



Duff-Norton®

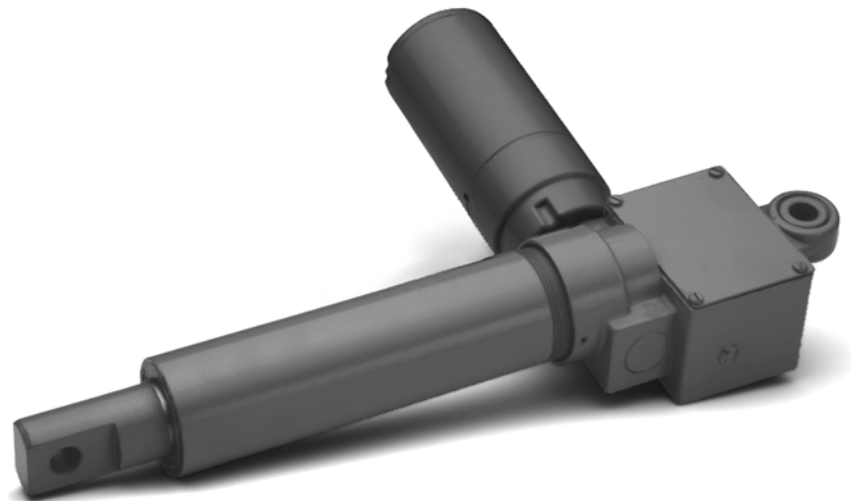
ACTUATORS



Electromechanical Actuators with Built-In Limit Switches

***Installation, Operation
& Maintenance Instructions***

***Publication Part No.
SK-6905-200***




***3905 Series 12 VDC
3904 Series 24 VDC***

***6905 Series 12 VDC
6904 Series 24 VDC***

 **CAUTION**

This manual contains important information for the correct installation, operation and maintenance of the equipment described herein. All persons involved in such installation, operation, and maintenance should be thoroughly familiar with the contents. To safeguard against the possibility of personal injury or property damage, follow the recommendations and instructions of this manual and keep it for further reference.

 **WARNING**

Improper use can result in personal injury. To avoid injury:
Do not use actuators to lift, support, or transport people or loads over people without written approval from Duff-Norton. Read all product warnings and operating instructions.

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Section I

General Information

1-1. General

This manual provides instructions for the installation, operation and maintenance of the Duff-Norton 3905, 3904, 6905 & 6904 Series DC electromechanical actuator. It includes proper procedures for the disassembly, cleaning, inspection, rebuilding and assembly of the actuator. To ensure efficient, long, satisfactory use of this unit, these instructions should be followed closely.

1-2. Industrial Use Only

The 3905, 3904, 6905 & 6904 Series actuators described and illustrated in this manual are intended for industrial use only and should not be used to lift, support or otherwise transport people, unless you have a written statement from Duff-Norton which authorizes this actuator unit, as used in your application, as suitable for moving people.

1-3. Factory Preparation

Each actuator is carefully assembled and tested at the factory to ensure that the motor and the mechanical components will function properly and that the actuator will lift its rated load.

The brake is preset at the factory and no further adjustment is required. With proper maintenance, this brake prevents the actuator from self-lowering.

The actuator is prelubricated at the factory and thus requires minimum maintenance.

Limit switches are checked at the factory for proper functioning.

The motor current draw is checked to make certain that it is within Duff-Norton standards.

Every effort has been made to deliver this unit in its factory-approved state. You should, however, carefully inspect the actuator for damage that may have occurred during transit.

1-4. Warranty and Warranty Repair

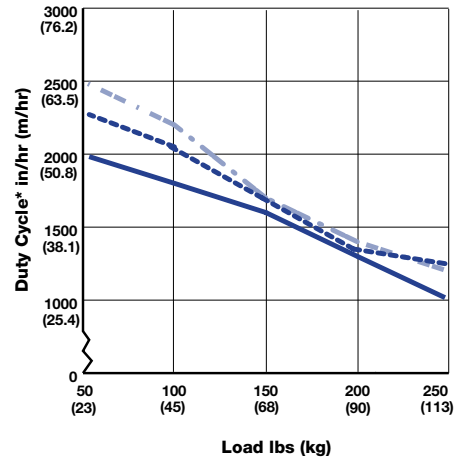
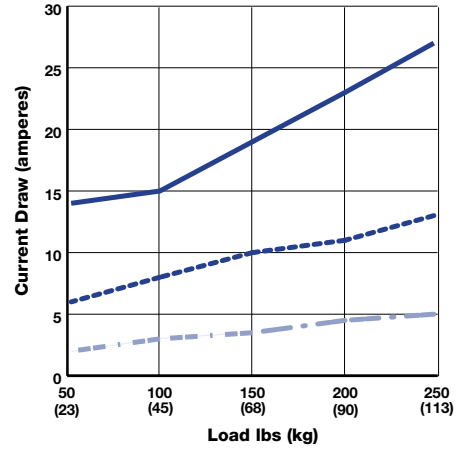
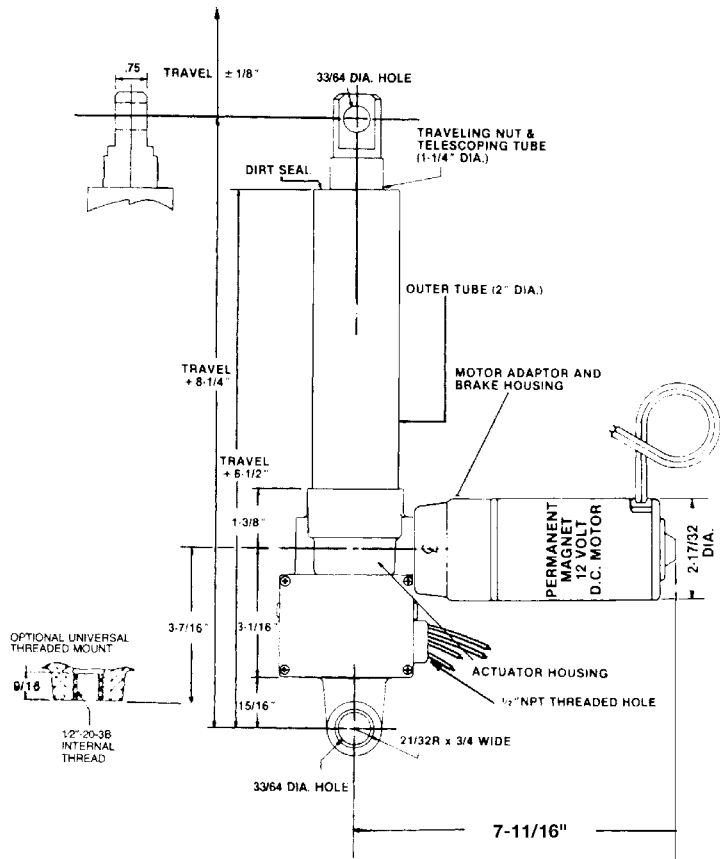
Subject to the conditions stated herein, Duff-Norton will repair or replace, without charge, any parts proven to Duff-Norton's satisfaction to have been defective in material and workmanship. Claims must be made within one year after date of shipment. Duff-Norton will not repair or replace any parts that become inoperative because of improper maintenance, eccentric loading, overloading, chemical or abrasive action, excessive heat, or other abuse.

Equipment and accessories not of Duff-Norton's manufacture are warranted only to the extent that they are warranted by their manufacturer, and only if the claimed defect arose during normal use, applications and service. Equipment which has been altered or modified by anyone without Duff-Norton's authorization is not warranted by Duff-Norton. EXCEPT AS STATED HEREIN, DUFF-NORTON MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

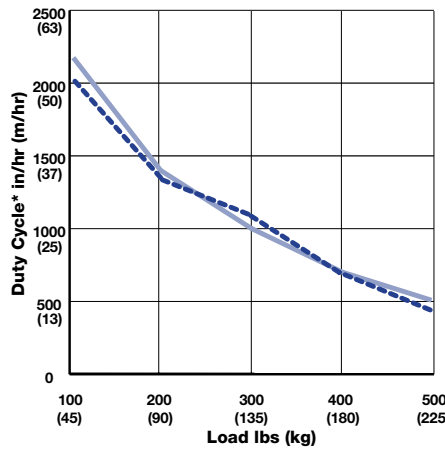
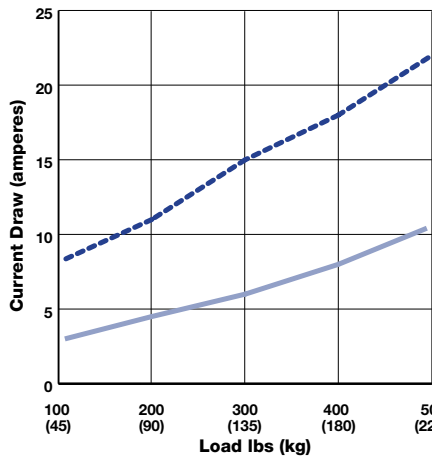
If you have any questions concerning warranty repair, please contact Duff-Norton.

Authorization for return must be received from Duff-Norton before returning any equipment for inspection or warranty repair.

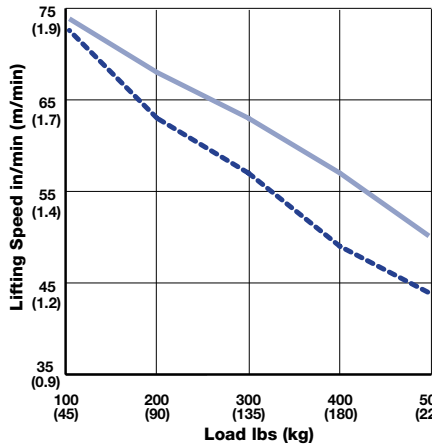
1-5. Dimensions and Specifications



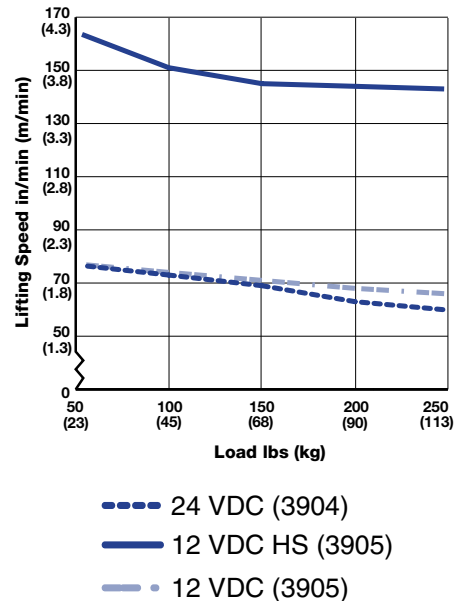
*Duty Cycle ratings represent the total travel (extension and retraction) per hour with equally timed intervals between cycles.



*Duty Cycle ratings represent the total travel (extension and retraction) per hour with equally timed intervals between cycles.



— 24 VDC (6904)
 - - - 12 VDC (6905)



- - - 24 VDC (3904)
 — 12 VDC HS (3905)
 - · - 12 VDC (3905)

Figure 1-5. Illustration and Charts

Section II Installation

2-1. Installation Procedures

Use Figure 6.1 on page 13 as a guide to properly attach the 3905, 3904, 6905 & 6904 DC actuator to your power source. Duff-Norton's PDC series control box or 2 SPDT relays must be used to avoid burning up the limit switches.

2-2. Limit Switch Cam Adjustment

IMPORTANT

Before attempting to set limit switch cams by these instructions, be certain that the red and black motor leads and the "Cam" and "Gear Cam" switch leads are connected properly per Figure 6.2. Unless leads are connected exactly as shown, the following steps will be meaningless.

1. Set Retract Position
 - a. Do not connect translating tube to work piece at this time.
 - b. Energize and retract actuator until gear cam opens limit switch.

NOTE

Translating tube may have to jam and spin prior to switch activation.

- c. Unscrew the translating tube until the measured distance between the housing clevis hole centerline and the translating tube clevis hole centerline equals the desired closed height. If the mating clevis holes are not aligned, manually rotate the translating tube to align the clevises, this will be less than 180° rotation and the closed height of the actuator will then be within 1/4" of the desired retracted dimension.
 - d. Pin the translating tube clevis in place and energize the actuator to check the drift.
2. Set Extend Position
 - a. Restraining the translating tube from turning, operate actuator and extend to desired position.
 - b. Adjust steel switch cam until switch is activated, allowing for drift. (This is accomplished by loosening socket head set screw until cam rotates with a slight drag on the shaft when the Allen wrench is used as a lever.)
 - c. Check travel and readjust if necessary.
 - d. Socket head set screw on cam should be

tightened after final adjustment is made. Do not strip threads by over tightening.

At maximum load, repeatability is 1/8" in either direction including drift and normal wear of parts.

FOR UNITS WITH POTENTIOMETER

2.3 Potentiometer Installation

1. Loosen pot locknut and remove from actuator.
2. For best accessibility, solder leads to pot at this time.
3. Limit switches should be set for extreme limits of travel per instructions. Limit switch cam adjustments should be made per paragraph 2 prior to potentiometer installation.

CAUTION

Do not engage potentiometer shaft gear teeth with plastic worm before reading the following procedure. Failure to adhere to the following procedure could cause damage to the potentiometer.

4. Retract actuator translating tube until stopped by limit switch.
 - 5a. **For travels up to 9" (single turn pot):**
 - i. Turn pot shaft counterclockwise until resistance between terminal **S** and **CCW** is approximately 100 ohms. This will be the pot's full retracted position.
 - ii. Being careful not to turn the pot shaft, slide it into engagement with the plastic worm and tighten locknut.
 - iii. Re-check resistance. If necessary loosen locknut slightly and twist pot to re-establish 100 ohm resistance. Pot does not have end of the resistive element. No continuity will be measured to terminal **S** if the slider is in the deadband.
 - iv. Run actuator to full extension (do not let tube rotate) until it is stopped by its limit switch.
 - v. Check resistance between **S** and **CCW** to be sure the slider is still on the element and the resistance is greater than 100 ohms. The pot has enough rotation for 9.43 inches of travel. (For strokes shorter than 9", the retracted resistance can be increased so that pot adjustment is less critical.)
 - 5b. **For travels greater than 9" (multi-turn pot):**
 - i. Turn pot shaft counterclockwise until it reaches its stop. Now turn shaft back clockwise 1/4 turn.

- ii. Without turning pot shaft, slide pot into engagement with the plastic worm and tighten locknut.
 - iii. Starting 1/4 turn from the end, the 3-turn pot has enough rotation for 25" of actuator travel.
6. With this set-up, potentiometer will have increasing resistance from S to CCW (and decreasing resistance from S to CW) as the actuator extends.

2-4. Digital Position Indicator (Duff Norton part no. SK6300-4K)

The model SK6300-4K is a highly versatile,, panel mount, digital readout device that provides a very precise indication of actuator position. It can be programmed to display percentage, inches, or any other desired unit. The indicator is self calibrating wth no need for measurements or calculations.

See the detailed instructions with the SK6300-4K indicator for installation and programming instructions. Potentiometer terminal CCW should be connected to indicator Common, CW to Excitation Voltage, and S to Signal Voltage Input.

Section III Operational Precautions

3-1. D.C. Motor

This motor is a totally enclosed weather resistant, permanent magnet type. This type motor is smaller, cooler running, more efficient and has higher duty cycles than series-wound motors. Lower current draw provides for longer battery life. The rotation is reversible by reversing the two color coded leads. Torque is the same in either direction.

3-2. Voltage Supply

Avoid using a low voltage supply for the DC motor. All wiring, switches, etc., must be of sufficient capacity to carry the required current. (Actuator capacity may be reduced his motor is a totally enclosed weather resistant, permanent magnet type. This type motor is smaller, cooler running, more efficient and has higher duty cycles than series-wound motors. Lower current draw provides for longer battery life. The rotation is reversible by reversing the two color coded leads. Torque is the same in either direction.his motor is a totally enclosed weather resistant, permanent magnet type. This type motor is smaller, cooler running, more efficient and has higher duty cycles than series-wound motors. Lower current draw provides for longer battery life. The rotation is reversible by reversing the two color coded leads. Torque is the same in either direction at low voltages.)

3-3. Clevis Pins

The axis of the clevis pins should be parallel so that the actuator can pivot without binding. A few drops of oil should be used on the clevis pins.

WARNING

The actuator is not recommended for use in applications where it can be jammed. Examples of jamming include overtraveling the limit switches and thus jamming the nut and screw internally at the extreme ends of the stroke, and driving the actuator against an immovable object and thus overloading the actuator severely.

Do not operate actuator before setting limit switches. Some actuator external surface temperatures may reach 230°F at or near maximum allowable duty cycle. The actuator can jam a limited number of times without damage. Therefore, consult Duff-Norton Engineering if jamming is expected.

Section IV Maintenance

4-1. Lubrication

Duff-Norton recommends using the following lubricant in conjunction with proper maintenance procedures of this unit: Mobil XHP-461 or XHP-462.

4-2. Required Tools

A bearing puller and press, soft jaw table clamp and common hand tools are required for proper disassembly and assembly.

4-3. General Procedures

Duff-Norton recommends following these procedures during disassembly and assembly:

1. Tag critical parts to facilitate reassembly.
2. Mark mating surfaces to ensure proper meshing.
3. Clean and lubricate parts as required.
4. All seals must be replaced at time of rebuild.
5. All screws, washers and other small common parts must be replaced if mutilated in any way.

4-4. Disassembly

Disassemble the 3905, 3904, 6905 & 6904 Series DC actuator as follows while referring to Figure 5.1. Read instructions thoroughly before disassembling.

NOTE
Disassembly should be accomplished on a clean cloth.

1. Clamp actuator housing (22) in vise (use soft jaws). Unit should be in horizontal position with switch cover (2) up.
2. Remove screws (1) from cover (2) housing (22), limit switch box and remove switch cover (2) and gasket (3).
3. If unit has potentiometer, loosen nut (7a) and remove potentiometer (7) from potentiometer bracket (6).
- 4a. Loosen screws (back end of motor (23)) from motor adapter (29) (do not remove screws from motor).
- 4b. Remove motor (23) from motor adapter (29) (use screwdriver to separate motor end from adaptor). Taking care that motor end bells do not separate from motor shell.
- 4b. Remove brake springs (27) from motor adaptor (29) and brake cam (26) from pinion (32).
5. Remove screws (28) from housing (22) and remove motor adapter (29).
6. Remove pinion (32) and bearing (31) from housing (22).
7. Remove retaining ring (30) from pinion (32) and remove bearing (31) from pinion (32).
8. Clamp housing (22) clevis end in vise (use soft jaws), remove set screw (35) from housing (22).
9. Unscrew outer tube (41) from housing (22) and remove translating tube (50) screw (46), gear (37) and outer tube (41) from housing (22).
10. Remove translating tube (50) from outer tube (41) by slipping outer tube (41) over translating tube (50) towards clevis end.
11. Remove seal (43) from outer tube (41) and press guide bushing (42) from outer tube (41). Seal and guide bushing need not be removed unless damaged.
12. Support screw (46) end taking care not to damage gear (37) teeth. With a 3/16" diameter punch, drive pin (38) from screw (46) and remove gear (37), bearing (39) and washer (40) from screw.
13. Thread screw (46) part way out of nut (48) and check screw (46) and nut (48) for wear. There should not be excessive play between screw and nut thread. If screw or nut are not excessively worn, the disassembly of screw (46), nut (48) and translating tube (50) will not be necessary.
14. Pins (49) should be approximately 1/32" above translating tube (50) OD. Grind pins (49) flush with OD of translating tube (50).
15. Using 3/16" diameter punch, drive pins (49) far enough into the lifting nut (48) to just clear the translating tube (50) wall. Do not drive pins against OD of screw (46). Remove nut (48) with screw (46) from translating tube (50).
16. Remove screw (46) from nut (48).
17. Remove pins (49) from nut (48) by driving pins (49) remaining distance into ID of nut (48).
18. Remove stop pin (47) from screw (46).
19. If worm (44) or pin (45) must be replaced, remove worm (44) from pin (45) by closing pliers loosely around pin (45) behind worm and lightly tap up with a plastic or wood hammer. To remove pin (45) from screw (46) clamp pin (45) in vise and rotate and pull on screw (46). Pin will come out.

20. Drive pin (25) from motor (23) shaft and remove coupling (24).

NOTE

If coupling is not damaged, it need not be removed.

21. If bushing (36) in housing (22) is worn, remove it.

22. If bushing (33) in housing (22) clevis is worn, press bushing (33) out.

NOTE

If switches (16), switch gear cam (13), switch cam (11), or gear cam shaft (10) do not have to be replaced, do not remove. Disassembly of actuator is complete. If these parts must be removed, proceed as follows:

23. Remove set screws (14) from switch gear cam (13) and set screw (12) from switch cam (11). With a 3/16" diameter punch and hammer, tap on bearing (9) driving bearings and gear cam shaft (10) out. (Bearings (9) will be damaged and must be replaced.)

24. Remove screws (15) (potentiometer bracket (6) if actuator has potentiometer unit), switches (16) with terminal wires (17, 18, 19 and 20) and insulation (8 and 21) from housing (22). Remove terminal wires (17, 18, 19 and 20) from switches (16).

25. If gear (5) on potentiometer is damaged, it must be replaced. Remove gear (5) from potentiometer (7) shaft. Take care to prevent damage to potentiometer. Disassembly is now complete.

4-5. Assembly

1. Assemble drive coupling (24) on motor (23) shaft. Align hole in coupling (24) with hole in motor (23) shaft and install pin (25).

2. Assemble bearing (31) on pinion (32) and install retaining ring (30) on pinion (32).

3. Apply Loctite retaining compound grade AV (or equivalent) to OD of bushing (34) and install in housing (22). Assemble into housing (22) end opposite side of housing with 4 holes for mounting motor adapter (29).

4. Press bushing (33) in housing (22) clevis.

5. Press bushing (36) in housing (22).

6. Install red jumper wires (17) and (18) on limit switch (16) (jumper wire 18 with flag terminal on N.C. spade of switch 16). See Figure 6.2.

NOTE

COM. and N.C. markings on terminal wires.

7. Install black jumper wires (19) and (20) on opposite switch (16).

NOTE

Terminal wires with COM. and N.C. markings must be connected to identically marked switch terminals.

Assembly of limit switch components in housing. Refer to Figure 5.1.

NOTE

Housing (22) should be in a soft-jaw vise with housing limit switch box up.

8. Place insulation (21) in housing (22) limit switch box. Install switches (16) with screws (15) (N.O. and N.C. terminals should be facing to top of box. Common contact should face toward sides of box away from center).

Feed terminal wires thru 1/2" tapped hole to outside of housing.

If actuator has potentiometer feature, potentiometer bracket (6) should be installed on top of left hand switch (16) (switch with red terminal wires).

9. Install bushing (9) in left side of housing (22) switch box only.

10. Insert gear cam shaft (10) into switch box from right side of box assembling switch cam (11) and switch gear cam (13) on shaft. Position cams between switches with switch gear cam on left and switch cam on right. Insert left end of gear cam shaft (10) in bearing (9) and install right side bearing (9) on gear cam shaft (10) and into right side of housing (22) switch box. [Stake around bearing (9) to prevent axial movement of gear cam shaft (10)]

NOTE

Check to ensure that gear cam shaft rotates freely.

11. Thread set screws (14) in switch gear cam (13) and tighten against gear cam shaft (10) (care should be taken not to strip threads).

NOTE

Rotate gear cam shaft to make sure that switch gear cam is properly located and activates switch.

12. Thread set screw (12) in switch cam (11). Tighten lightly against shaft to prevent movement.

13. Install pinion (32) and pinion bearing (31) into housing (22).

14. Assemble motor adapter (29) onto housing (22) holding in place with screws (28).

15. Press bushing (42) into outer tube (41). Press seal (43) in outer tube (41). Seal lip should be facing inward.
16. Assemble nut (48) on screw (46). Flange of nut (48) must face towards turned end of screw (46).
17. Install stop pin (47) into screw (46) taking care to center pin.
18. Fill translating tube (50) approximately half full with Shell Darina EP2 grease.
19. Assemble nut (48) into translating tube (50) and align holes in translating tube with holes in nut. Install pins (49). Pins should be 1/32 inch above OD of tube.
20. Assemble washer (40) on screw (46).
21. Assemble bearing (39) on gear (37) and assemble on screw (46). Align slot in gear (37) with hole in screw (46) and install pin (38). Pin should be centered when assembled. Be careful not to damage gear teeth.
22. Assemble worm (44) and pin (45) assembly in screw (46).
23. Assemble worm (44) on pin (45). Worm end with hex I.D. must be flush with end of pin.

NOTE

Pin dia. and hole in end of screw must be clean and free of dirt, oil and grease.

24. Clamp housing (22) in vise (use soft jaws gear cavity up). Fill cavity approximately to centerline of pinion (32) with Shell Darina EP2 grease.
25. Assemble translating tube (50), bearing (39) and gear (37) assembly into housing. Take care not to damage gear (37) teeth. Rotate pinion (32) while assembling to be sure of proper mesh gear (37) teeth with pinion (32) thread.

NOTE

Also check mesh of worm (44) with switch gear cam (13).

26. Grease OD of translating tube (50) with Shell Darina EP2 grease.
27. With translating tube (50) extended approximately 31/2" to 4" from washer (40), assemble outer tube (41) on translating tube (50) and thread outer tube (41) into housing (22) against bearing (39). Torque in place at 40 ± 10 foot pounds.
28. Spot drill outer tube (41) through set screw hole (use drill slightly smaller than ID of thread). Remove chips and install set screw (35) and lock in place against outer tube (41).

29. Assembly of Motor:

- I. Assemble brake cam (26) on pinion (32).
- II. Install brake spring (27) into motor adaptor (29) (see figure 4-2).
- III. Taking care that the motor (23) end bells do not separate from motor (23) shell, align drive coupling (24) pins as shown in figure 4-2 and assemble motor (23) to motor adaptor (29) holding in place with screws.

If unit has potentiometer assembly which does not have to be replaced, or unit has no potentiometer, proceed to step 31.

30. Potentiometer Assembly

- A. Assemble washer (7b) and nut (7a) on potentiometer (7) (nut should not be tightened).
- B. Assemble gear (5) on potentiometer (7) shaft.

NOTE

Gear should be assembled on potentiometer shaft with a very light press fit. See sketch for required dimensions of gear on potentiometer. Take care not to damage potentiometer.

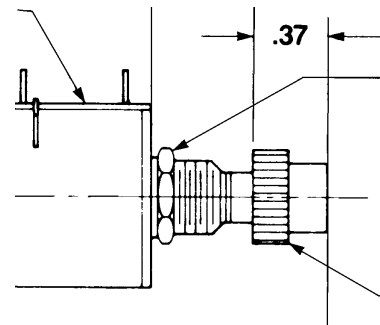


Figure 4-1. Potentiometer Nut and Washer Illustration

31. Adjust limit switches per Paragraph 2-2 and calibrate and install potentiometer (if applicable) per Paragraph 2-3.
32. Assemble gasket (3) and cover (1) on housing (22) and hold in place with screws (1).

ASSEMBLY IS NOW COMPLETE.

Section V Parts List and Technical Illustration

Table 5-1. Parts List for 3905, 3904, 6905 & 6904 Series, DC with Limit Switch

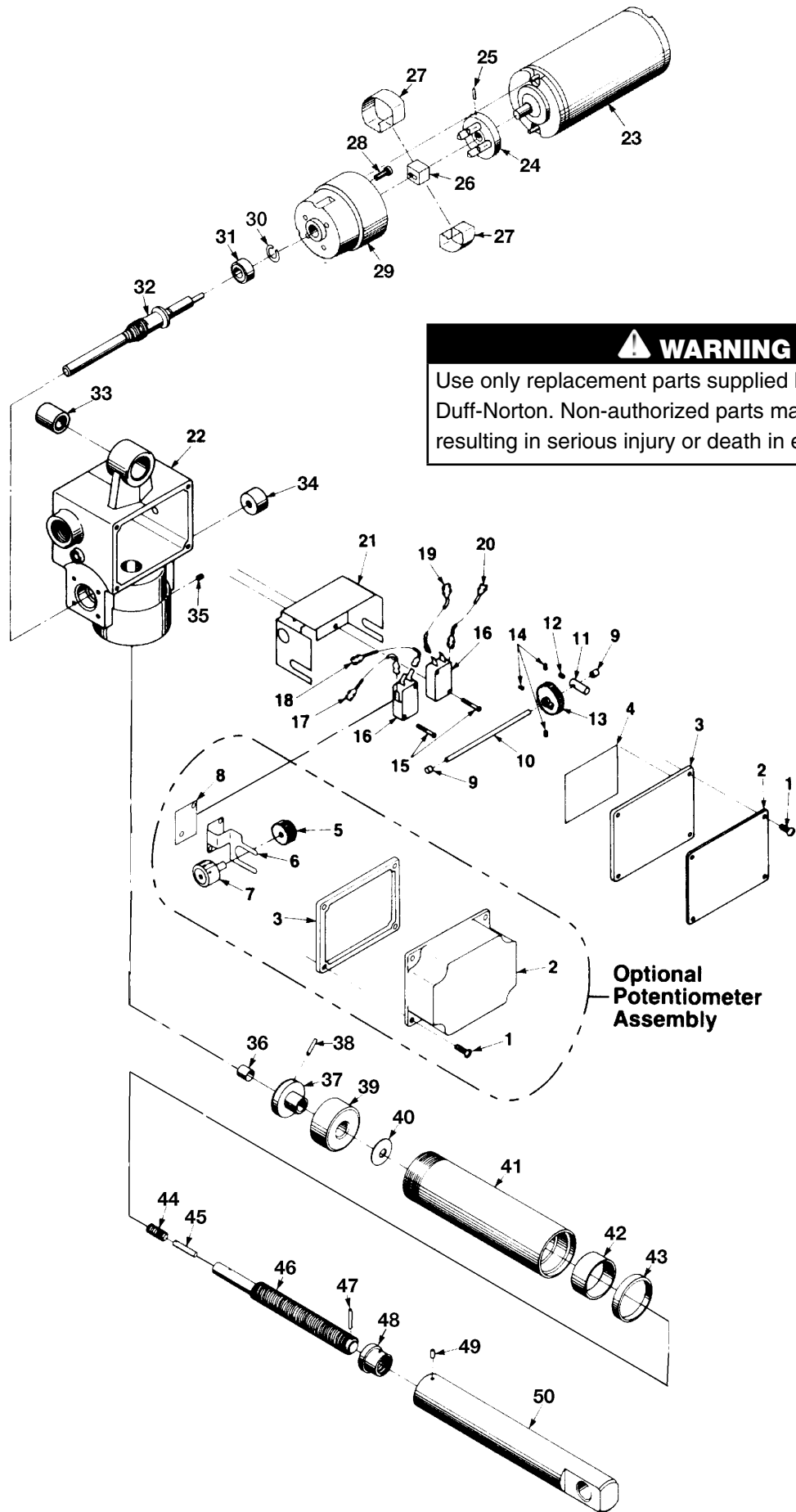
Index No.	Part Name	Qty. Req.	Part Number
1	Screws	4	H-2979
2	Switch Cover	1	SK-6905-2
2	Switch Cover (Optional Pot Unit)	1	SK-3608-34
3	Switch Cover Gasket	1	SK-6905-14
3	Switch Cover Gasket (Opt. Pot. Unit)	1	SK-3608-35
4	Instruction Decal	1	SK-6905-15
5	Worm Gear (Pot. Opt.)	1	SK-6415-62
6	Potentiometer (Opt. 7b)	1	SK-6415-71
7		1	††See Below
8	Insulation (Opt.)	1	SK-6415-66
9	Bushing	2	SK-6905-9
10	Gear Cam Shaft	1	SK-6905-5
11	Switch Cam	1	SK-6905-6
12	Set Screw	1	S-7-117
13	Switch Gear Cam	1	SK-6905-4
14	Set Screw	3	S-7-1
15	Screws	4	H-2979
16	Switch	2	SK-6905-13
17	Jumper Wire (Red COM.)	1	SK-6905-19-
18	Jumper Wire (Red N.C.)	1	SK-6905-19-
19	Jumper Wire (Black N.C.)	1	SK-6905-20
20	Jumper Wire (Black COM.)	1	SK-6905-19
21	Insulation	1	SK-6905-7
22	Housing	1	SK-6905-1
23	Motor 12 VDC (Std')	1	SK-6405-22-
23	Motor 24 VDC (Opt.)	1	SK-6505-159
23	Motor 12 VDC High Speed (Opt.)	1	SK-2374-43
24	Drive Coupling	1	SK-2374-20
25	Pin	1	S-50-68
26	Brake Cam	1	SK-2374-19

Index No.	Part Name	Qty. Req.	Part Number
27	Spring	2	SK-2374-18
28	Screw	4	SK-2374-25
29	Motor Adaptor	1	SK-2374-2
30	Retaining Ring	1	SK-2374-8
31	Pinion Bearing	1	SK-2374-5
32	Pinion	1	SK-2374-3
33	Bushing (Housing Clevis)	1	SK-6405-4
34	Bushing	1	SK-2374-10
35	Set Screw	1	S-7-94
36	Bushing	1	SK-2374-11
37	Gear	1	SK-2374-4
38	Pin	1	H-5167
39	Load Bearing	1	SK-2374-6
40	Washer	1	SK-2374-9
41	Outer Tube	1	SK-6405-12*
42	Guide Bushing	1	SK-2374-26
43	Seal	1	SK-2374-16
44	Worm	1	SK-6905-3
45	Pin	1	SK-6905-26
46	Screw	1	SK-2374-12*
47	Pin (Stop)	1	H-5159
48	Nut	1	SK-2374-13
49	Pin	2	H-5160
50	Translating Tube & Clevis Assembly	1	SK-6405-25-

* Denotes dash number is equal to travel

†† **Optional**

Travel	Potentiometer (7)	Ohms	Ohms/Inch Change	Potentiometer with gear (7 & 5)
9" or less	SK-3275-24	5000	530	SK-6415-70-10A
Over 9"	SK-6200-18	5000	167	SK-6415-70-5A



⚠ WARNING
 Use only replacement parts supplied by or approved by Duff-Norton. Non-authorized parts may be inadequate, resulting in serious injury or death in event of failure.

Figure 5-1. Exploded Illustration DC Actuator

Section VI Technical Illustrations

6-1. Brake Coupling

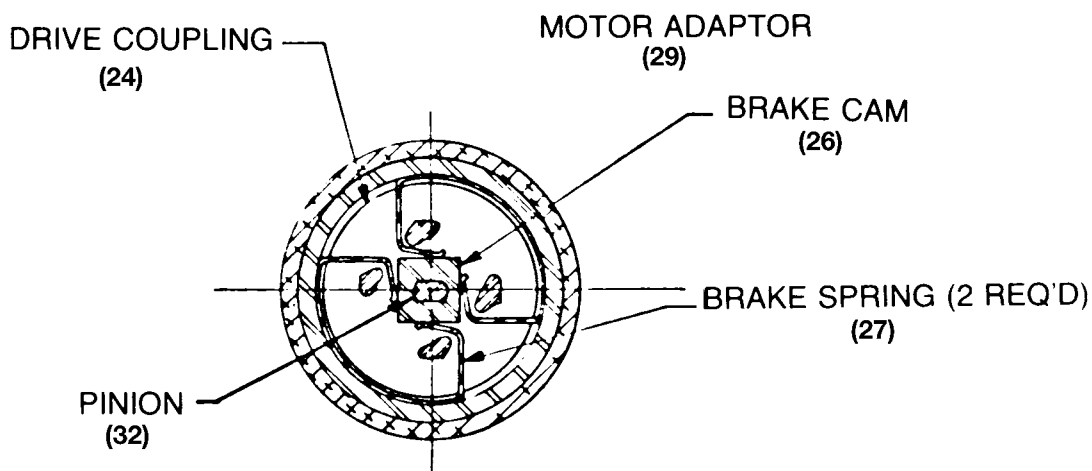
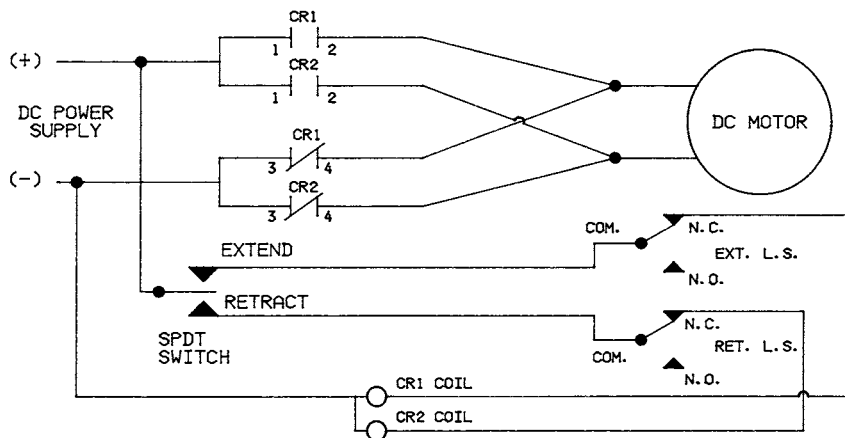


Figure 6-1. Brake Coupling Alignment DC Unit

6-2. Limit Switch



Duff-Norton's PDC Series Control Box or 2 SPDT Relays must be used to avoid burning up the limit switches.

Low voltages may reduce load rating of the actuator

Figure 6-2. Limit Switch Wiring Diagram, DC Actuator

6-3. Limit Switch Assembly

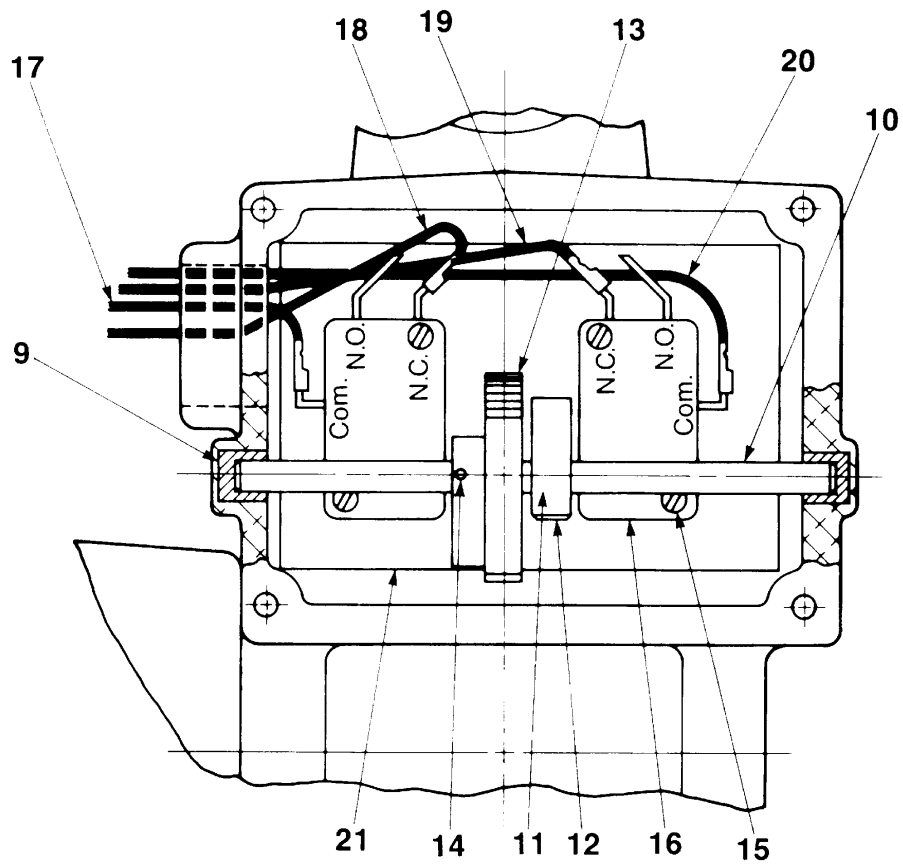
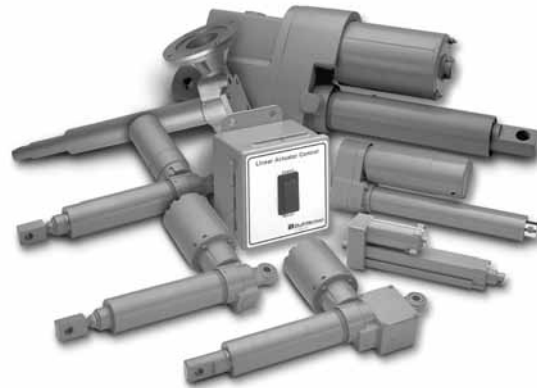


Figure 6-3. Limit Switch Assembly DC Actuator

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