



Technical Manual

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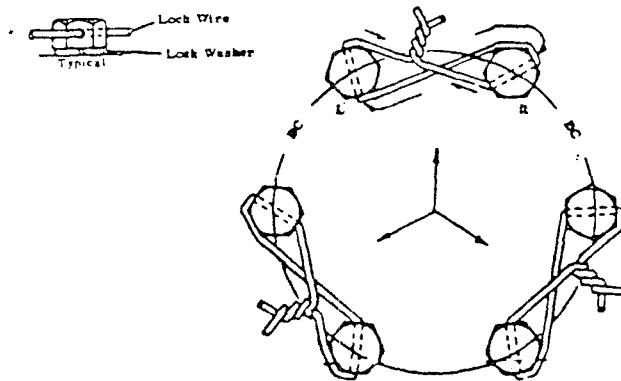
Section 1 – Engineering Data (Continued)	Page
Shrink Fit Mounting Data	13
Cap Screw (Bolt) Class	14
Turn-of-Nut Method	14
Torque Method	14
Engineering Standard 1101-2	16
Dragline Boom Inspection	16
Preliminary Instructions for Gear Installation	18
Clean	18
Find the Match Marks	18
Before Mounting the Coupling Hub	18
The Mounting Surface	19
Split Ring Gear Installation Instructions:	
Mount One Gear Half	19
Bolt Assembly Clearance Check	19
Mounting Second Gear Half	19
Alignment Bolt Installation:	
An Alignment Bolt Assembly	19
Coat	19
Insert Tapered Alignment Bolt	20
Check Alignment	20



Shaft		Running Clearance	Shaft		Running Clearance
Nom. Diam.	O.D.		Nom. Diam.	O.D.	
34-1/2	34.500 34.494	.046 .068	38-1/2	38.500 38.494	.051 .073
34-3/4	34.750 34.744	.046 .068	38-3/4	38.750 38.744	.051 .073
35	35.000 34.994	.046 .068	39	39.000 38.994	.051 .073
35-1/4	35.250 35.244	.046 .068	39-1/4	39.250 39.244	.051 .073
35-1/2	35.500 35.494	.046 .068	39-1/2	39.500 39.494	.051 .073
35-3/4	35.750 35.744	.048 .070	39-3/4	39.750 39.744	.052 .074
36	36.000 35.994	.048 .070	40	40.000 39.994	.052 .074
36-1/4	36.250 35.244	.048 .070	40-1/4	40.250 40.244	.052 .074
36-1/2	36.500 36.494	.048 .070	40-1/2	40.500 40.494	.052 .074
36-3/4	36.750 36.744	.049 .071	40-3/4	40.750 40.744	.054 .076
			41	41.000 40.994	.054 .076
			41-1/4	41.250 41.244	.054 .076
			41-1/2	41.500 41.494	.054 .076
			41-3/4	41.750 41.744	.055 .077
			42	42.000 41.994	.055 .077
			42-1/4	42.250 42.244	.055 .077
			42-1/2	42.500 42.494	.055 .077
			42-3/4	42.750 42.744	.056 .079



ENGINEERING STANDARD 1101-2 for wire lock cap screws. This standard establishes recommended method for these fasteners. Use here is for designs where maximum locking assurance is required and periodic visual inspection is not possible. Check classification 121F for special fasteners with 1/8" holes for locking with 14 gauge soft annealed wire. **RECOMMENDED WIRING METHOD:** The following procedures will exert a tightening force on cap screws as the wire is twisted tight.



Wired in Pairs: Establish left and right hand fasteners as viewed from center of bolt circle. Insert left end of wire thru left hand fastener from inside to outside of bolt circle. Insert right end of wire thru right hand fastener from outside to inside of bolt circle.

DRAGLINE BOOM INSPECTION on a systematic and regular basis must be established. Service personnel should quickly develop the habit of looking over ALL boom parts in their regular, daily routines. Early detection and quick repair prevents failure. A stretch, bend or defect often shows up in surface paint condition. Wrinkles or waves in surface paint show a problem. A collection of dust along a line may indicate a crack in metal or weld. Bright or shiny spots indicate movement. A complete and competent visual inspection, **ONCE A WEEK**, is necessary to emphasize the following points.

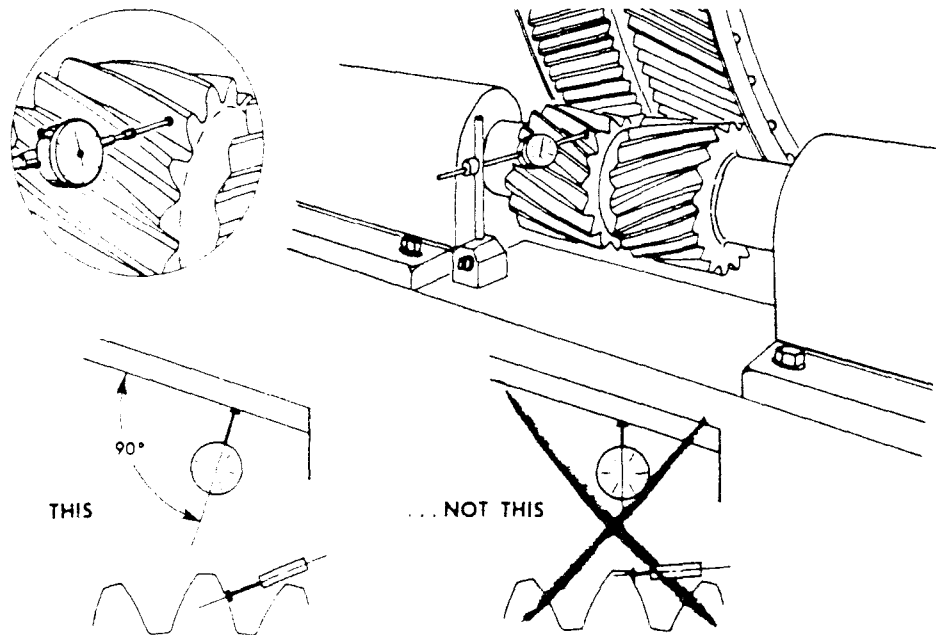
1. Boom foot castings and gussets: Look closely at welds on gusset plate ends.
2. Are boom chords straight? is ANY area of chord and web **BENT OR DEFORMED**, as if struck by the bucket? It happens.
3. Is boom lacing straight? Look for break in weld or parent metal. Check closely where lacing pipe attaches to boom chord and where these lacing pipes join. The **CRITICAL AREA IS the WELD and the PIPE METAL just NEXT TO WELD**. Sight along the boom. Bent pipes show up easily this way. Check ALL horizontal, vertical and diagonal pipes.
4. Inspect the boom foot apex. This is the **MOST CRITICAL AREA**. Carefully look and check the gusset plates, weld and pipe connections.



The EXAMPLE (right) shows the contact and backlash measurements of a gear set of 1 diametral pitch. From table 3, the recommended backlash is .030 minimum and .060 maximum.

Position of Gear Relative to Mesh	Contact		Backlash	
	Left CL	Right CR	Left BL	Right BR
Start Position	.000	.002	.048	.047
90 ⁰ from Start Position	.000	.001	.047	.045
180 ⁰ from Start Position	.002	.000	.042	.045
270 ⁰ from Start Position	.003	.000	.037	.040

ALTERNATE METHOD OF CHECKING TOOTH CONTACT AND BACKLASH: When impossible to use a feeler gauge due to space limitations, obtain proper contact pattern by the trace method. Satisfactory patterns are shown in sketch.



After a correct pattern is established, CHECK the backlash with an indicator as shown in sketch. DETERMINE proper backlash from table 3. USE CARE in adjusting pedestals to establish correct backlash. Use indicators at EACH pedestal for EQUAL in - out movement so not to affect a change in contact setting. After proper backlash is obtained, RECHECK contact.

FINAL CHECK FOR UNIFORM CONTACT PATTERN: After establishing pinion alignment (with pedestals firmly secured); make a final check for tooth contact to assure accurate gear alignment. Apply a very thin coat of Prussian blue pigment, lamp black, or red lead to five or six pinion teeth, previously cleaned (see above), COVER ENTIRE profiles of the



on a new rope due to minimum surface contact of each wire. As these wires wear, they present a flattened surface and the rate of normal wear decreases.

Determine the cause of outer wire breaks by examining the break.

Tension breaks show a cup and cone effect at the break. This is caused by overload, shock load, jerking a load or catching a falling load.

Careless operational load handling.

Fatigue break showing a square end break with granular metal appearance. Repeated bending over sheave causes fatigue or the sway and vibration at dead end anchor and static sheave.

A shear break indicated by a smooth, twisted break generally comes from external damage (nicks or kinks) in the rope.

Several outer wire breaks at isolated areas along rope length cause little concern. Concentrated breaks at a single location indicate severe rope damage. Retire this rope.

External corrosion indicated by rust, scales or pitting on rope surface remains out in the open. Internal corrosion may appear as pitting in strand valley or rust and scale working out from under strands. Outside wire or strands appear slack or seem to stand out from inner portion with severe corrosion. Under a load this rope shows a loss in diameter.

Internal wear or core fatigue indications emulate those of severe corrosion. Wire or strands appear slack and noticeable loss in diameter occurs under load. Internal wear often results from faulty equipment (tight sheave groove, etc.) in a local area.

Rope retirement from service requires a decision based upon a combination of factors.

Inspection determines the abrasive wear effect on outer wires. Percentage of rope area intact indicates rope strength percentage remaining.

The number of broken wires contained within one lay (one full strand wrap) evaluates remaining rope strength to some degree.

No reliable means of determining corrosive effect and internal wear exists. Good operating conditions and effective lubrication keeps these factors to a minimum.

Study the entire rope to determine the section suffering the most severe deterioration. One or more of the following indicates this deteriorating:

Drastic loss in rope diameter and lay lengthening.

Outer wire abrasion.



correctly and brace, clamp, or tack weld to maintain alignment. Use the specified welding preheats for ALL arcing or burning.

PREHEAT area adjacent to weld area to specified temperatures. (See Welding Specifications).

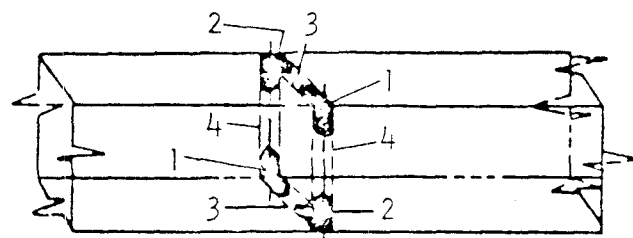
INCREASE preheat temperature 50 degrees F. (10 degrees C.) for material (at weld) 1-1/2 to 2-1/2 inches thick and up to 100 degrees F. (38 degrees C.) for material OVER 2-1/2 inches thick.

MAINTAIN preheat until weld is completed. This is important. Templi-Stiks (from Tempil Corp., N.Y., N.Y.) are helpful for temperature determination.

POSTHEAT area adjacent to weld 100 degrees F. (38 degrees C.), higher than preheat specified. (See Welding Specifications). **MAINTAIN** postheat for one hour PLUS 1/2 hour for each inch of thickness. **CONTROL** cooling rate so temperature is about 50 degrees F. (10 degrees C.) per hour until temperature reaches 150 degrees F. (65.5 degrees C.). This is important.

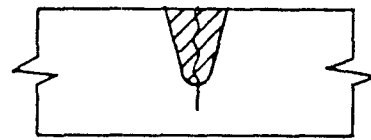
THE ORDER OF WELDING reduces warpage and provides a favorable locked up or residual stress pattern. The use of block welding (short, full size welds) helps reduce warpage. In many cases, V-ing out small areas and rewelding each of these areas; continuing until completing repair eliminates warpage. A favorable locked up or residual stress condition is obtained by making FULL DEPTH welds at the area farthest from the neutral axis first; then making welds closest to this neutral axis last.

To eliminate fusion cracks that persist when welding castings; first deposit a thin layer of weld metal on surfaces for weld, then complete the weld. In box section members this means; first, weld the two diagonal corners; second, the remaining corners; third, the top and bottom; and last, the sides. (See sketch). This procedure creates residual compression at the extreme fibers where it is most beneficial.

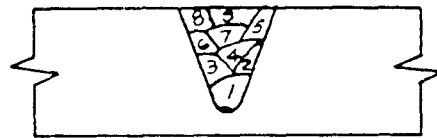


Preferred sequence for blocking
in butt joint in box section

PEENING often reduces locked up stresses and maintains original dimensions and alignment, as well as, help prevent weld metal cracking in rigid sections. Use a blunt nosed tool. **DO NOT** peen the first (root or base) pass or cover passes. Avoid **EXCESSIVE** peening in other passes.



Crack not completely removed
reappears in repair weld



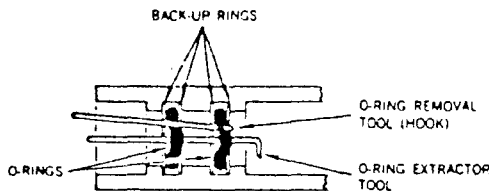
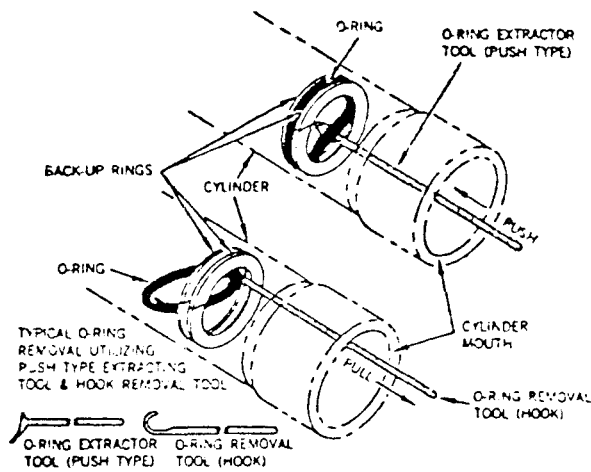
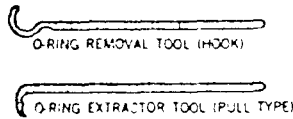
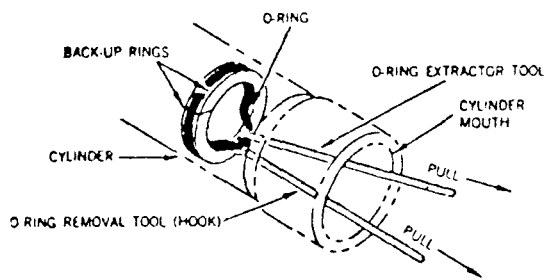
Whenever possible make center
pass last as shown



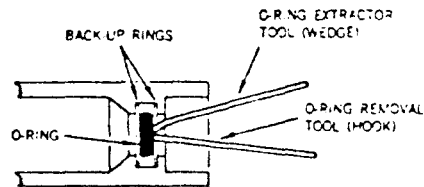
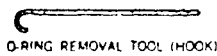
DO NOT USE pointed, sharp-edged or hardened steel tools (screwdrivers, church keys or knives) for removal or installation of backup rings or seals. Soft-metal tools of brass or aluminum, plastic, wood or phenolic rod when formed into desired shape save the critical surfaces.

Tool surfaces need to be well rounded, polished and no burrs on working end. This obviously prevents scratches.

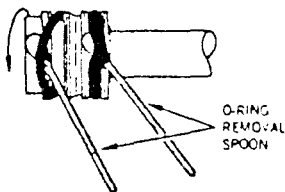
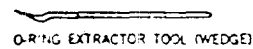
Removal from cylinders and pistons means every effort is needed to avoid contact with machined surfaces.



TYPICAL DUAL O-RING INTERNAL EXTRACTION AND SIMULTANEOUS REMOVAL

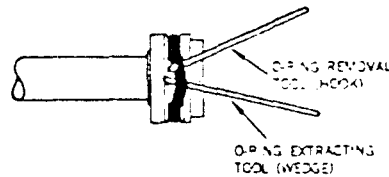


TYPICAL SINGLE O-RING INTERNAL EXTRACTION UTILIZING WEDGE TYPE EXTRACTING TOOL AND HOOK REMOVAL TOOL



TYPICAL EXTERNAL O-RING REMOVAL UTILIZING O-RING REMOVAL SPOON

CAUTION: DO NOT PERMIT UNNECESSARY CONTACT OF TOOLS WITH BEARING AND CYLINDER WALL SURFACES. AVOID DROPPING TOOLS INTO CYLINDERS.



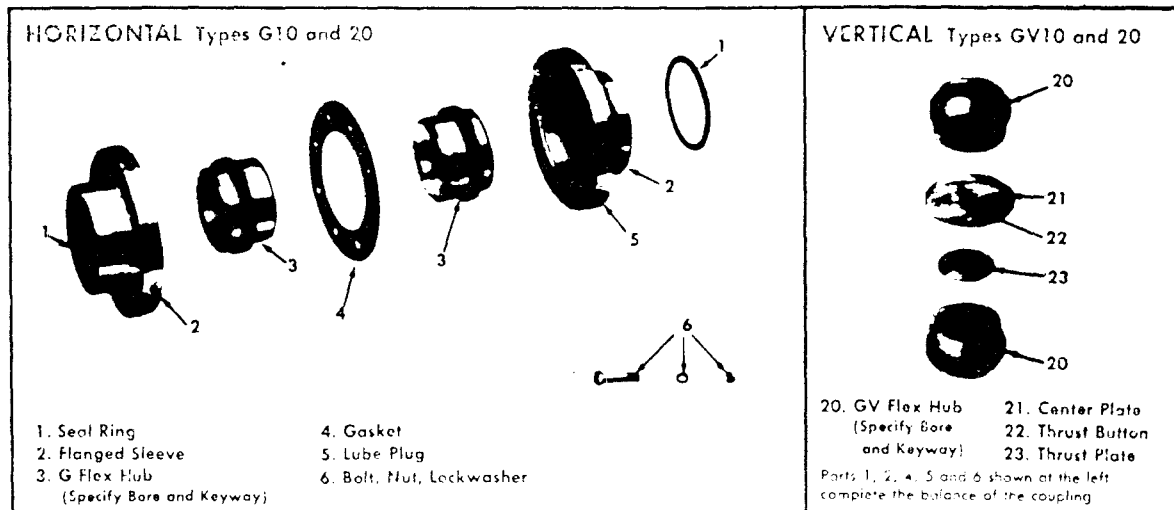
TYPICAL SINGLE O-RING REMOVAL UTILIZING WEDGE TYPE EXTRACTING TOOL AND HOOK TYPE REMOVAL TOOL

NOTE: AFTER O-RING IS DISLODGED FROM GROOVE, HOLD SPOON TOOL STATIONARY. SIMULTANEOUSLY ROTATE AND WITHDRAW PISTON FROM RING.



FALK COUPLING TYPE G AND GV

G TYPE INSTALLATION

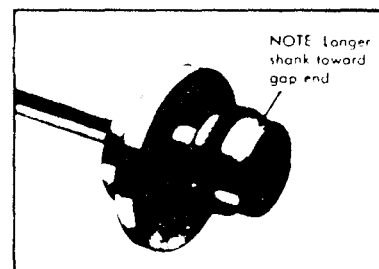


1. Clean all parts. Heat hubs in an oil bath or oven to a maximum of 275 degrees F. (135 degrees C.). DO NOT rest gear teeth on container bottom or apply a flame directly to gear teeth.

Pack sleeve teeth with grease and lightly coat seals with grease BEFORE assembly. DO NOT use cup grease. DO NOT DAMAGE SEALS.

Use a dial indicator to align dynamically balance couplings and assembly parts with mating match marks aligned. Mount indicator on one hub and take readings for OFF-SET check on O.D. of other hub. The difference between minimum and maximum readings DIVIDED by two should not exceed the values in Table. For ANGULAR check, take readings on either face of other hub. The difference between the minimum and maximum readings should not exceed the values in Table.

2. MOUNT FLANGED SLEEVES, SEAL AND HUBS—Place flanged sleeves WITH seal rings on shafts before mounting hubs. CAUTION: DO NOT DAMAGE SEALS. Mount hubs on respective shafts, as shown so each hub face is flush with its shaft end. Position equipment in approximate alignment with approximate gap specified in Table.



2 MOUNT FLANGED SLEEVES, SEALS AND HUBS

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CONVERSION TABLE

Fractional Inch to Decimal Inch and Millimeters

Fractional Inch	Decimal Inch	Millimeters	Fractional Inch	Decimal Inch	Millimeters
1/64	0.015625	0.3906	31/64	0.515625	13.0689
1/32	0.03125	0.7937	17/32	0.53125	13.4977
3/64	0.046875	1.1906	35/64	0.546875	13.8906
1/16	0.0625	1.5875	9/16	0.5625	14.2875
5/64	0.078125	1.9814	17/64	0.578125	14.6844
3/32	0.09375	2.3812	19/32	0.59375	15.0812
7/64	0.109375	2.7781	39/64	0.609375	15.4781
1/8	0.125	3.1750	5/8	0.625	15.8750
9/64	0.140625	3.5719	41/64	0.640625	16.2719
5/32	0.15625	3.9687	21/32	0.65625	16.6687
11/64	0.171875	4.3656	43/64	0.671875	17.0656
3/16	0.1875	4.7625	11/16	0.6875	17.4625
13/64	0.203125	5.1594	45/64	0.703125	17.8594
7/32	0.21875	5.5562	23/32	0.71875	18.2562
15/64	0.234375	5.9531	47/64	0.734375	18.6531
1/4	0.25	6.3500	3/4	0.75	19.0500
17/64	0.265625	6.7469	49/64	0.765625	19.4469
9/32	0.28125	7.1437	25/32	0.78125	19.8437
19/64	0.296875	7.5406	31/64	0.796875	20.2406
5/16	0.3125	7.9375	13/16	0.8125	20.6375
21/64	0.328125	8.3344	53/64	0.828125	21.0344
11/32	0.34375	8.7312	27/32	0.84375	21.4312
23/64	0.359375	9.1281	55/64	0.859375	21.8281
3/8	0.375	9.5250	7/8	0.875	22.2250
25/64	0.390625	9.9219	57/64	0.890625	22.6219
13/32	0.40625	10.3187	29/32	0.90625	23.0187
27/64	0.421875	10.7156	59/64	0.921875	23.4156
7/16	0.4375	11.1125	15/16	0.9375	23.8125
29/64	0.453125	11.5094	61/64	0.953125	24.2094
15/32	0.46875	11.9062	31/32	0.96875	24.6062
31/64	0.484375	12.3031	63/64	0.984375	25.0031
1/2	0.50	12.7000	1	1.00000	25.4000

CONVERSION TABLE

Millimeters to Inches

Millimeters	Inches	Millimeters	Inches	Millimeters	Inches
1	0.0394	36	1.4173	71	2.7923
2	0.0787	37	1.4567	72	2.8316
3	0.1181	38	1.4961	73	2.8710
4	0.1575	39	1.5354	74	2.9104
5	0.1968	40	1.5748	75	2.9497
6	0.2362	41	1.6142	76	2.9891
7	0.2756	42	1.6535	77	3.0285
8	0.3150	43	1.6929	78	3.0679
9	0.3543	44	1.7323	79	3.1072
10	0.3937	45	1.7716	80	3.1466
11	0.4331	46	1.8110	81	3.1860
12	0.4724	47	1.8504	82	3.2254
13	0.5118	48	1.8898	83	3.2647
14	0.5512	49	1.9291	84	3.3041
15	0.5905	50	1.9685	85	3.3435
16	0.6299	51	2.0079	86	3.3828
17	0.6693	52	2.0472	87	3.4222
18	0.7087	53	2.0866	88	3.4616
19	0.7480	54	2.1260	89	3.5009
20	0.7874	55	2.1653	90	3.5403
21	0.8268	56	2.2047	91	3.5797
22	0.8661	57	2.2441	92	3.6191
23	0.9055	58	2.2835	93	3.6584
24	0.9449	59	2.3228	94	3.6978
25	0.9842	60	2.3622	95	3.7371
26	1.0236	61	2.4016	96	3.7765
27	1.0630	62	2.4409	97	3.8159
28	1.1024	63	2.4803	98	3.8553
29	1.1417	64	2.5197	99	3.8947
30	1.1811	65	2.5590	100	3.9341
31	1.2205	66	2.5984		
32	1.2598	67	2.6378		
33	1.2992	68	2.6772		
34	1.3386	69	2.7165		
35	1.3779	70	2.7559		

1 millimeter = .03937 inch.
1 inch = 25.4 millimeter.

METRIC CONVERSIONS

To convert a metric unit to the equivalent English unit, multiply or divide by the conversion factor as indicated below.

To convert from an English unit to a corresponding metric unit, use the same conversion factors, but, reverse all multiplications to division and all divisions to multiplication.

- Calories × 3.965 = British thermal units
- Calories ÷ .252 = British thermal units
- Centimeters × .3937 = Inches
- Centimeters ÷ 2.54 = Inches
- Cubic Centimeters ÷ 16.387 = Cubic Inches
- Cubic Centimeters ÷ 3.70 = Fluid Drams (U.S.P.)
- Cubic Centimeters ÷ 29.57 = Fluid Ounces (U.S.P.)
- Cubic Meters × 35.314 = Cubic Feet
- Cubic Meters × 1.35 = Cubic Yards
- Grams × 15.432 = Grains
- Grams ÷ 28.35 = Ounces avoirdupois
- Grams per cu. cm. ÷ 27.7 = Pounds per cubic inch
- Grams (water) ÷ 29.57 = Fluid Ounces
- Hectares × 2.471 = Acres
- Hectares × .603251 = Square Miles
- Hectoliters × 2.84 = Bushels (2159.42 Cubic Inches)
- Hectoliters × 3.53 = Cubic Feet
- Hectoliters × .131 = Cubic Yards
- Hectoliters × 26.42 = Gallons (231 Cubic Inches)
- Kilo per cheval × 2.235 = Pounds per horse power
- Kilo per cubic meter × .062 = Pounds per cubic foot
- Kilo per meter × .672 = Pounds per foot
- Kilogram Meters × 7.233 = Foot Pounds
- Kilograms × 2.2046 = Pounds
- Kilograms × 35.3 = Ounces avoirdupois
- Kilograms ÷ 997.18 = Short Tons (2000 pounds)
- Kilograms per sq. cm. × 14.223 = Pounds per square inch

- Kilograms per sq. cm. ÷ .0703 = Pounds per square inch
- Kilograms per sq. mm. × 1422.32 = Pounds per square inch
- Kilometers × .621 = Miles
- Kilometers ÷ 1.6093 = Miles
- Kilometers × 3280.8 = Feet
- Kilowatts × 1.34 = H.P. (33,000 ft. lbs. per min.)
- Liters × 61.025 = Cubic Inches
- Liters ÷ 28.317 = Cubic Feet
- Liters × 33.81 = Fluid Ounces (U.S.P.)
- Liters × 2.642 = Gallons (231 Cubic Inches)
- Liters ÷ 3.785 = Gallons (231 Cubic Inches)
- Meters × 3.28 = Feet
- Meters × 39.37 = Inches
- Meters × 1.09 = Yards
- Metric Tons × 2204.6 = Pounds
- Millimeters × .03937 = Inches
- Millimeters ÷ 25.4 = Inches
- Square Centimeters × .155 = Square Inches
- Square Centimeters ÷ 6.45 = Square Inches
- Square Kilometers × 247.1 = Acres
- Square Kilometers × .3861 = Square Miles
- Square Meters × 10.764 = Square Feet
- Square Millimeters × .09155 = Square Inches
- Square Millimeters ÷ 645 = Square Inches
- Watts ÷ 746 = Horse Power
- Watts × .00134 = Horse Power



CODE	NAME	DESCRIPTION
continued. . . .		
GL	Enclosed Gear Case	<p>3. Inside machinery house, where oil is not pumped, use GL-200 except where freezing temperatures rarely or never occur, use GL-250.</p> <p>For large shovels and walking draglines:</p> <ol style="list-style-type: none"> 1. For crawlers, use GL-140. 2. For gear cases inside machinery house: <ol style="list-style-type: none"> a. Use GL-200 where temperatures rarely go below freezing. b. Use GL-250 instead of GL-200 where temperatures rarely go below freezing. c. Use GL-140 with older type pumps. <p>On new machines, oil should be drained after first 60 days of operation and replaced with new oil. Thereafter, change oil once a year, or when determined necessary by oil supplier. Oil should be checked for contamination every 30 days.</p>
PO	Pneumatic Oil	<p>Petroleum oil especially compounded for use in air line oilers or built in lubricators having the correct viscosity, low pour point, emulsifying ability, film strength and free of deposit forming tendencies. It should not cause swelling or deterioration of rubber or leather seals and gaskets.</p>
EMG	Electric Motor Grease	<p>Electric motor bearing grease meeting the requirements of G.E. Specification D6A2C5 or Westinghouse equivalent.</p>

In addition to the aforementioned products the following lubricants may also be required. No specification or standard for these products have as yet been prepared.

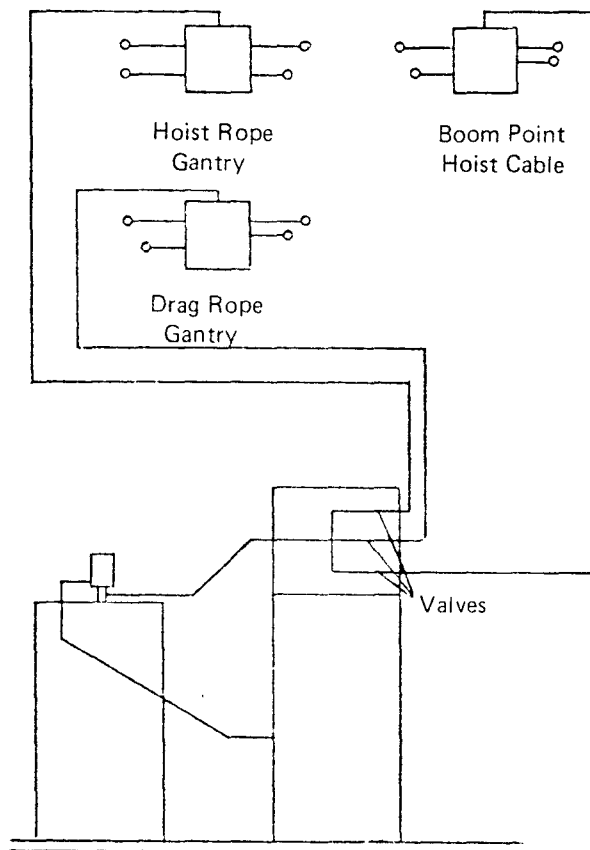


The AUTO LUBE ALARM SOUNDS WHEN:

Any main line to an injector breaks
The air supply fails
The supply line is blocked

A lube drum empties or cavitates
A pump fails
The control system breaks down

The **AUTO LUBE FOR WIRE ROPE SPRAY** supplies the hoist ropes on one line to the boom point, drag ropes on a line and hoist ropes on another line to the fairlead. Open **ONLY** one of these three valves at one time. Lube moving ropes for best results. Please use oil type dressing, **NOT GREASE**. The system uses a 400 pound drum of wire rope lube.



NOTE: Do not use pipe unions on boom, hose ends work well here. Allow slack where needed for movement. Avoid sharp bends. Use hose for equal length from tee to spray points on boom point. Recommend lubing once in each 8 hour shift, but conditions may change this at site.



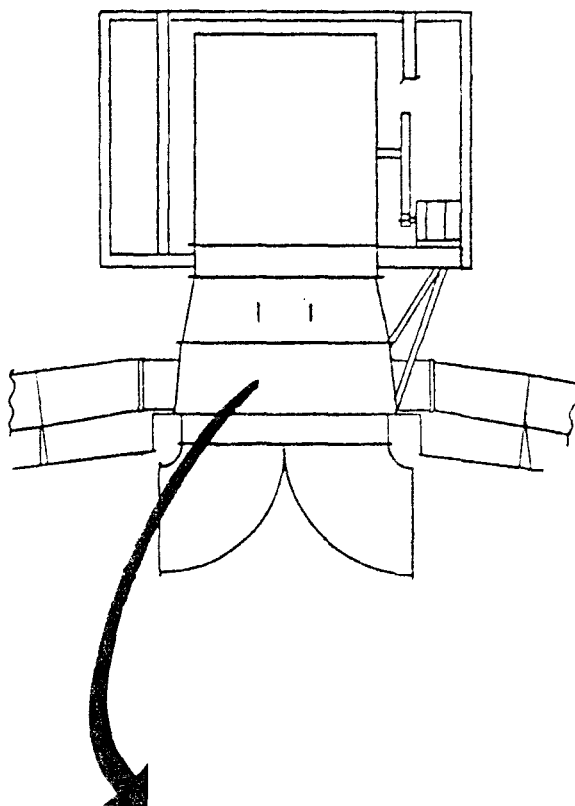
AIR FILTER SYSTEM

The entrance of dust and dirt into electrical equipment and other machinery causes extra wear to components. This is why ALL air entering the machinery house passes thru the filter house on top. Blowers create a slight pressure above the outside air. Leaving an access door open reduces this pressure. Dust and dirt generally enter. In operation, this slight pressurizing reverses any possible IN FLOW thru cable openings and personnel opening and CLOSING doors. This means ALL air drawn into the house is FILTERED. Thus protecting D.C. motors and generators, while providing longer life to commutators, carbon brushes and other machinery. Filtered air circulation reduces dust accumulation and results in lower operational temperatures of ALL equipment, including personnel.

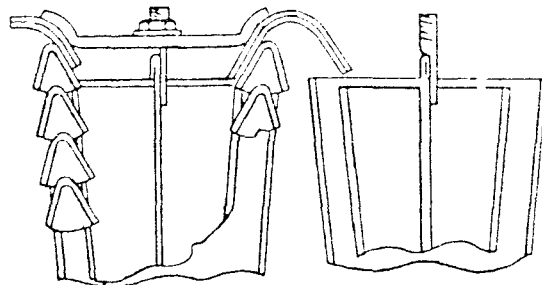
Dirty air passes into the inlets located at the wide end of wedge shaped cells. Most air (about 90%) changes direction quickly and passes thru the narrow side passages. The dirt particles due to their greater mass, tend to continue strait into the bleed air duct. The dirt ladden bleed air (about 10%) continuously cleans the bleed air duct. Thus dirt particles and bleed air return outside. These self-cleaning filters require no regular maintenance.

A few suggestions may be helpful. For instance, keep air passages free of paper, leaves, wiping cloths, etc. This allows constant air flow. An inspection helps here. Check also for build-up of deposits on filter blades. A light coat of dust is normal. Heavier build-up may require cleaning. Oil mist and similar vapors generally cause this problem. Remove the filters and scrub in soapy water. Please do not use solvents. The filter vanes do not need oil. Believe it or not, it's been done.

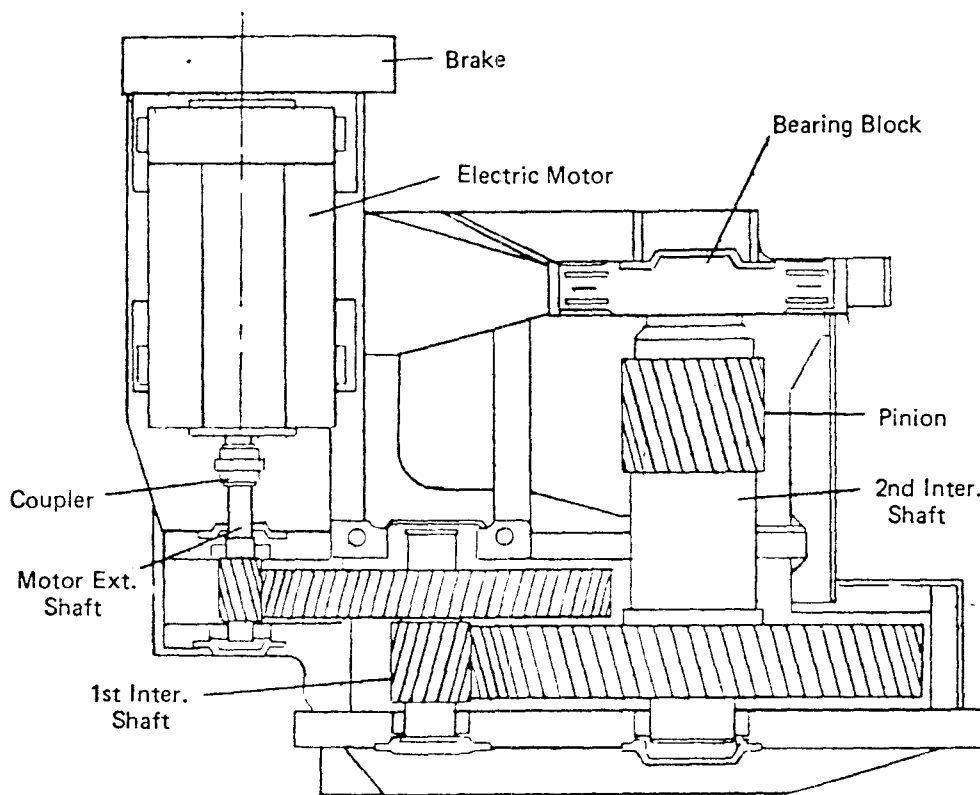
AIR FILTER HOUSE
ATOP MACHINE



CUTAWAY OF
FILTER SECTION



The 1st intermediate propel shaft includes a large diameter gear that meshes with the motor extension shaft pinion. The gear is attached to the integral pinion and shaft by involute splines. The assembly is supported by two tapered roller bearings. The 2nd intermediate shaft consists of a large gear that meshes with the 1st intermediate pinion. The gear is attached to the shaft by involute splines. The shaft extends outside the gear case when the integral pinion drives the main propel gear.



The 2nd intermediate shaft assembly is supported by one double row, tapered, roller bearing in the gear case and one cylindrical roller bearing in the outboard bearing.

The shaft assemblies can be removed from the gear case without draining the lubricant from the cases.

DISASSEMBLE GEAR CASE by separating the motor coupler and remove the oil seal from side of the case at the 2nd intermediate propel shaft. Remove the gear case cover hold down bolts and bearing housing rod bolts. Remove all cap screws from top half of all bearing retainer plates and loosen cap screws in bottom half of retainer about two turns.

It may be necessary to drive a small wedge between cover and case to break seal to separate cover from gear case. Lift off cover using lifting lugs provided. Remove bearing retainer



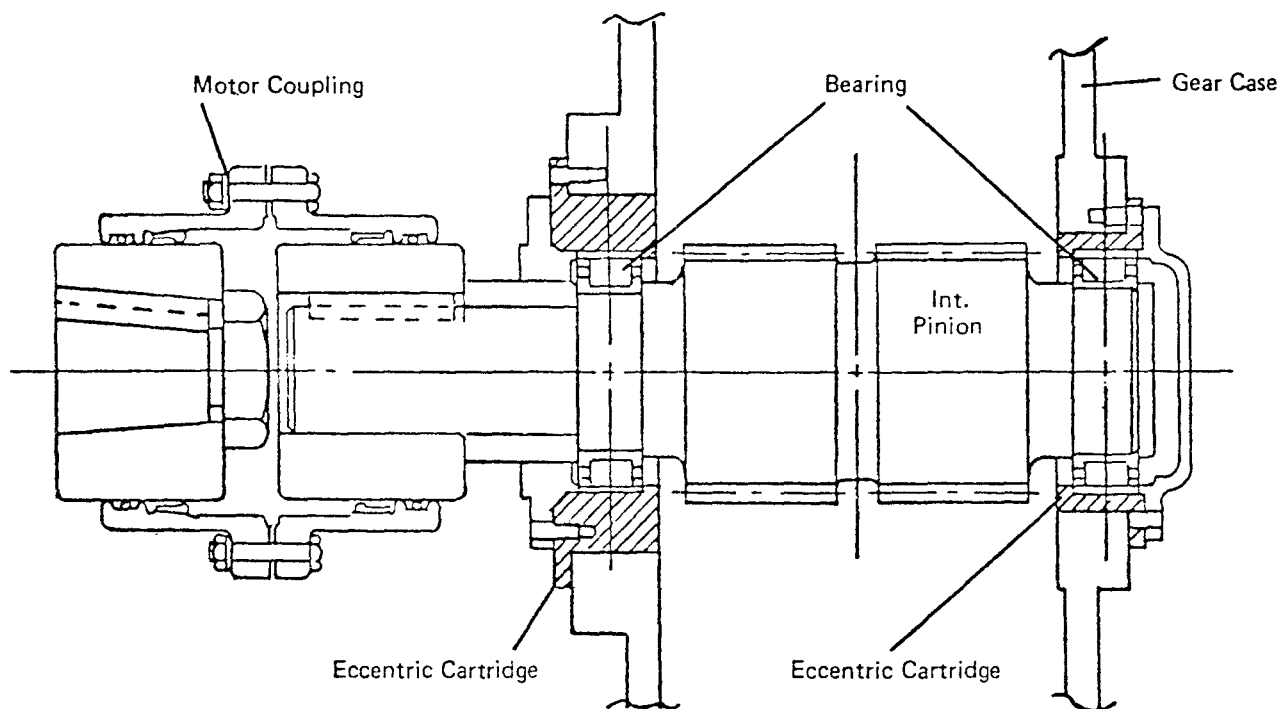
ECCENTRIC CARTRIDGE MOUNTING OF EXTENSION SHAFT GEARS — Each hoist, drag or propel motor extension shaft cylindrical roller bearing mounts in an eccentric cartridge housing. Accurate axial alignment of motor extension shaft and pinion is obtained in BOTH planes by using this cartridge.

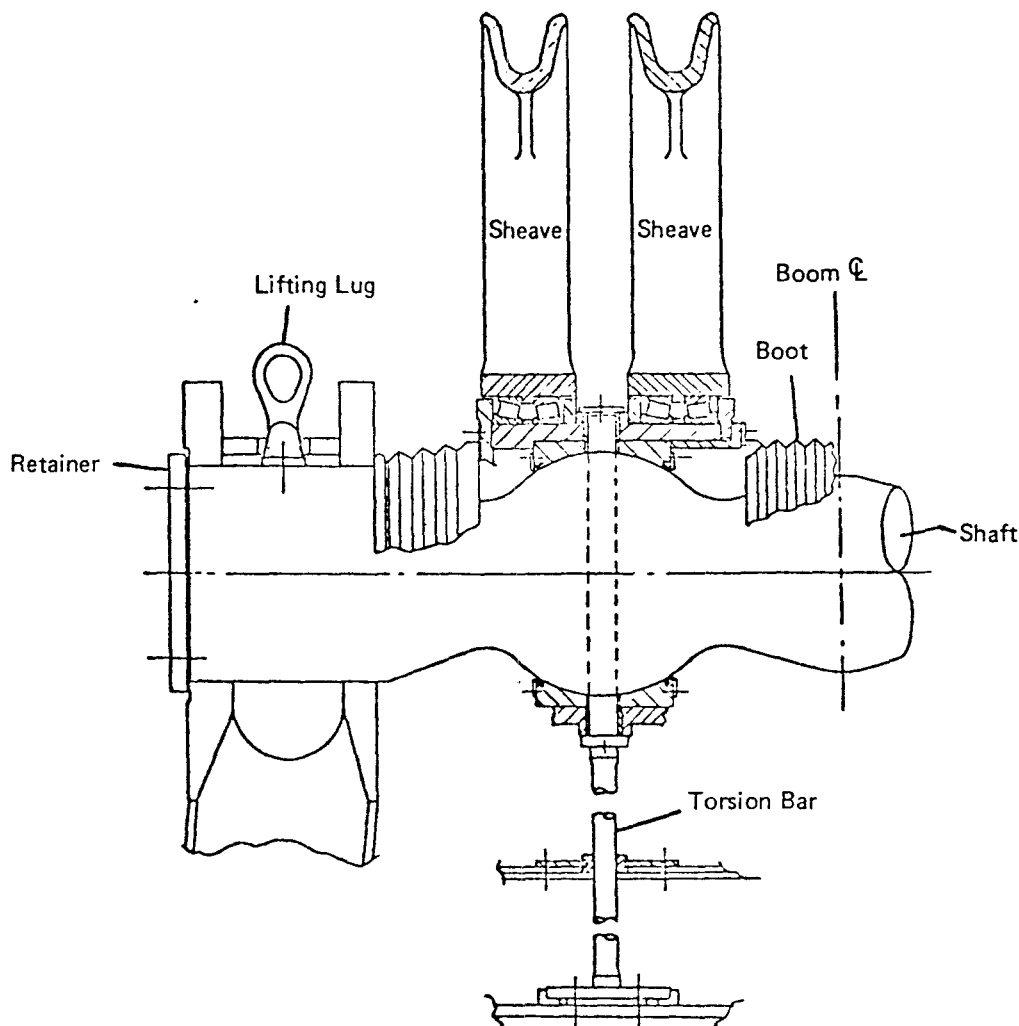
The cartridge is machined so the index boss fits the gear case bore. The cartridge has a flange concentric to the index bore with slotted mounting holes. The cylindrical roller bearing bore is machined eccentric to the index bore.

One cartridge mounts in the gear case (motor side) to allow the eccentric anti-friction bore movement perpendicular to the intermediate gear radius as the cartridge turns in the index bore.

Likewise, the cartridge mounted at the far side allows bore movement parallel to the intermediate gear radius. Each has a flange notch for use to bump the cartridge into position. The bearing bore eccentricity is slight and within the allowable misalignment range of the cylindrical roller bearing.

Tooth contact between gear and pinion indicates TRUE alignment or nature of misalignment.





To **DISASSEMBLE POINT SHEAVES** lower boom to ground on suitable cribbing or support. (See Lowering Boom.) Remove the rope guard and live end of torsion bars from the shaft assembly. Remove the dust boots and all automatic lubrication equipment.

Attach a lifting device to the lifting lugs provided at each shaft end. Pull up snug enough to support assembly weight and remove the bearing caps and rod bolts.

Remove the split retainer ring and pull away bearing retainer ring with labyrinth seal.

Slide sheave hub, anti-friction bearing and bearing carrier toward end of shaft, off spherical bushing. Remove the spherical bushing pin and bushing. When replacing spherical bushing, be sure mating parts are assembled together, check match marks carefully.

Pull out tapered roller bearing assemblies from sheave hub. Clean inside of hub and remove all burrs.



SECTION 5

ELECTRICAL MAINTENANCE

CARE OF D.C. MOTORS AND GENERATORS—

One of the most essential points in the care of electrical equipment, especially D.C. equipment, is absolute cleanliness. Too much emphasis cannot be given to pointing out the necessity of keeping motors and generators clean and free of dirt, oil or grease.

There are a few troubles common to both motors and generators which the operator should be able to recognize and remedy. Normally, D.C. motors and generators give very little trouble, but there are times when something happens that can be taken care of quickly by anyone. The most serious trouble should be handled by a competent electrician. If the commutation is bad and cannot be corrected by simple remedies, consult the electrical equipment manufacturer.

BRUSHES—

If there is an excessive amount of arcing between brushes and commutator while the shovel is operating under normal loads and speeds, inspect the brushes and check for the following:

1. See that they are not sticking in the holders.
2. Make certain the contact surfaces of brushes are clean and brushes are making full contact on the commutator.

NOTE: This can be determined by removing brush and looking at the surfact. Where the brush has been rubbing, the surface is smooth and polished. Any portion not in contact with the commutator will have a dark, rough appearance.

Excessive arcing may also be caused by loose brush holder studs which throw brushes out of line. This causes brushes to ride on heel or toe, moving out of normal commutating plan, resulting in considerable sparking. This can be corrected by tightening the brush holder in its correct position.

The brush holder yoke screw may become loosened, permitting the brush yoke to rotate and shift all the brushes. When brushes are moved out of their normal position, they will arc badly. The simple correction is to move the brush holder back into position.



The best test for rectifiers uses D.C. voltage at least 1/4th its rating. Connect a resistor in series with rectifier to limit current to a safe value. Connect resistor and rectifier across D.C. voltage, then read voltage across resistor. Reverse rectifier and measure resistor voltage. A good rectifier gives voltage across resistor with only one polarity.

Many other failures occur and often good intuition and ingenuity is needed to find them.

The trouble discussed thus far usually results in complete and permanent mal-function.

Perhaps more common and more difficult to find are intermittent failures resulting in only partial power loss. These trouble types distinguish a good trouble shooter from an average one.

Start as before, interviewing operator, oiler and witnesses. Try in questioning to determine the exact nature of trouble. When complaint indicates partial power loss, find the effect under various load conditions and determine the cause for this effect.

Often a cause for weakening may be determined in a similiar manner as locating complete failure. Select a starting point and compare measurements taken against recorded data. Compare honestly. A slight difference shows due to aging, temperature or an inaccurate instrument along with failure. Tests under one condition might not give a true problem indication. For example, tests at stall do not indicate no-load voltage is incorrect. Likewise, test for proper motor field voltage ONLY with controller (master switch) in proper position. In addition, check that stall current or no-load voltage varies properly with master switch position, since trouble could be failure of master switch.

In locating trouble of the weakening kind, one needs to know the various devices functions used to augment or increase power under certain conditions. Master switch contacts fall in this device class. Motor field contactors increase field strength under certain conditions. Conversely, current or voltage feedback circuits limit certain quantities to acceptable values. Failures resulting in decreased or increased outputs generally come from failure in these supplementary circuits.

Help here comes from knowing the effects certain changes have on performance. Naturally, reducing stall current reduces motor torque so an equally heavy load cannot be lifted as before. A reduction in no-load voltage causes decreased speeds.

A change in motor field strength offers various effects. A lower field voltage provides higher speed for light loads, but lower speed for heavy loads. Complete field loss gives very high speeds with light loads. Although this is uncommon, too strong a field creates low speed with light loads and probably high speed with heavy loads.

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