BI005625

Technical Manual

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MAINTENANCE TIPS

Just as the operator acquires a "feel" for the machine, the entire crew should try to sense failure before it strikes. Take that extra step to examine anything that appears out of place. How about a bubble or discolored crack in the paint? It is an early warning for metal stress or breakage. Could that slight hiss indicate a growing air leak? After all, it is easier to tighten a packing nut than shut down for packing repairs. An alert crew will:

Check operating air pressure.

Wipe away excess lube around bearings and gears.

Maintain correct supply lubricants.

Lube regularly.

Never lubricate parts in motion, that is gears, etc.

Look for and secure any loose bolts or locking devices.

Check all wire ropes for early signs of wear or failure.

Promptly replace all guards, inspection plates, access covers or other safety devices after inspection/repair.

USE EXTREME CAUTION around ANY electrical lines and equipment. This pertains to low as well as high voltage.

Never attempt electrical repairs, unless qualified.

Assure power source is properly grounded.

Check limit switches for proper operation.

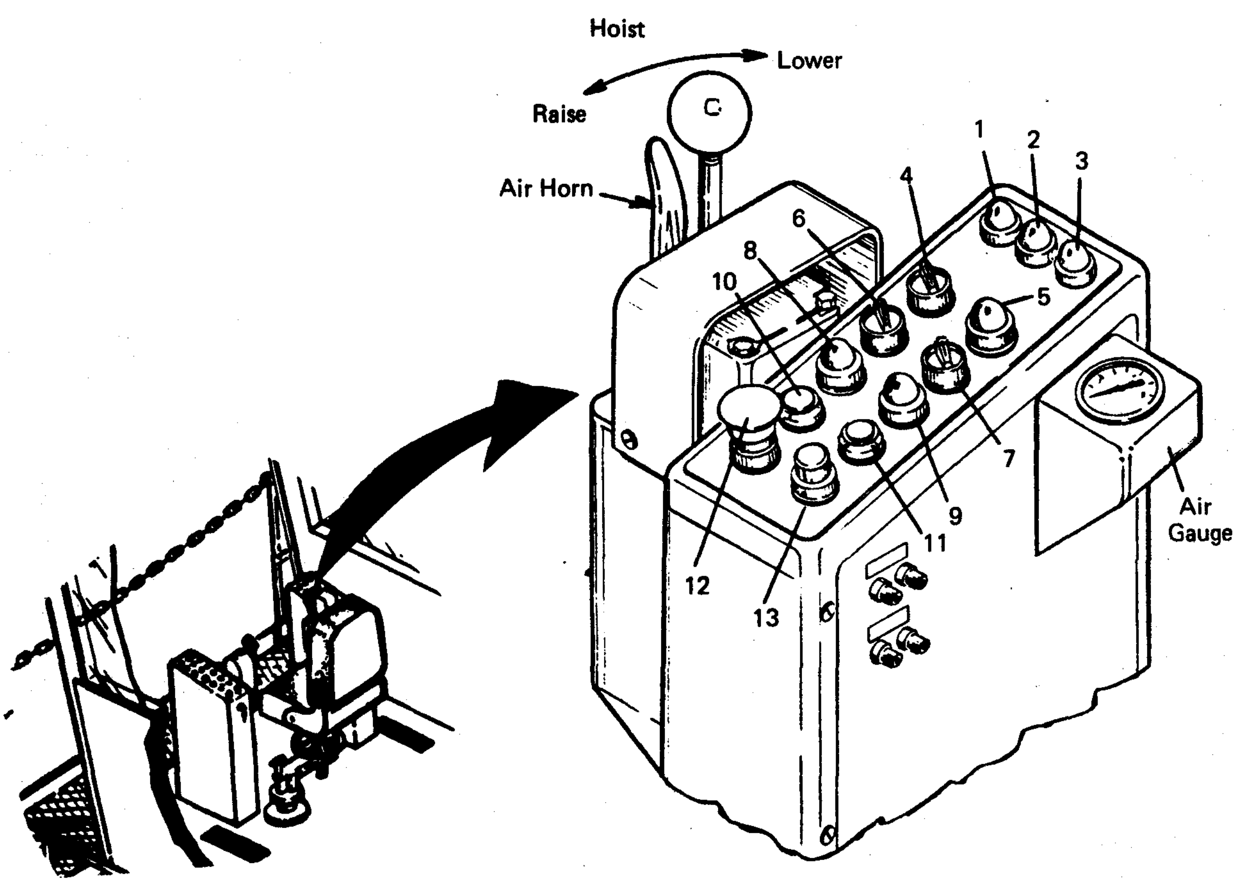
Check overloads and thermal breakers.

In normal operation, stop or retard the motion of D.C. drive motors by moving the control lever (or pedal) in the opposite direction. This reverses the current in the generator field. This reversing of field acts as a braking force, retarding or stopping the motion. At the same time the rotation reaches zero, you must move the controller lever (or pedal) to the neutral position.

Plugging the motion rapidly dissipates the energy of heavy rotating parts by regenerating back into the power source, thus preventing heat created by mechanical friction brakes.

When hoist or drag controllers are returned to neutral, the control automatically plugs that motion to slow it down and finally come to rest.

CONTROL PANELS on top (incline portion) of each controller stand contains push buttons, selector switches and indicator lights; all clearly marked.



The hoist stand panel (right hand) contains six lights, four push buttons and three selector switches. They are:

ing edge. To relieve this condition to some degree, rest the bucket on the ground and allow the hoist rope to support bucket rigging during this sliding portion of the walking cycle. Then as the tub lowers to the ground, pick up the bucket. (See NOTE under RAMPING for non-level conditions.) When ground continues to roll ahead of the tub and tub lowers onto this roll, the front of the tub is too high. In this case swing machine 30 or 40 degrees to one side and propel one step. This act spreads the pile or roll over a large area. Then return to original line of travel and propel.

The Marion dragline design incorporates a calculated balance between boom length, boom angle and allowable load at bucket and machine weight and ballast. During normal digging cycles, the center of gravity shifts from front to rear within a specific area called the kern. As long as the center of gravity falls within the kern, the machine maintains stability and relatively even ground bearing pressure over the entire tub area. If for any reason, the digging radius or allowable load increases and the center of gravity goes beyond the kern to the perimeter of the tub; this increased rim pressure causes the tub edge to cut into the ground. Rotating the machine in this condition causes the ground supporting the tub to form into the shape of a cone. This cone results in an undesirable rocking motion and an unstable machine. This also causes concentrated ground bearing pressure at the center of the tub.

In cases where surface is dry, sandy or powdery, the ground may tend to pile up ahead of tub trailing edge. This condition can be relieved to some degree by allowing the bucket to rest on ground with the hoist ropes taut during sliding position of the step. Then as tub lowers, the bucket weight gradually picks up as tub settles down.

CAUTION: DO NOT allow bucket to be jerked off ground.

The walking mechanism lowers both walking shoes to contact ground at same time (level ground). The walking shoes swivel allows for ground unevenness without damage to walking mechanism. If one of the walking shoes does not strike ground, or steps in a soft spot that will not support machine weight, the machine will rotate around tub side, in this case operator should stop the step before machine lifts and reverse walking step to return to normal position. Swing machine to walk around soft spot.

RAMPING the machine from one level to another requires exercising great care. Walking the machine subjects the tub and upper frame to stresses much greater than a normal digging operation. Ramps for up and down propelling should be no greater than 10 percent in grade. Ramps for a new machine should be no greater than a 5 percent grade.

NOTE: When propelling up a ramp, lower the bucket to the ground. THIS IS A MUST. When propelling down a ramp, carry the bucket in the air 100 feet from the machine. Do not heel the bucket. At other times carry the bucket suspended and pulled in approximately

LUBRICATION SPECIFICATIONS

SPECIFICATION – GREASES

CODE OR SYMBOL NO.	ASTM or TEST	MPG	RGL	OGL TYPE B	OGL TYPE H
Penetration Worked 60X					
Summer, NLGI	D-217	2	semi-	1	–
Winter, NLGI		1	fluid	0	–
Penetration Worked 5000X, Max. Change	D-217	10%	–	–	–
Dropping Point, Min. °F.	D-566	350	–	325	–
Base Oil Viscosity @ 210°F., Min.	D-446	75 SUS	140 SUS	200 SUF	200 SUF
Oxidation Stability Max. psi Drop – 100 hrs.	D-942	10	–	–	–
Water Resistance Max. Loss @ 100°F.	D-1264	20%	–	10%	10%
Texture	Visual	Buttery	–	Adhesive	Tacky
EP Timken, Min. OK	–	35 lbs.	–	35 lbs.	35 lbs.

SPECIFICATION – OILS

CODE OR SYMBOL NO.		ASTM or TEST	MO	OILS PO
Pour Point °F. Max.	Summer	D-97	5	15
	Winter		0	15
Flash Point °F. Min.	Summer	D-92	450	410
	Winter		420	410
Viscosity @ 100°F. SUS		D-446	–	150 Min.

ALL plugs have been removed; ALL lines filled and ALL plugs REPLACED. With these steps complete the system is ready for automatic operation.

NOTE: Do not use pipe unions on boom and gantry, hose ends work well here. Allow slack where needed for movement. Avoid sharp bends.

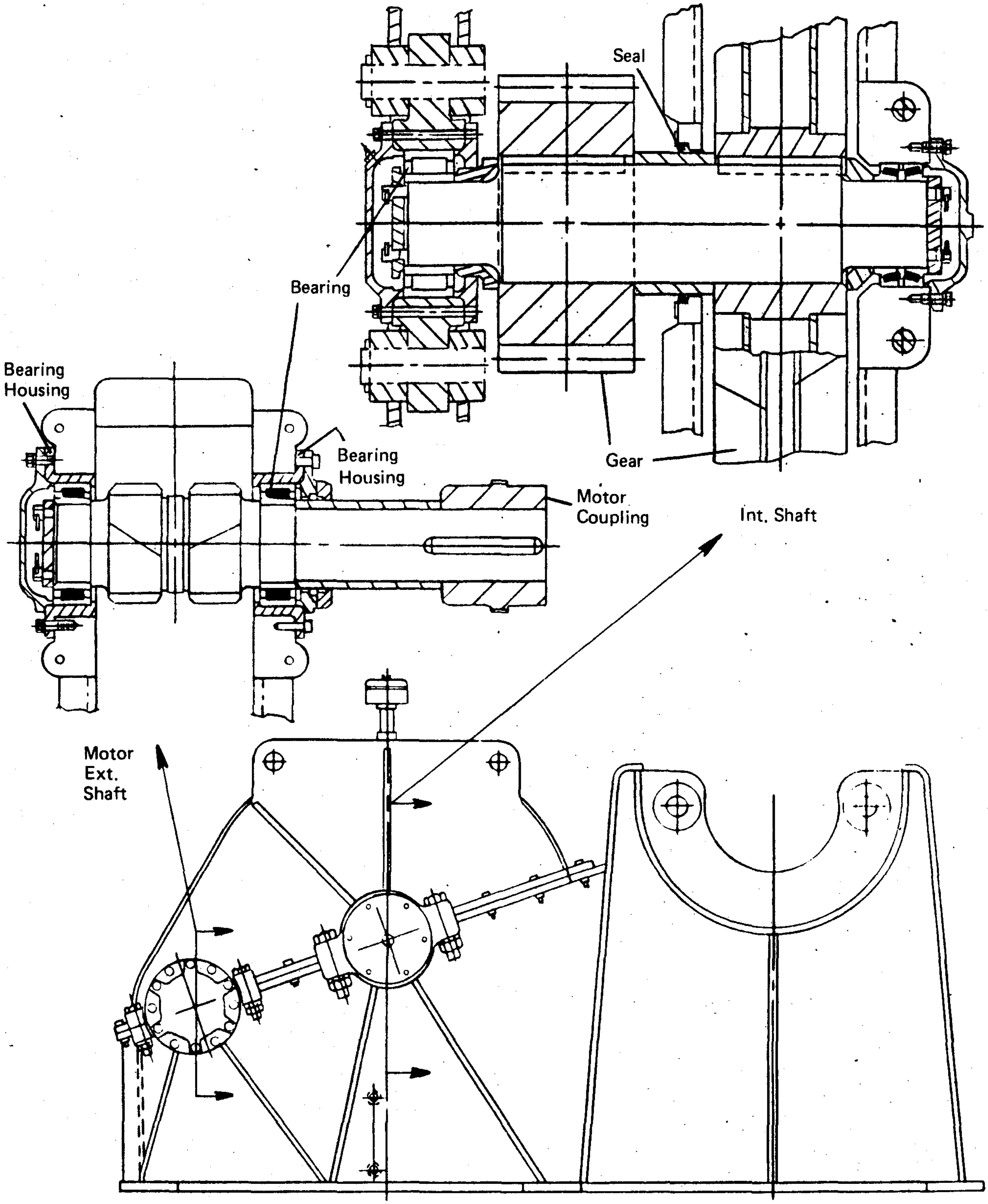
AUTO LUBE FOR WIRE ROPE SPRAY supplies spray to the hoist rope at boom point and at deflecting sheaves located on top of gantry. The drag rope is sprayed at the fairlead sheaves. Set air pressure regulator at 60 psi. Open air valve first. Then open ONLY one of the three line valves at a time. Lube ropes every eight hours or as required, depending on site conditions. For best results lube rope when paying out. Use wire rope lube NOT GREASE. After spraying both ropes, close air valve.

AUTO LUBE FOR OPEN GEAR supplies the Hoist Gear, Swing Pinions and Roller Circle Rail thru Line A during the digging cycle only. Line B supplies the propel gear and one side of the drag gear during propel cycle. Line AB supplies other side of the drag gear during propel and dig cycle.

AUTO LUBE FOR ROTATING FRAME/PROPEL supplies the propel pinion and shaft bearings and each walking arm assembly thru Line B, this operates during the propel cycle ONLY. Line AB, this operates during propel and dig cycle, supplies lube to the two swing shaft bearings, center journal, propel clutch and hose reel.

AUTO LUBE FOR FRONT END is supplied thru Line A. This line feeds seven points at the fairlead and six points at the boom point shaft.

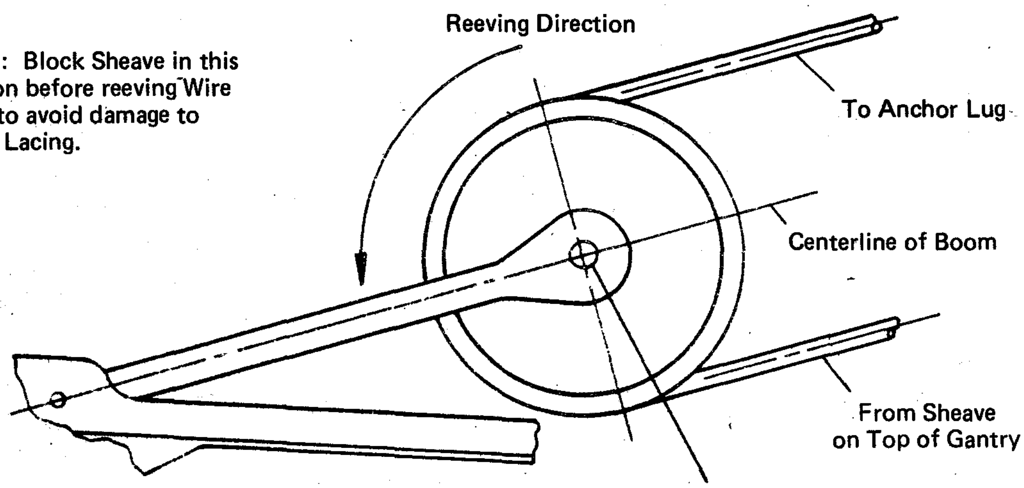
Section 4 – Mechanical Adjustment (cont.) Page



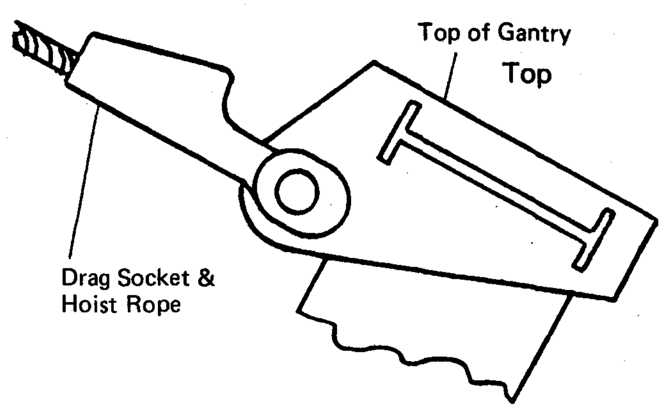
GEAR CASE ASSEMBLY

Place bucket on ground and swing boom clear of bucket. Set swing brakes. Remove hoist rope from the socket at bucket rigging.

Attach snatch block on top of gantry in area of socket lug. Reeve deck winch line up gantry to snatch block, then out to boom point.



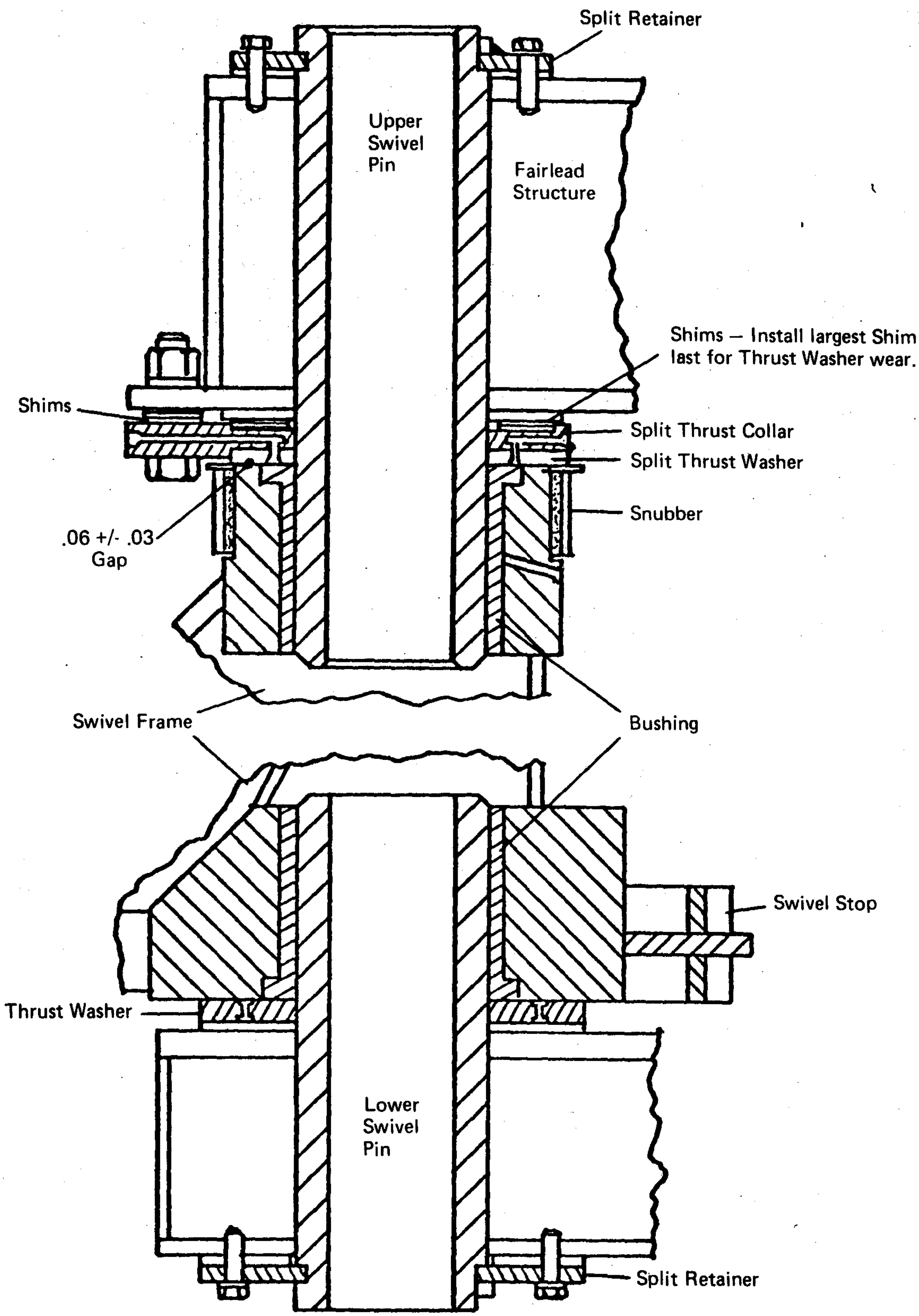
Lubricate the bushing (fitting on top of pin) and groove of the small sheave on top of boom (at point). Next, remove hoist rope from point sheave and reeve it around small sheave from right to left. Attach drag socket and winch line to hoist rope. With winch pull hoist rope to top of gantry and pin socket in place. Remove winch line from hoist rope only.



Set hoist power at 75 percent in the power control room. See Electrical Manual.

Place cribbing under rear of machine to prevent rear end settling when there is no boom load.

At this point check hoist motor brake for proper adjustment, U-bolts on drum for tightness, socket wedge and pin installed okay.



Split Retainer
Upper
Swivel
Pin
Fairlead
Structure
Shims – Install largest Shim
last for Thrust Washer wear.
Shims
Split Thrust Collar
Split Thrust Washer
Snubber
.06 +/- .03
Gap
Swivel Frame
Bushing
Swivel Stop
Thrust Washer
Lower
Swivel
Pin
Split Retainer

Accurate, properly maintained test equipment, suitable for the quantities for measurement is needed also.

a D.C. voltmeter for 125 - 600 volts,

a D.C. millivoltmeter for 600 millivolts,

zero center meters preferred,

a volt-ohm-milliamp meter or

a multi-meter (example, Simpson 260),

an A.C. voltmeter, unless multi-meter is accurate,

a quality tachometer is often handy, and

a 500 volt D.C. megger test insulation quickly.

Knowing the capabilities and limitations of each instrument helps keep repair and replacement costs reduced, since most test equipment suffers from the wrong connection rather than damage from dropping.

Now – get set to find the trouble.

INVESTIGATION: When trouble occurs, the operator is the "Expert Witness", so contact him first for answers to the following important questions:

How many motions are effected?

Is motion dead or just retarded?

Is it intermittent or continuous?

Did trouble develop slowly or suddenly?

What happened just before the failure?

A complaint concerning POWER means different things to different people, so try to get specific answers to the following:

Will machine lift as heavy a load as before?

RUNNING CLEARANCE FOR BRONZE BUSHINGS

Shaft Nom. Diam.	Shaft O.D.	Running Clear-ance	Shaft Nom. Diam.	Shaft O.D.	Running Clear-ance
1	1.000 .999	.006 .010	5	5.000 4.998	.011 .020
1-1/4	1.250 1.249	.005 .010	5-1/4	5.250 5.248	.011 .020
1-1/2	1.500 1.499	.008 .013	5-1/2	5.500 5.498	.012 .020
1-3/4	1.750 1.749	.008 .013	5-3/4	5.750 5.748	.012 .021
2	2.000 1.999	.007 .012	6	6.000 5.998	.012 .021
2-1/4	2.250 2.248	.006 .013	6-1/4	6.250 6.248	.012 .021
2-1/2	2.500 2.498	.006 .013	6-1/2	6.500 6.498	.012 .021
2-3/4	2.750 2.748	.008 .015	6-3/4	6.750 6.748	.013 .022
3	3.000 2.998	.008 .015	7	7.000 6.998	.013 .022
3-1/4	3.250 3.248	.008 .015	7-1/4	7.250 7.248	.013 .022
3-1/2	3.500 3.498	.008 .015	7-1/2	7.500 7.498	.014 .022
3-3/4	3.750 3.748	.011 .019	7-3/4	7.750 7.748	.016 .024
4	4.000 3.998	.011 .019	8	8.000 7.998	.015 .024
4-1/4	4.250 4.248	.010 .019	8-1/4	8.250 8.248	.015 .024
4-1/2	4.500 4.498	.010 .019	8-1/2	8.500 8.498	.016 .025
4-3/4	4.750 4.748	.014 .022	8-3/4	8.750 8.748	.016 .025

Once insuring a clean bore, quickly locate pinion in the SAME angular position on shaft as before when cold readings were taken. Just as pinion nearly engages with taper fit, but not in actual contact, SNAP pinion into place with a quick, forceful PUSH. This is important. The HOT pinion must be snapped into position rapidly, before it COOLS. Otherwise, the pinion SEIZES on the shaft and stops any further adjustment.

Check this hot or Shrunk-On pinion position using the micrometer depth gauge as before.

The ACTUAL advance is the DIFFERENCE of depth gauge readings in HOT and COLD positions. To control pinion stresses, this advance MUST fall within the limits specified in the table herein. If this advance is NOT within the given limits, PULL and REMOUNT the pinion.

Assemble the lockwasher and nut AFTER proper pinion installation.

DO NOT permit the shoulder on nut to bottom BEFORE the main part of this nut tightens on locking plate. If this happens, REMOVE the nut and grind or turn so the needed clearance is available.

Now, certain the nut secures tightly against locking plate and pinion, turn up the locking plate on at least TWO faces of the nut.

This pinion fit and key fit are the important points of holding the pinion on the shaft. The locking plate just serves to hold the nut on the shaft. A CORRECT fit places no LOAD on this nut and locking plate.

PINION REMOVAL from armature requires the use of a suitable pinion puller. This avoids causing damage to motor frame, bearings, armature shaft or pinion.

Please do NOT heat the pinion before pulling.

Please do NOT use wedges between the pinion and bearing cap.

Please do NOT use sledge hammer on the puller.

(NOTE: This information obtained from Engineering Standard 790-1 and CI-772; MPSD.)

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GEAR INSPECTION PROCEDURES

METHOD OF CHECKING RIM FACE RUNOUT OF GEAR. If gear can be rotated without end float., place dial indicator squarely against the rim face stamped (000), at station stamped (1) and set to zero.

Revolve gear slowly. Record reading at each station. After one complete revolution, indicator should read within (plus or minus) .002". If not, recheck. Allowable rim face runout is shown in table 1. Total rim face runout is the algebraic difference between maximum plus and maximum minus readings.

EXAMPLE: Readings for a 16 foot diameter gear are listed in a chart below.

Total tim runout is .020" is obtained between station 3 with a maximum plus reading of .005" and station 9 with a maximum minus reading of .015". This is within allowable .022" shown in table 1.

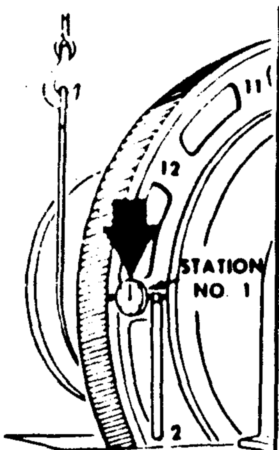


TABLE 1

Outside Diameter of Gear (feet)	Allowable Rim Face Runout (inches)
6	.006
7	.007
8	.008
9	.009
10	.010
11	.012
12	.014
14	.018
16	.022
18	.026
20	.032
22	.038
24	.044

Station No.
Indicator Reading

1	2	3	4	5	6	7
.000	+.004	+.005	+.004	.000	−.005	−.010

8	9	10	11	12	1
−.014	−.015	−.014	−.010	−.005	.000

CHECKING RADIAL RUNOUT OF GEAR: Mount a dial indicator so it can be set against one of four machined surfaces. See sketch. Place indicator square with the machined surfaces at one of the stations stamped on the gear rim face. Revolve gear slowly and record readings at each station under the corresponding station number. After one complete revolution, indicator should read within (plus or minus) .002" of initial reading at starting station.

ALLOWABLE RADIAL RUNOUT is shown in table 2. The total radial runout is the algebraic difference between maximum plus and maximum minus readings. If radial runout ex-

Broken wires.

Corroded wires.

Marks indicating mechanical abuse, distortion or crushing.

Inspect rope sheaves often. Check sheaves and drums for proper alignment. Use no reeving that requires reverse bends unless provided with sufficient space between the bends for adequate rope recovery.

Do not allow wear at rope sheave groove. An old rope wears a groove to a reduced radius. This groove crushes or deforms a newly installed rope.

Avoid sheave groove or drum lagging from assuming rope lay shape. Alternate right and left hand lays, if needed. Keep sheaves and drum free of rough spots, nicks or burrs. Never use cracked or chipped sheave.

Maximum rope life and the best service evolves from extreme care in handling and installation. This is important. Working a new rope at reduced loads gives the rope lay time to acquire a permanent set. Slow acceleration and deceleration of load and eliminating sudden actions are good habits to develop. Never overstress a rope by jerking or catching a heavy, falling load.

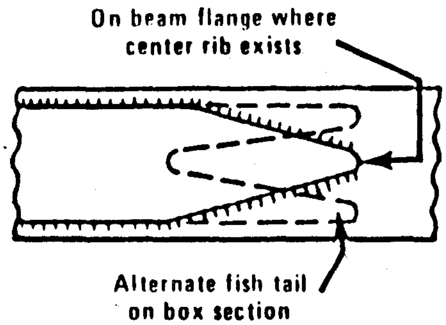
Lubrication remains the most important item in rope care. All rope is lubed when manufactured. Generally thin and filmy, this lube eases the manufacture rather than preserves the rope. This film drys rapidly or dissipates thru surrounding conditions.

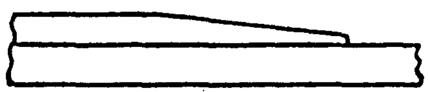
Lubricate every rope at installation and keep coated thru continued service. Lubricant serves to reduce internal friction wear and the outer wire wear against sheave or drum. Lube protects rope from weather and corrosive air, too.

Marion recommends a light, penetrating type lubricant (WRL) containing anti-rust or corrosion agents and anti-wear additives. This lube saturates rope interior thus reducing internal friction while providing a protective outer coating.

The rope lubricant selected may be an asphaltic type containing volatile solvent or diluent which allows strand and core penetration. This lube type works well for operations in highly abrasive material or water submersion.

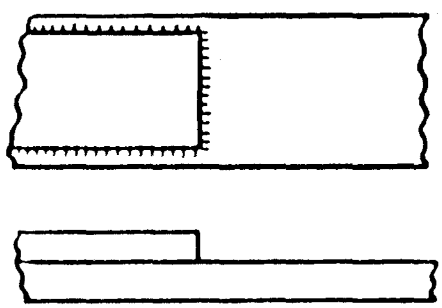
One method of rope lubrication utilizes an automatic system that provides a drip fixture above sheaves on boom point, gantry, and fairlead. This system is generally timer controlled with manual override for severe conditions.





Reinforcing Plate Taper End recommended

REINFORCING REQUIRES EXTREME CAUTION in weld repairs. Faulty reinforcing has caused many repeat failures. The weld alone, if PROPERLY made, is sufficient to make the part as strong as it was originally. However, in cases where reinforcing seems needed, apply the following. Patch plates of NOT greater than three fourths the thickness of the part being reinforced to EXTEND beyond the critical areas. TAPER and ROUND the ends of these plates. EXTEND the weld completely around the ends and SMOOTH OUT gradually to the original structure. TAKE every care to eliminate stress concentration, such as: square ends; sharp break offs; exposed and rough, flame-cut edges; etc. (See sketches).



Reinforcing Plate Square End, <u>not recommended</u>

POSTHEAT TREATMENT: When employing this or in cold weather, SLOWLY COOL the welding area at a rate of 50 degrees F. or 27 degrees C. per hour to the normal temperature of 150 degrees F. (65.5 degrees C.) This is important. This usually means additional general heating AFTER completing the weld. Smooth up ALL rough edges and welds. Clean and repaint the repair areas.

ADDITIONAL INFORMATION or material on welding for a particular repair job may be obtained by sending ALL details to the Service Department of Marion Power Shovel Division, at Marion, Ohio 43302.

MATERIAL IDENTIFICATION

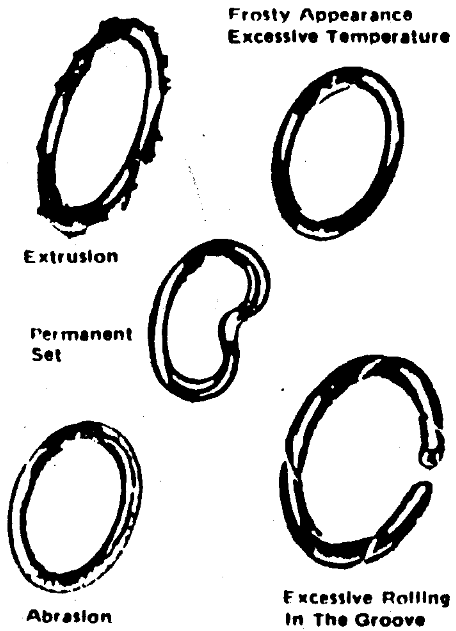
MARION MATERIAL SYMBOLS and

MAJOR COMPONENT PARTS

The following information contains the various materials used in major parts. Refer to the identification plate or material symbol on casting for specifics.

NOTE: Use E-6010 or E-6012 for nonstructural parts ONLY. For example; sheet metal, guard rails, catwalks, house coverings and stiffners.

O-rings in service undergo slight swelling and softening which may be non-visible, when worn. Increased damage can occur on re-installation, so use ONLY NEW RINGS. Inspection of old, damaged rings can identify failure from extrusion, wear, torsion set, excessive permanent set or rolling in the groove.



Excessive extrusion may indicate the use of the wrong ring or backup rings were not installed. Irregular wear may indicate a rough spot or eccentricity in the cylinder. The ring may also fail from defect that careful pre-installation inspection may have seen. Some O-rings, lacking proper resilience, might have been subjected to overtemperatures. Since rings are not designed for high temperatures, they should be replaced, regardless of appearance, once known rings have been subjected to unusual heat. Overheated rings are hardened, crack with flexing, take a set and lack resilience. Once old ring has been inspected, cut it in two pieces and THROW AWAY.

Before installing, check surfaces and rings. Metal surfaces must be free of dust, dirt and gunk. Stoddard solvent (kerosene base with rust inhibitor) cleans parts and leaves a good surface for lube to adhere to. However, these cleaning fluids can cause some rings to swell. So check that cleaning fluid does not harm the O-ring if left on surface.

Once the proper O-ring is selected and part number is rechecked; examine the ring closely for defects, dirt or lint.

Throw out faulty rings after cutting so they do not get mixed with good ones. Discard new rings that are too tight once installed, do not return these to storage.

Once installed; an O-ring seats snugly, but freely in its groove.

PREPARATION requires checking the surface for scratches from fingernails, tools or fitting threads. DO NOT pinch ring between boss and fitting. Watch for sharp edges on groove shoulder or fitting. Thread burrs may be removed by running a nut onto the thread.

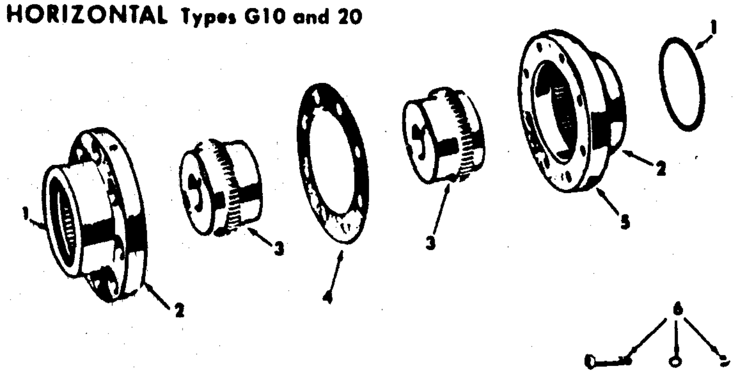
Before installing, lube ring and surface sparingly with a light coat of grease. Lubing helps eliminate a distorting stretch (causing a leak) and aids ring in seating naturally in groove without wrinkles or twists. Remember, the lube must be compatible with O-ring material and system fluid.

FALK COUPLING

TYPE G AND GV

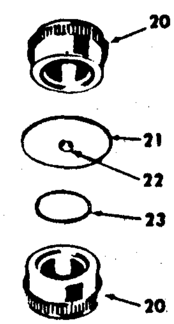
G TYPE INSTALLATION

HORIZONTAL Types G10 and 20



1. Seal Ring
2. Flanged Sleeve
3. G Flex Hub (Specify Bore and Keyway)
4. Gasket
5. Lube Plug
6. Bolt, Nut, Lockwasher

VERTICAL Types GV10 and 20



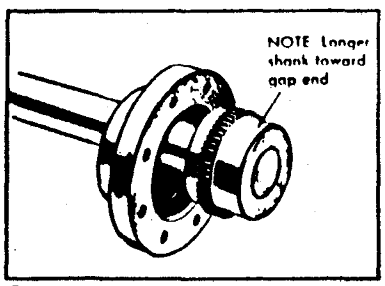
20. GV Flex Hub (Specify Bore and Keyway)
21. Center Plate
22. Thrust Button
23. Thrust Plate

Parts 1, 2, 4, 5 and 6 shown at the left complete the balance of the coupling

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, SEALS AND HUBS

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.

CONVERSION TABLE
Fractional Inch to Decimal Inch and Millimeters

Fractional Inch	Decimal Inch	Millimeters	Fractional Inch	Decimal Inch	Millimeters
1/64	0.015625	0.3969	33/64	0.515625	13.0969
1/32	0.03125	0.7938	17/32	0.53125	13.4938
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	1.9844	37/64	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	3.9688	21/32	0.65625	16.6688
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	7.1438	25/32	0.78125	19.8438
19/64	0.296875	7.5406	51/64	0.796875	20.2406
5/16	0.3125	7.9375	13/16	0.8125	20.6375
21/64	0.328125	8.3414	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	21.281
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	10.3188	29/32	0.90625	23.0188
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	2.7953
2	0.0787	37	1.4567	72	2.8316
3	0.1181	38	1.4061	73	2.8740
4	0.1575	39	1.5354	74	2.9134
5	0.1968	40	1.5748	75	2.9527
6	0.2362	41	1.6142	76	2.9921
7	0.2756	42	1.6535	77	3.0315
8	0.3150	43	1.6929	78	3.0709
9	0.3543	44	1.7323	79	3.1102
10	0.3937	45	1.7716	80	3.1496
11	0.4331	46	1.8110	81	3.1890
12	0.4724	47	1.8504	82	3.2283
13	0.5118	48	1.8898	83	3.2677
14	0.5513	49	1.9291	84	3.3071
15	0.5905	50	1.9685	85	3.3464
16	0.6299	51	2.0079	86	3.3858
17	0.6693	52	2.0472	87	3.4252
18	0.7087	53	2.0866	88	3.4616
19	0.7480	54	2.1260	89	3.5039
20	0.7874	55	2.1653	90	3.5433
21	0.7874	56	2.2047	91	3.5827
22	0.8661	57	2.2441	92	3.6220
23	0.9055	58	2.2835	93	3.6614
24	0.9449	59	2.3228	94	3.7008
25	0.9842	60	2.3622	95	3.7401
26	1.0236	61	2.4016	96	3.7795
27	1.0630	62	2.4409	97	3.8189
28	1.1024	63	2.4409	98	3.8583
29	1.1417	64	2.5197	99	3.8976
30	1.1811	65	2.5590	100	3.9370
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 x 3.968 = British thermal units
Calories ÷ .252 = British thermal units
Centimeters x .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 x 35.314 = Cubic Feet
Cubic Meters x 1.308 = Cubic Yards
Grams x 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 x 2.471 = Acres
Hectares x .003861 = Square Miles
Hectoliters x 2.84 = Bushels (2150.42 Cubic Inches)
Hectoliters x 3.53 = Cubic Feet
Hectoliters x .131 = Cubic Yards
Hectoliters x 26.42 = Gallons (231 Cubic Inches)
Kilo per cheval x 2.235 = Pounds per horse power
Kilo per cubic meter x .062 = Pounds per cubic foot
Kilo per meter x .672 = Pounds per foot
Kilogram Meters x 7.233 = Foot Pounds
Kilograms x 2.2046 = Pounds
Kilograms x 35.3 = Ounces avoirdupois
Kilograms ÷ 907.18 = Short Tons (2000 pounds)
Kilograms per sq. cm. x 14.223 = Pounds per square inch
Kilograms per sq. cm. ÷ .0703 = Pounds per square inch
Kilograms per sq. mm. x 1422.32 = Pounds per sq. inch
Kilometers x .621 = Miles
Kilometers ÷ 1.6093 = Miles
Kilometers x 3280.8 = Feet
Kilowatts x 1.34 = H.P. (33,000 ft. lbs. per min.)
Liters x 61.025 = Cubic Inches
Liters ÷ 28.317 = Cubic Feet
Liters x 33.81 = Fluid Ounces (U.S.P.)
Liters x .2642 = Gallons (231 Cubic Inches)
Liters ÷ 3.785 = Gallons (231 Cubic Inches)
Meters x 3.28 = Feet
Meters x 39.37 = Inches
Meters x 1.094 = Yards
Metric Tons x 2204.6 = Pounds
Millimeters x .03937 = Inches
Millimeters ÷ 25.4 = Inches
Square Centimeters x .155 = Square Inches
Square Centimeters ÷ 6.45 = Square Inches
Square Kilometers x 247.1 = Acres
Square Kilometers x .3861 = Square Miles
Square Meters x 10.764 = Square Feet
Square Millimeters x .00155 = Square Inches
Square Millimeters ÷ 645 = Square Inches
Watts ÷ 746 = Horse Power
Watts x .00134 = Horse Power

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