specific gravity) meter should show close to maximum charging rate.

If a battery is fully charged (1.260 specific gravity) charging rate should have tapered to approximately 2 amps per 100 AH of capacity (finished rate) or less, recheck line voltage adjustment.

If correct, move adjustment lead on control panel towards the high setting one tap. Let the charger go through another overnight cycle. Repeat process of moving tap until battery shows full charge 1.260 when charging current is approximately 2 amps per 100 AH of capacity (finished rate) or less after completed cycle.

On the other hand, if after an overnight cycle ammeter is showing a reading of 3 amps per 100 AH of capacity (finished rate) or more, check your battery for faulty cells.

WARNING !!!!!!!!!

**AT NO TIME SHOULD AMMETER READ HIGHER THAN DC AMPERE RATING OF CHARGER
DO NOT DISCONNECT BATTERY WITH SWITCH IN "ON" POSITION**

BATTERIES AND CHARGERS
CHARGERS (continued)

TROUBLE SHOOTING

IN CASE CHARGER DOES NOT OPERATE CORRECTLY

1. Check fuses on terminal panel inside charger.
2. Check fuse or breaker in AC supply
3. Check battery connections on battery and connectors to charger.
4. If DC fuse blows, check for too high charging rate at start of charge, dead or **shorted cell in battery** (2 volt or less per cell during charge) or short in charging line, or shorted diode.
5. If AC fuse blows, check for defective rectifier in charger. (This condition will occur when battery is not attached). Defective rectifier will blow AC with battery not attached and will blow DC fuse immediately when battery is attached with power off.
6. Weak or damaged rectifier can be detected through sudden amperage drop to half of usual output or less.
7. Defective power transformer cannot increase or partially decrease output. It will either decrease output to zero or blow AC fuses.
8. Defective control transformers will increase charging rate substantially. No taper charge will occur.
9. Low output on initial installation usually is caused by connecting a charger set on 240V to a 208 VAC line.

CHARGER PARTS LIST

PARTS NO.	DESCRIPTION
* 76-026-00	CHARGING RECEPTACLE, TYPE EC 300 AMP (EE)
79-390-10	CHARGER, 36 VOLT, 100 AMP, SINGLE PHASE
79-392-10	CHARGER, 36 VOLT, 150 AMP, THREE PHASE

- * Chargers come with 175 amp connectors unless otherwise specified.

MODEL P 2-50 EE RATED VEHICLE

This version of the Model p 2-49 tractor conforms to all the specifications of Section 3 of this manual. In addition, it also conforms to those requirements of ANSI B56.8-1981 for 'EE' rated vehicles. The primary differences are:

1. 'EE' rated 8 hp motor.
2. Batteries and charger (not standard) connectors are EC type, 300 amp.
3. All conductors are routed through conduit, and terminated in junction boxes as shown below.

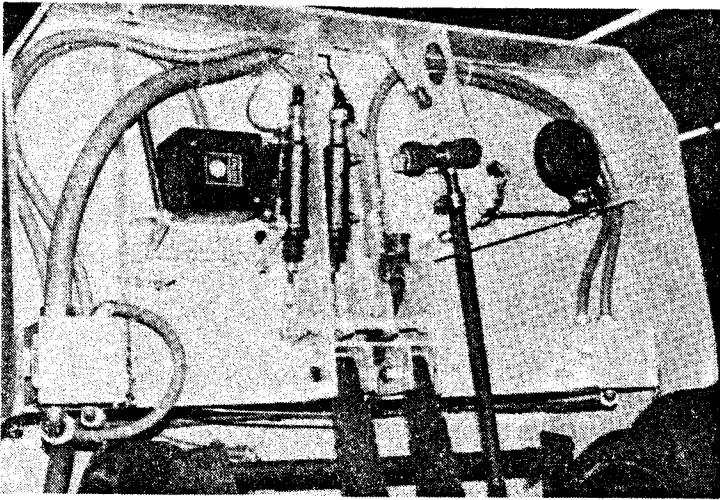


FIG. 1

Forward end showing conduit routing to accelerator and 'J' boxes.

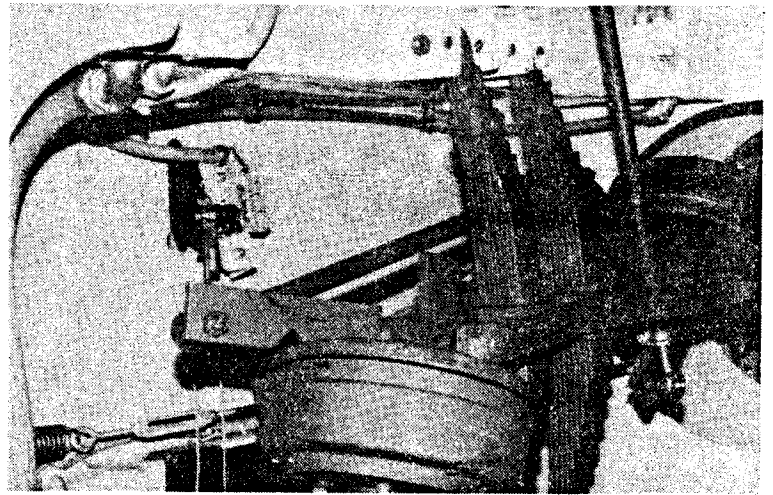


FIG. 2

Forward end (left side of Fig. 1) showing linkage and park brake interlock switch.

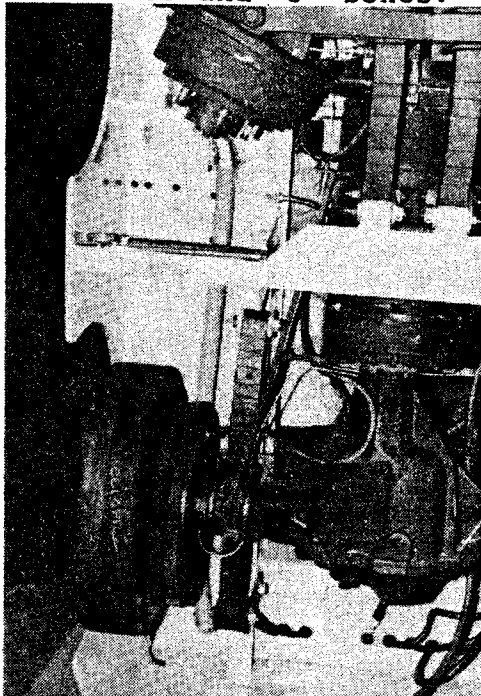


Fig. 3

Left rear, showing conduit from bottom of EV-1 compartment to forward terminations.

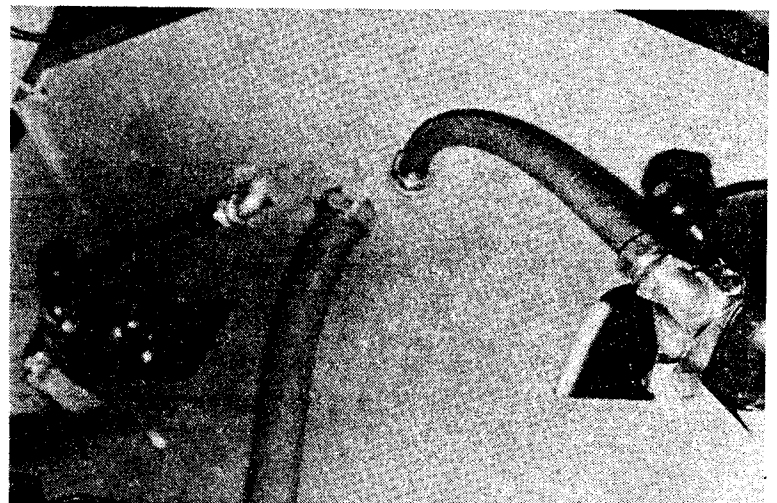
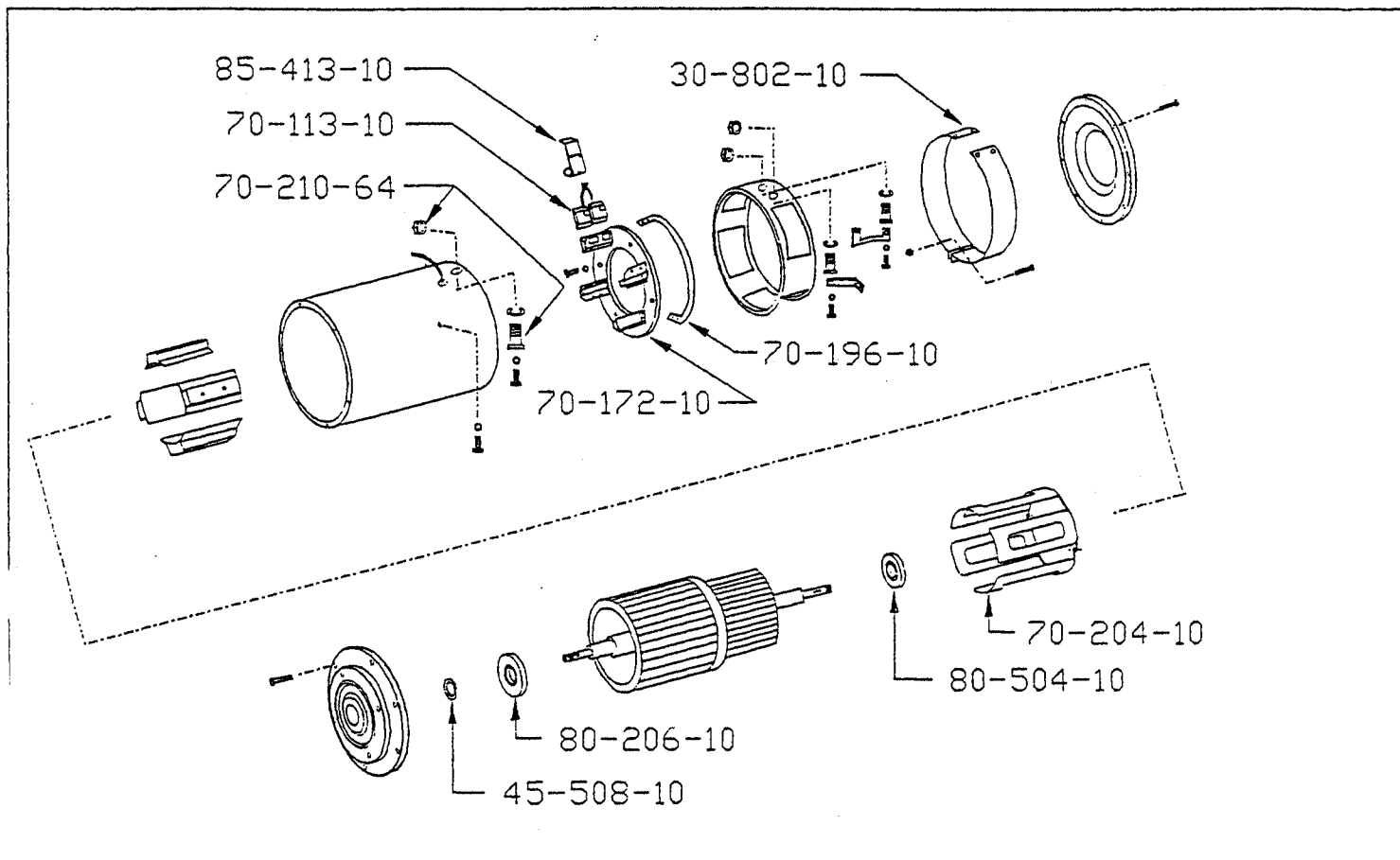


Fig 4

Underside of control panel (forward deck) with control harness and headlight conduits.

ELECTRIC MOTORS



For D.C. motor replacement parts, IT IS NECESSARY TO INCLUDE COMPLETE MOTOR NAMEPLATE DATA WITH THE ORDER.

FIG. I.D.	T-D PART NO.	DESCRIPTION	QTY.
	Replacement Parts for G.E. Motor 5BT1344B144'EE' 70-061-10		
1	70-204-10	COIL, FIELD GE 8 HP TYPE 'EE' (PAIR)	2
2	80-504-10	BALL BEARING, COMMUTATOR END, GE 8 HP	1
3	80-206-10	BALL BEARING, PULLEY END, GE 8 HP	1
4	70-196-10	CONNECTOR, ARMATURE TERM. TO BRUSH SET	1
5	70-172-10	BRUSH HOLDER, ASSEMBLY WITH BRUSHES	1
6	70-113-10	BRUSH, MOTOR ASSEMBLY 8 HP TYPE 'EE' (PAIR)	4
7	85-413-10	SPRING, BRUSH TORSION	8
8	30-802-10	COVER, BRUSH INSPECTION	1
9	45-508-10	OIL SEAL, GE 8 HP	1
10	70-210-64	MOTOR TERMINAL INSULATOR KIT	1