

ENERFLEX

COOLER



Installation, Maintenance, and Operating Instructions
for
Engine Drive Units

Air-x-changers has prepared this manual for the care and up keep of your cooler. With these simple instructions and a few tools, the owner can perform many maintenance and light repair procedures such as tightening the V-belts, checking fan blade angle, greasing bearings, setting the vibration switch, and cleaning fins and tubes. If more information is needed about a specific component we recommend that you refer to the attached specific manufactures maintenance instructions i.e. (motors, fans, and bearings).

Because this manual covers several cooler styles and sizes, the instructions outlined are general in nature. This should be noted when looking at any illustration or parts of the manual that may not apply to your cooler.

Good judgement should be used when purchasing either replacement parts or products to be used in your repair or maintenance work. Some products may cause a decrease in performance. All replacement parts should be equivalent to the manufacture's original parts. Replacement parts ordered from the factory always carry our required high level of quality. DO NOT take a chance with products that might not do the job.

EQUIPMENT SITING AND INSTALLATION

Setting of cooler(s) is the responsibility of the purchaser who must insure that cooler intake areas are free from obstruction to airflow and sources of hot air (including other air coolers). Spacing of air coolers should be adequate to avoid hot air recirculation. Raising and or separating units should compensate for the effects of grouping coolers together.

ON ARRIVAL AT SITE SHIPPING DAMAGE

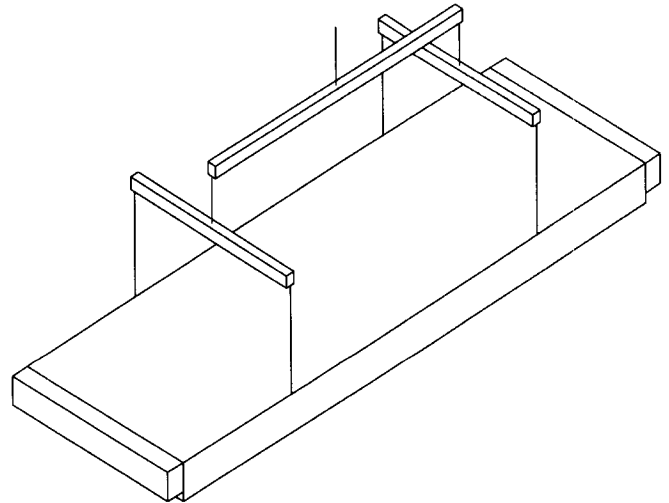
The cooler should be thoroughly inspected for damage by receiving personnel. Damage in transit can be result of dropping or being struck by heavy objects, any damage should be described on receiving documents presented by carrier. Prompt claim filing will expedite early compensation from the offending carrier.

Loose Parts

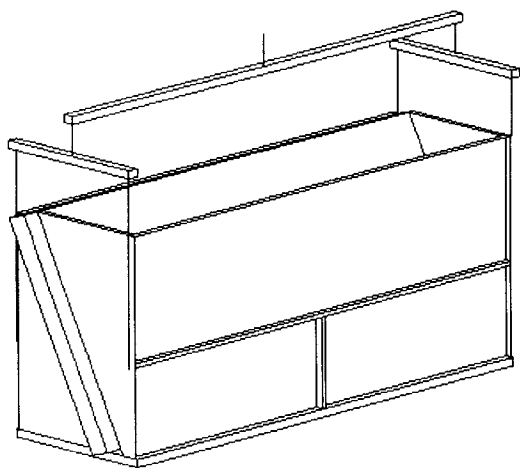
The parts list should be checked to see that all parts shipped with the cooler are present. These parts may be secured to the skid base (if so designed) or inside the plenum area. Basically this cooler is completely shop assembled and no assembly at the job-site is required, but occasionally special accessory devices will be required which must be shipped disassembled to meet height or width limitations.

UNLOADING COOLER

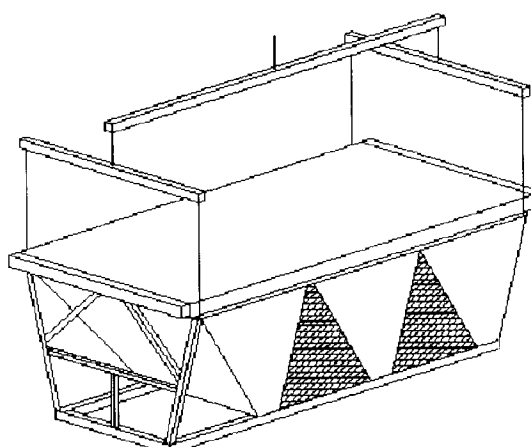
Spreader bars are to be used for lifting when the cooler is eight (8) feet. The cooler is supplied with lifting points to be used for off loading from carrier. Lifting by any other point may cause damage to the cooler. Following are some suggested ways of lifting. Locate the picture which resembles the type of unit you have and use as a guide on how to unload and handle the cooler properly. (See unit name plate for unit type i.e. EH, H, FI, etc.)



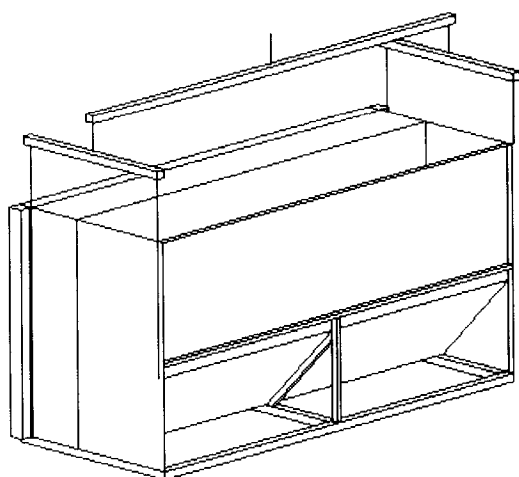
TUBE BUNDLES



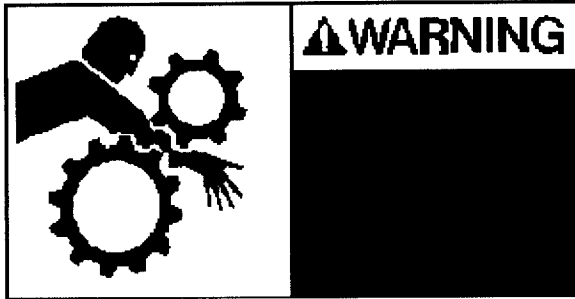
EH-UNITS



F-UNITS



VI-UNITS



TURN OFF AND LOCK OUT DRIVER BEFORE ENTERING COOLER

PRIOR TO RUN-IN

NOTE: Check all nuts and bolts for tightness, bolting will loosen during shipment.

Fans

Check fan blade bolts and hub set screws for tightness. Rotate fan by hand to insure that shaft, speed reducer, and driver turn freely. The fan should be checked for adequate tip clearance and blade pitch angle. Slight adjustment of the tip clearance can be made by loosening the fan shaft bearing bolts and moving the complete fan and fan shaft assembly until it is centered in the ring. To check the fan blade angle, use a level bubble protractor (this can be obtained from the factory). Loosen the nuts on the bolts and place the protractor on the angle setting mark or the clevis (refer to fan manufactures information for proper location). Using a mallet tap on the shank end of the blade to adjust the angle. Tighten fan blade bolts to the proper torque (refer to manufactures maintenance instructions) making sure to tighten evenly. Recheck blade angle. Some coolers are equipped with an automatic fan. These fans have blade angles controlled by varying the air supply pressure. Air pressure should be applied by to the fan before starting to check for proper operation. Before starting, the motor should be bumped to check for proper direction of fan rotation.

Bearings

Bearing mounting bolts and set screws should be checked for tightness. The manufacturer lubricates the bearings and no additional grease is necessary to start. When remote lube lines are provided check to insure they are full by loosening at the bearing end, then fill with grease from fitting end. This will insure that the grease lines are full of grease. During high-speed operation too much grease will cause over heating. To protect bearings against entrance of foreign material when dust and water are present the bearings should contain as much grease as speed will allow. Daily lubrication may be required to maintain a slight leakage at the seals. Under normal conditions use the following table as a guide. However, certain conditions may require a change of lubrication periods such as the ones described above.

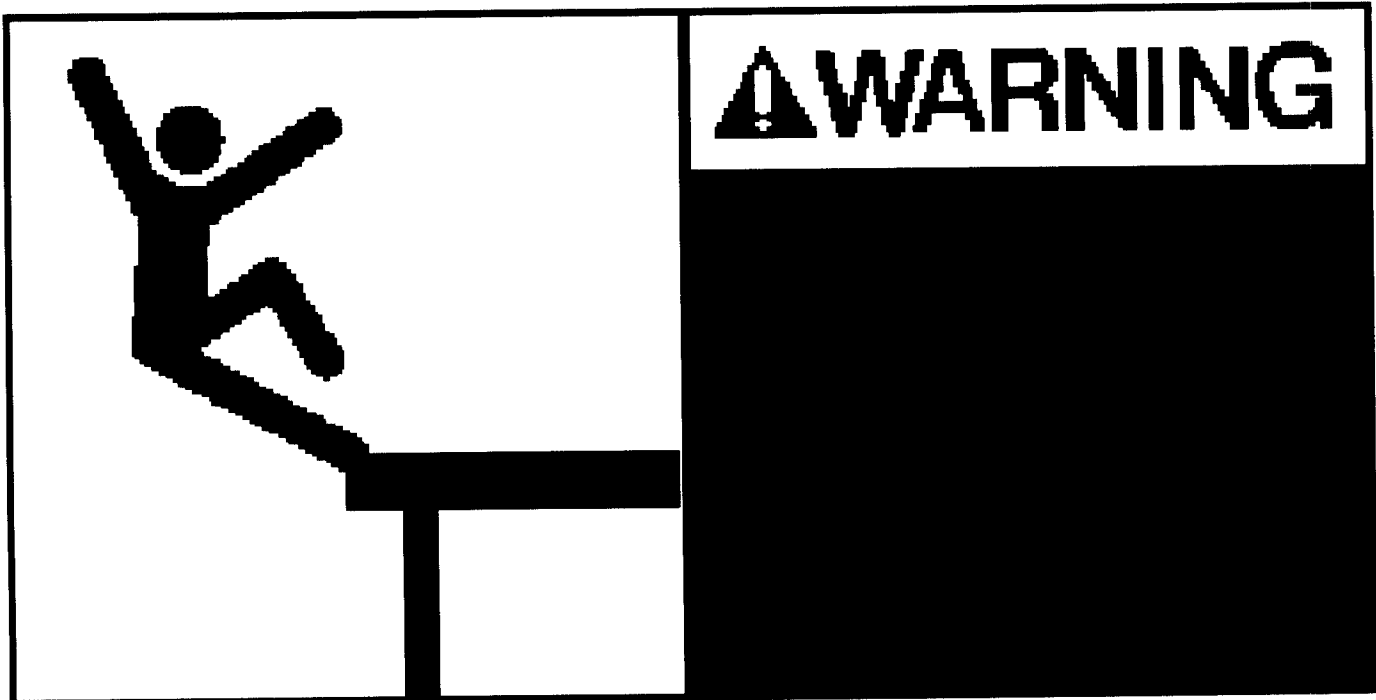
Read preceding page before establishing lubrication schedule

LUBRICATION GUIDE

	Suggested Lubrication Period in Weeks							
HOURS PER DAY	1 TO 250 RPM	251 TO 500 RPM	501 TO 750 RPM	751 TO 1000 RPM	1001 TO 1500 RPM	1501 TO 2000 RPM	2001 TO 2500 RPM	2501 TO 3000 RPM
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	1	1
24	10	5	3	2	1	1	1	1

Louvers

Check all mounting brackets and bolts for tightness. On manually operated louvers, to insure that the linkage is adjusted properly, operate blades from a fully open position to a fully closed position. On automatic air motor (optional) operated louvers, air should be applied to actuator to check for proper linkage adjustment, free operation, and sufficient air supply. See manufacturer maintenance instructions for further information on air motors.



**DO NOT WALK ON LOUVERS
OR USE AS A LADDER!!**

U-Joints

Relubrication cycles vary depending on the service requirements and operating conditions of the drive. Under normal conditions, a maximum relubrication cycle of 30 to 60 days is recommended. Consult the manufacturer service manual for specific grease and lubrication requirements.

RUN-IN

Vibration Switch (optional) (Murphy & Nelson)

After the switch has been installed, adjust by turning the adjustment screw in a clockwise direction until the starting torque does not trip the vibration switch. For other brands see manufactures information.

Process Start-up

The process start-up should be conducted in a manner that will minimize thermal shock of the tube bundles. Over cooling of fluids during periods of low ambient temperature and low heat loads should also be avoided during start up.

Plugs

Header plugs are installed at room temperature in our plant. To correct any minor leaking, it may be necessary to tighten the plugs when the bundle is at operating temperature. **WARNING:** Do not tighten plugs while the bundle is under pressure. If any plugs are removed, the gasket (for shoulder plugs only) should always be replaced. Replacement gaskets should be ordered from the factory. When installing the plugs, a thread lubricant and antigalling compound should be used.

LONG TERM

Fin Cleaning

Fins should be kept free of dirt and lint, which can be removed by directing compressed air perpendicular to the tubes in a direction opposite to the normal airflow. Do not use steam or chemicals to clean fins.

Tube Cleaning

The internal cleaning of tubes can be done three different ways:

1. **Mechanical Cleaning**

This consists of using drills, (or wire brushes), on long rods. And rotating them with air or electric motors. This is normally followed by a water wash or air purge.

2. **Chemical Cleaning**

This consists of circulating hot chemical solution through the tubes. The solution contains inhibitors to avoid corrosion of the tube walls.

3. **High Pressure Water Sprays**

This consists of placing a high-pressure water jet head at the end of the hollow rods and pushing through the individual tubes.

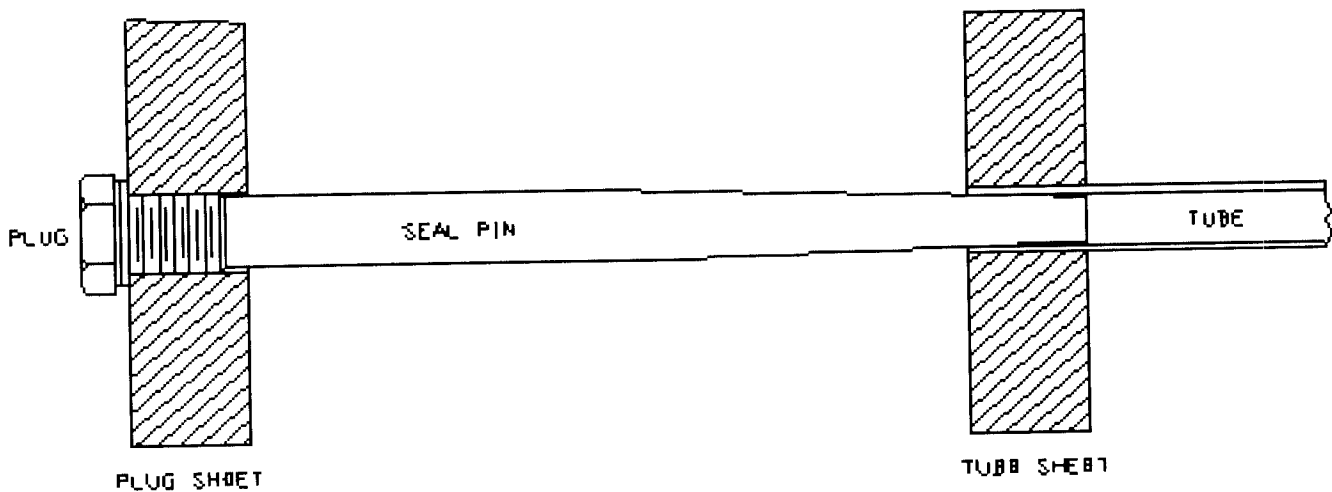
NOTE: The last two processes will not work on tubes that are plugged, they must be drilled out mechanically.

Leaking Tubes

Tube leaks can be two types: (1) leaks through the tube wall and (2) leaks in the tube attachment. In the first case it is most practical to plug both ends of the tube. Only a limited number of tubes can be sealed off in this manner before performance is affected. When performance drops below acceptable limits, tube bundle must be retubed. If leaks develop in the tube end attachment, rerolling of the tube will be necessary. Care must be taken in selecting the proper tube expander for the size and gauge of tube to be rolled. When rolling a tube, over-rolling must be avoided. Consult the factory for information on taper pins to plug the tubes and roller tube sizes.

INSTRUCTIONS FOR USING TAPER PINS FOR SEALING LEAKING TUBES

1. Remove plug from one end of leaking tube (do not switch plugs in holes).
2. Insert taper pin through plug hole into tube and tap lightly with hammer until seated firmly, but not too tight to be removed.
3. Measure plug for depth it was originally screwed into the plug sheet.
4. Measure the distance that the taper pin protrudes from the plug sheet in seated position.
5. Add the distance measured in Steps 3 and 4 then subtract $\frac{1}{8}$ ". This will be the length which should be cut off the large end of the taper pin



6. Remove the taper pin from the end of the tube.
7. Saw a piece off the large end of the taper pin, the length figured in Step 5. Be careful not to cut the pin too short.
8. Re-insert the taper pin in the tube and drive well into place.
9. Lubricate plug (see PLUGS page 12) and replace in plug sheet. Run up tightly. The plug should now seat and help hold the taper pin in place.
10. Repeat operation on opposite end of tube.

NOTE: If the plug removed does not seal replace it and the gasket if so equipped.

Recommended Spare Parts

We suggest that one each of the parts, which are designated by an asterisk (*) on the parts list be carried in your stock of spare parts. The down time caused by waiting for delivery of a spare part usually cost more in lost production or service than the cost of the part itself.

Spare parts orders should be specified in accordance with the parts list description and the Job number of the unit.

P.O.	QTY.	DESCRIPTION OF COMPONENTS
		SECTIONS IN ACCORDANCE WITH SPECIFICATION SHEET DATED: _____
		____ STRUCTURE(S): _____
		SET(S) SHUTTERS: _____
		SET(S) TURNING VANES: _____
*		FAN (S) ____ " DIA. ____ BLADES ____ HAND ____ MAKE ____ ° ANGLE AT ____
		____ " BORE WITH ____ "X ____ " KEYWAY. _____
*		FAN SHAFT(S): ____ " DIA. X ____ " LONG WITH ____ " SQ. KEYS ____ END,
		KEYWAY LENGTH ____ "
*		____ " FAN BEARING(S): _____
*		____ " IDLER BEARING(S): _____
*		IDLER SHAFT(S) ____ " DIA. X ____ " LONG WITH ____ " SQ. KEY ____ " LONG ONE END.
*		IDLER PIVOT SHAFT(S) ____ " DIA. X ____ " LONG, CRS, WITH ONE HOLE DRILLED FOR 1/4"
		COTTER PIN 1/4" FROM THE END.
		SET(S) _____ TYPE IDLER FRAME PARTS; PULLROD LENGTH ____ ", MINIMUM
		THREAD LENGTH _____
		VIBRATION SWITCHES ____ MAKE _____ MODEL
*		V-BELTS: _____ TYPE, ____ " CENTER DISTANCE, ____ HP EACH, MATCHED SETS OF ____
		SHEAVE SET(S): _____
		____ GROOVES, FAN SHEAVE: ____ " OD, ____ " BORE WITH ____ "X ____ " KEYWAY
		____ PITCH, MOTOR SHEAVE: ____ " OD, ____ " BORE WITH ____ "X ____ " KEYWAY
*		MOTOR (S): _____ HP, ____ RPM, ____ PHASE, ____ HZ, ____ VOLTS, ____ ENCL., VARIABLE
		TORQUE, SINGLE WINDING, ____ SHAFT, ____ MOUNTING, ____ FRAME, ____ SLIDEBASE,
		CUST. SPECIFICATIONS __ , MOTOR DATA REQUIRED __ , WIRING DIAGRAMS ____
		* RECOMMENDED SPARE PARTS

INSPECTION

Tubes

Tubes are to be inspected for internal and external corrosion and/or erosion periodically. This depends on the severity of service and atmosphere that the tubes are in. Inspection of the tubes should be performed every six months. Tube wall thickness can be checked externally using the ultrasonic technique.

Fans

Fans should be inspected for wear (pitting, cracks and corrosion) on all surfaces. These inspections should be performed every six months. In addition to surface inspections, all bolts and nuts must be checked for proper torque.

Bearings

In addition to bearing checks as recommended by the manufacture; the mounting bolts should be checked for proper torque and alignment. These checks should be done at least every six (6) months.

Structure

A general inspection of the structure should be performed every six (6) months. This inspection should include checks for corrosion, damaged members and sheeting, and for loose bolting.

Headers

Headers should be inspected for corrosion. This corrosion should not be allowed to proceed past the stated corrosion allowance as stated on the specification sheet.

WARRANTY

Air-x –changers warrants that the apparatus it manufactures is free of defects in material and workmanship, when operated in accordance with conditions stated, for a period of one (1) year after start-up not to exceed fifteen months from shipment. Such warranty shall not apply to any equipment, which has been altered or repaired by other than the Company's personnel. The Company's obligation under this warranty is limited, however, to repairing or, if in the Company's judgement it seems more appropriate, to furnishing without charge, F.O.B. the Company's factory, a similar part to replace any part which after examination shall, to it's own satisfaction be determined to have been defective at the time it was shipped. This warranty applies only if the Company received an immediate written notice upon discovery of such defect. The Company makes no warranties covering deterioration or failure due to corrosion, erosion or fouling or due to improper installation or operation. EXCEPT AS SPECIFICALLY STATED ABOVE, AIR-X-CHANGERS HEREBY DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE.

LIMITATION OF LIABILITY

THE REMEDIES SET FORTH HEREIN ARE EXCLUSIVE. AIR-X-CHANGERS SHALL NOT BE LIABLE, IN EXCESS OF THE PURCHASE PRICE OF THE EQUIPMENT, FOR ANY DAMAGES, WHETHER IN CONTRACT, IN TORT OR ON ANY OTHER BASIS, SUSTAINED BY THE CUSTOMER OR ANY OTHER PERSON ARISING FROM OR RELATED TO THE DELIVERY, USE OR FAILURE OF THE EQUIPMENT OR FOR ANY DELAY, SPECIAL, INCIDENTAL, CONSEQUENTIAL, INDIRECT OR COMMERCIAL DAMAGES WHETHER DUE TO LOST PROFITS OR OTHERWISE RESULTING FROM THE DELIVERY, USE OR FAILURE OF THE EQUIPMENT.

IF IT IS EVER NECESSARY TO CONTACT OUR PLANT FOR SERVICE OR REPLACEMENTPARTS, IT IS ESSENTIAL THAT OUR JOB NUMBER AND OTHER IDENTIFYING DATA BE OBTAINED FROM THE METAL NAMEPLATE ATTACHED TO THE COOLER, OR THE NAMEPLATE ATTACHED TO THE TUBE BUNDLE HEADER BOX, WHICH ALSO CONTAINS THE DESIGN PRESSURE, TEMPERATURE, AND SERIAL NUMBER.

AIR-X-CHANGERS
P.O. BOX 1804
Tulsa, OK 74101
(918) 266-1850

SPARE PARTS

ITEM	DESCRIPTION	PRICE	AMOUNT
SEAL PINS	USED TO SEAL LEAKING TUBES		\$24.00 ea.
HAND TUBE ROLLER	USED TO ROLL TUBE IN BOX		\$134 ea.
V-BELT TENSIONER	USED TO SET BELT TENSION		\$15.00 ea.
SOCKETS FOR PLUGS			
TOOL KIT			
PROTRACTOR	USED TO CHECK FAN BLADE ANGLE		
PROTRACTOR BASE	USED ON VERTICAL FANS		
FIN COMB			\$20.00 ea.
PLUG GASKETS			\$0.20 ea.
TAPER PLUGS (BR)	TAPERED BRASS		\$1.50 ea.
TAPER PLUGS (STL)	TAPERED STEEL		
SHOULDER PLUGS			\$2.00 ea.
THEAD LUBE	LOK-CEASE COMPOUND		
THEAD LUBE (SS)	LIQUID-O-RING #404		
NOTE: PRICE INCLUDES ALL SHIPPING AND HANDLING			TOTAL FROM ABOVE
			TAX
			TOTAL ENCLOSED

PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE AND WITHOUT INCURRING OBLIGATION.

WHEN ORDERING PROVIDE FOLLOWING INFORMATION.

JOB NUMBER _____

MODEL TYPE _____

ORIGINAL CUSTOMER _____

AIR-X-CHANGERS STANDARD CONDITIONS OF SALE

1. **PRICES...**Unless otherwise specifically provided, all prices are F.O.B. the Company's plant at the Port of Catossa, Oklahoma and are subject to withdrawal or change without notice at any time prior to the Company's acceptance of a purchase order, as provided in Paragraph 3 of these Standard Conditions of Sale. After the Company's acceptance of a purchase order, prices are subject to the timely receipt of all required information and material from the Purchaser and to the timely approval of prints by the Purchaser.
2. **TAXES...**Prices do not sales, use, excise or similar taxes. Consequently, in addition to the price, the amount of any present or future sales, use, excise or other tax applicable to the sale or use of the Company's product or equipment shall be paid by the Purchaser unless the Purchaser shall have provided the company with a tax exemption certificate acceptable to the taxing authorities.
3. **ACCEPTANCE...**Acceptance of all purchase orders will be by authorized personnel at our general offices, subject to review of purchase order documents and credit approval.
4. **DELIVERY...**All delivery terms and dates are subject to: (i) the prior sale of the product or equipment of any part thereof; (ii) causes beyond the Company's reasonable control; (iii) acts of God, fires, floods, epidemics, riots, wars, priorities and acts of civil or military authority; (iv) strikes, labor difficulties and shortages of labor; (v) delays in transportation, car shortages and shortages in fuel, power, materials and supplies; (vi) acts of the Purchaser and receipt of all required information and materials from the Purchaser.
5. **TERMS OF PAYMENT...**The Terms of Payment shall be those set forth in the Company's quotation.
6. The Company warrants that the apparatus covered by this quotation is free of defects in material and workmanship, when operated in accordance with the conditions stated in this proposal, for a period of one year after start-up not to exceed fifteen (15) months from shipment. Such warranty shall not apply to any equipment, which has been altered or repaired by other than the Company's personnel. The Company's obligation under this warranty is limited, however, to repairing or, if in the Company's judgement it seems more appropriate, to furnishing without charge, F.O.B. the Company's factory, a similar part to replace any part which after examination shall, to its own satisfaction be determined to have been defective at the time it was shipped. This warranty applies only if the Company received an immediate written notice upon discovery of such defect. The Company makes no warranties covering deterioration or failure due to corrosion, erosion or fouling or due to improper installation or operation. EXCEPT AS SPECIFICALLY STATED ABOVE. AIR-X-CHANGERS HEREBY DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHERWISE.
7. **LIMITATION OF LIABILITY...**THE REMEDIES SET FORTH HEREIN ARE EXCLUSIVE. AIR-X-CHANGERS SHALL NOT BE LIABLE, IN EXCESS OF THE PURCHASE PRICE OF THE EQUIPMENT, FOR ANY DAMAGES, WHETHER IN CONTRACT, IN TORT OR ON ANY OTHER BASIS, SUSTAINED BY THE CUSTOMER OR ANY OTHER PERSON ARISING FROM OR RELATED TO THE DELIVERY, USE OR FAILURE OF THE EQUIPMENT OR FOR ANY DELAY, SPECIAL, INCIDENTAL, CONSEQUENTIAL, INDIRECT OR COMMERCIAL DAMAGES WHETHER DUE TO LOST PROFITS OR OTHERWISE RESULTING FROM THE DELIVERY, USE OR FAILURE TO THE EQUIPMENT.
8. **CHANGES...**The Purchaser may change the specification of their order only upon written notice. Any additional charges accrued as a result, will be for Purchaser's account.
9. **CANCELLATION...**Should the order require cancellation, written notice should be forwarded to Air-X-Changers main office immediately. A review of all costs incurred on the Purchaser's behalf, will be made, to establish cancellation charges.
10. **WAIVER AND MODIFICATION...**No waiver or modification of any of the companies terms shall be effective unless acknowledged in writing and signed by an authorized Air-x-changers' employee.
11. **SITING/INSTALLATION...**Siting of cooler(s) is the responsibility of the purchaser. Purchaser must insure that cooler air intake areas are free from obstruction to airflow, and sources of hot air (including other coolers). Spacing of air coolers should be adequate to avoid hot air recirculation. Raising units should compensate for effects of grouping coolers together.

PARTS LIST



air-x-changers

a harsco company

Post Office Box 1804
Tulsa, OK 74015
Phone: (918) 266-1850
Fax (918) 266-1322

JOB NUMBER: 055572

CUSTOMER: **ENERFLEX**

ORDER COVERS: (1) Model 96AVI

REV.	BY	DATE	DESCRIPTION OF CHANGE
0	SBARGAS	9/272005	Initiated Parts List
1	PM	10/20/05	Added Fan and Idler Shaft length and Bugscreens

FINISH: EFX Standard

SURFACE PREPARATION: Chemical Clean

PRIMER: H-I-S 9267 Gray Primer; 1.5 TO 2.0 MILS. DFT.

FINISH COAT: AXC Std-Customer Tint; H-I-S S685 Gray Enamel; 1.5 TO 2.0 MILS. DFT.

Prior to painting, mask off the inside perimeter of each opening of the bugscreen frame with 1" wide weatherproof tape (3M Model 481).

P.O.	QTY.	DESCRIPTION OF COMPONENTS
		NOTE: AN ASTERIK (*) IN QUANTITY COLUMN INDICATES A RECOMMENDED SPARE PART
	<u>4</u>	SECTION(S) IN ACCORDANCE WITH SPECIFICATION SHEET.
	<u>1</u>	<u>96AVI</u> STRUCTURE(S), COMPLETE WITH: <u>EFX Standard Pipe Supports</u> <u>Rear Floor Underscoop</u> <u>EFX Standard "Fall Protection" Safety Hook</u> <u>Pump and Tank Bolt Holes with Nuts in Cooler Base</u>
	<u>1</u>	SET SHUTTERS: TYPE <u>Manual</u> , FOR SERVICE(S) <u>TAW/ELOW, EJW</u> , SQ. FT. = <u>48.4375</u> , #LINKAGE SETS = <u>1</u> , MOUNTING TYPE: <u>Standard</u> , EXTRA FEATURES: <u>Deep Side Frames</u> <u>Remote Linkage for Ground Level Operator</u>
	<u>1</u>	SET SHUTTERS: TYPE <u>Auto</u> , FOR SERVICE(S) <u>IC-1</u> , SQ. FT. = <u>15.625</u> , #LINKAGE SETS = <u>1</u> , MOUNTING TYPE: <u>Standard</u> , EXTRA FEATURES: <u>Deep Side Frames</u>
	<u>1</u>	SET SHUTTERS: TYPE <u>Auto</u> , FOR SERVICE(S) <u>IC-2, AC</u> , SQ. FT. = <u>38.9062</u> , #LINKAGE SETS = <u>1</u> , MOUNTING TYPE: <u>Standard</u> , EXTRA FEATURES: <u>Deep Side Frames</u>
	<u>1</u>	AIR MOTOR: FOR SERVICE(S) <u>IC-1, Garzo</u> MAKE, <u>501-12 w/Pivot Mount</u> MODEL, <u>6-30</u> SPRING OPTION, <u>Rubber</u> DIAP MTRL., POSITIONER: <u>None</u>
	<u>1</u>	AIR MOTOR: FOR SERVICE(S) <u>IC-2, Garzo</u> MAKE, <u>501-12 w/Pivot Mount</u> MODEL, <u>6-30</u> SPRING OPTION, <u>Rubber</u> DIAP MTRL., POSITIONER: <u>None</u>
	* <u>1</u>	FAN(S): <u>96</u> Inch DIAMETER, <u>8</u> BLADES, <u>LH</u> ROTATION, <u>MOORE-CL10K</u> MAKE, <u>10.4°</u> ANGLE @ <u>Clevis</u> , <u>2-7/16</u> Inch BORE WITH <u>5/8</u> Inch X <u>5/16</u> Inch KEYWAY. MODEL/PITCH: <u>48-HDVT/Manual</u> , HUB: <u>TAPER WELD VORTEX TIPS TO FAN BLADES!</u>
	* <u>1</u>	FAN SHAFT(S): <u>2-7/16</u> Inch DIA. X <u>69</u> Inch LONG WITH <u>5/8</u> Inch SQ. KEYS <u>each</u> END, KEYWAY LENGTH(DRIVE END): <u>6 Inch</u> , KEYWAY LENGTH(FAN END): <u>0 Inch</u> , KEY LENGTH: <u>0 Inch</u>
	* <u>2</u>	<u>2-7/16</u> Inch FAN SHAFT BEARINGS, MAKE/MODEL: <u>Dodge-S2000/P2B-S2-207R</u> , AXC P/N <u>BR1111</u>
	* <u>1</u>	IDLER SHAFT(S): <u>2-3/16</u> inch DIA. X <u>20</u> inch LONG WITH <u>1/2</u> inch SQ. KEY <u>4.5</u> inch LONG-ONE END
	<u>1</u>	SET(S): <u>Adj. Block</u> TYPE IDLER FRAME PARTS
	* <u>1</u>	<u>2-3/16</u> Inch IDLER BEARING(S), MAKE/MODEL: <u>Dodge-FB/CC203 w/'Boxed' Idler Housing</u> , AXC P/N
	<u>1</u>	SET(S) SOFT BUGSCREENS PANELS w/ FRAME/FAN GUARD: ONE SET CONSISTS OF: <u>3</u> PANEL(S) <u>46-1/2</u> Inches X <u>47-1/2</u> Inches <u>3</u> PANEL(S) <u>47-1/2</u> Inches X <u>53-1/2</u> Inches COMPLETE WITH ONE (1) SOFTBUGSCREEN INSTALLATION KIT.

**Alr-X-Changers****Harsco****PO BOX 1804
TULSA, OK 74101-1804
PHONE: 918-619-8000
FAX: 918-384-5202****Job No. 055572****Initial Release Date 9/27/2005****Page 1 of 1**

1	Purchaser	ENERFLEX	Ultimate User	EFX LEASING
2	Inquiry/PO#		Destination	BC/ALB/SASK
3	No. Units	1	Model:	96AVI
4	Assembly:	PACKAGED	Draft:	INDUCED
			Reference	H24GL(LCR) - JGJ/4 @ 530HP
			Overall Size (WxLxH),	~7.50x13.50x8.83
			Est. Wt., lbs.	11,400

PERFORMANCE

5	Service	EJW	TAW/ELOW	IC-1	IC-2	AC
6	Flow	130GPM	35GPM	3.18MMSCFD	3.18MMSCFD	3.18MMSCFD
7	Fluid	50%GLY	50%GLY	.65SPGR	.65SPGR	.65SPGR
8	Temp. In / Out, f	180.0 / 158.3	168.2 / 130.0	199.0 / 120.0	239.0 / 116.0	258.0 / 120.5
9	Pressure, psia			246.0	492.0	1,120.0
10	Pressure Drop, psi	4.9	6.9	1.7	3.8	1.6
11	Heat Load, btu/hr	1,308,700	597,933	293,738	478,037	582,867
12	True LMTD, f	44.5	34.5	48.2	48.9	59.2
13	Overall Rate, U, btu/hr ft ² f	159.2	149.7	65.8	80.7	85.1
14	Fouling Factor, ft ² hr f / btu	0.0005	0.0005	0.0020	0.0020	0.0020
15	Surface, Bare / Extended, sq.ft.	186 / 2964	116 / 1848	96 / 1530	127 / 1899	116 / 1848
16	Sections, No./Connected	(1) COMBINED w/2	(1) COMBINED w/1	(1) SINGLY	(1) SINGLY	(1) SINGLY
17	Design Temp. (Max / Min), f	300/-20	300/-20	350/-20	350/-20	350/-20
18	Design / Test Press., psig	*14 / 65	*14 / 65	645 / 839	1292 / 1680	1650 / 2145
19	Pass Arrangement	CROSSFLOW	CROSSFLOW	CROSSFLOW	CROSSFLOW	CROSSFLOW
20	No. Tube Rows/Tube Passes	5 / 2	5 / 4	5 / 1	5 / 3	5 / 2
21	Section Weight, lbs	1850		1050	1450	1350
22	Tubes, OD x BWG	5/8X16(.060MIN)	5/8X16(.060MIN)	5/8X14(.075MIN)	3/4X16(.060MIN)	5/8X16(.060MIN)
23	Material	SA214	SA214	SA179 STEEL	SA179 STEEL	SA179 STEEL
24	No. Per Section / Length, ft	93 / 12.5	58 / 12.5	48 / 12.5	53 / 12.5	58 / 12.5
25	Retarders					
26	Accelerators					
27	Fins, Type	L-TENSION / WHEEL	L-TENSION / WHEEL	L-TENSION / WHEEL	L-TENSION / WHEEL	L-TENSION / WHEEL
28	Material	ALUMINUM	ALUMINUM	ALUMINUM	ALUMINUM	ALUMINUM
29	Nozzles, Rating/Type	STUB	STUB	300 RF	600 RF	1500 RF
30	Material / Bore	SA106 GR.B / SCH-40	SA106 GR.B / SCH-80	SA105 / SCH-160	SA105 / SCH-160	SA105 / SCH-160
31	(No. Inlets) / Size, in	(1) / 3IN	(1) / 2IN	(1) / 4IN	(1) / 3IN	(1) / 2IN
32	(No. Outlets) / Size, in	(1) / 3IN	(1) / 2IN	(1) / 4IN	(1) / 3IN	(1) / 2IN
33	Headers, Type	RECT. TUBE	RECT. TUBE	BOX W/PLUGS	BOX W/PLUGS	BOX W/PLUGS
34	Material	SA500 GR.B	SA500 GR.B	SA516 70	SA516 70	SA516 70
35	Corrosion Allow., in			0.1250	0.1250	0.1250
36	Grooved Tubesheet			YES	YES	DOUBLE
37	Plugs, Type	TAPER	TAPER	SHOULDER	SHOULDER	SHOULDER
38	Plugs Material	B-16 BRASS	B-16 BRASS	SA105	SA105	SA105
39	Industry Specifications	AXC-STD	AXC-STD	AXC-STD	AXC-STD	AXC-STD
40	ASME Code Stamp / N.B.			YES	YES	YES
41	Canadian Registration #			YES	YES	YES
42	PWHT			YES	YES	YES
43	NACE					

44	Inspection/NDT	UB	UB	UB
	F= 100% R.T. of all header seam & nozzle butt welds PLUS 100% U.T. of all attachment welds. S= Spot R.T. of 1 long seam & 1 end closure, per header			
	U= 100% UT of all header seam, nozzle and coupling attachment & nozzle butt welds. B= 100% R.T. of all nozzle butt welds.			
	SB= S PLUS B as each are described above. UB= U PLUS B as each are described above.			

AIR-SIDE PERFORMANCE		FAN DATA		DRIVER DATA		REDUCER DATA	
45	Ambient Air Temp., In, f	90	No. Fans / Make / MOORE-CL10K	Type	ENGINE DRIVE	Type	REDUCER BY OTHERS
46	Elevation, ft	3000	Blade Material	ALUMINUM			
47	Air Flow, SCFM	65,237	HP @ RPM	25.67 @ 400			
48	Air Temp., Out, f	135.6	Dia., in / No. Blades	96 / 8			
49	Min. Ambient, f	-20	Blade Angle, Deg	10.4 @ Clevis			
50			Series/Blade Adj.	48-HDVT/Manual			
51			Fan Hub Bushing	TAPER			

* Actually built to standard 50# design. Designated 14# to eliminate necessity of Provincial registration.

Fan noise 84 dBA @ 1 meter, 65 dBA @ 15 m.

REV	DATE	BY	DESCRIPTION
1	9/30/2005	SB	Changed SCH Bore on IC-1 and IC-2 from 80 to 160.



Installation, Maintenance, and Operating Instructions

for

Engine Drive Units

Air-x-changers has prepared this manual for the care and up keep of your cooler. With these simple instructions and a few tools, the owner can perform many maintenance and light repair procedures such as tightening the V-belts, checking fan blade angle, greasing bearings, setting the vibration switch, and cleaning fins and tubes. If more information is needed about a specific component we recommend that you refer to the attached specific manufactures maintenance instructions i.e. (motors, fans, and bearings).

Because this manual covers several cooler styles and sizes, the instructions outlined are general in nature. This should be noted when looking at any illustration or parts of the manual that may not apply to your cooler.

Good judgement should be used when purchasing either replacement parts or products to be used in your repair or maintenance work. Some products may cause a decrease in performance. All replacement parts should be equivalent to the manufacture's original parts. Replacement parts ordered from the factory always carry our required high level of quality. DO NOT take a chance with products that might not do the job.

EQUIPMENT SITING AND INSTALLATION

Setting of cooler(s) is the responsibility of the purchaser who must insure that cooler intake areas are free from obstruction to airflow and sources of hot air (including other air coolers). Spacing of air coolers should be adequate to avoid hot air recirculation. Raising and or separating units should compensate for the effects of grouping coolers together.

ON ARRIVAL AT SITE SHIPPING DAMAGE

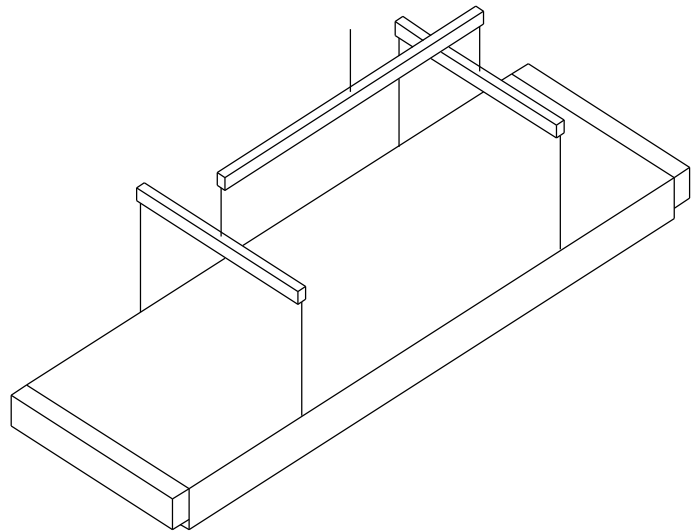
The cooler should be thoroughly inspected for damage by receiving personnel. Damage in transit can be result of dropping or being struck by heavy objects, any damage should be described on receiving documents presented by carrier. Prompt claim filing will expedite early compensation from the offending carrier.

Loose Parts

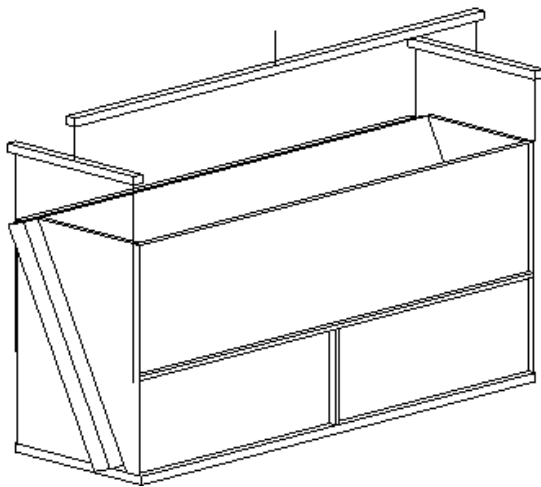
The parts list should be checked to see that all parts shipped with the cooler are present. These parts may be secured to the skid base (if so designed) or inside the plenum area. Basically this cooler is completely shop assembled and no assembly at the job-site is required, but occasionally special accessory devices will be required which must be shipped disassembled to meet height or width limitations.

UNLOADING COOLER

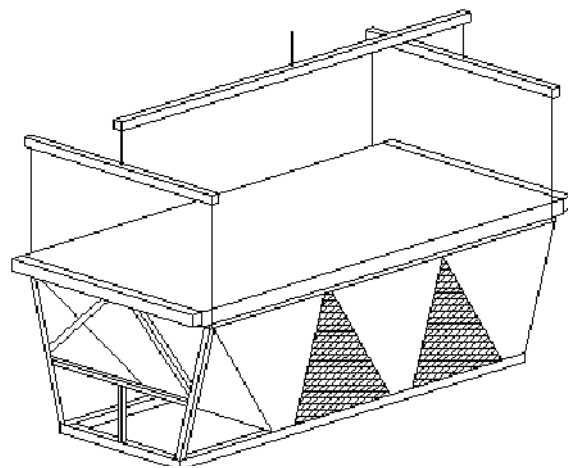
Spreader bars are to be used for lifting when the cooler is eight (8) feet. The cooler is supplied with lifting points to be used for off loading from carrier. Lifting by any other point may cause damage to the cooler. Following are some suggested ways of lifting. Locate the picture which resembles the type of unit you have and use as a guide on how to unload and handle the cooler properly. (See unit name plate for unit type i.e. EH, H, FI, etc.)



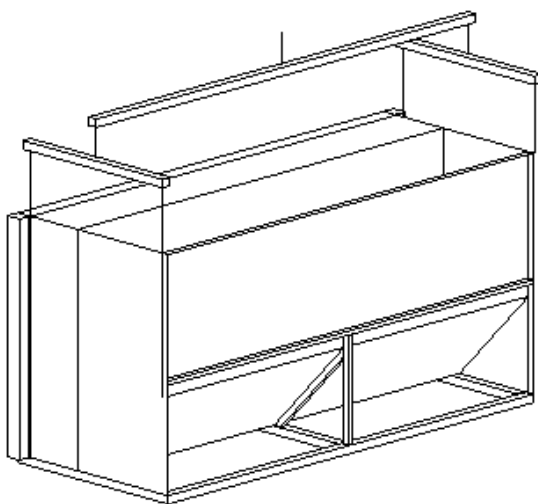
TUBE BUNDLES



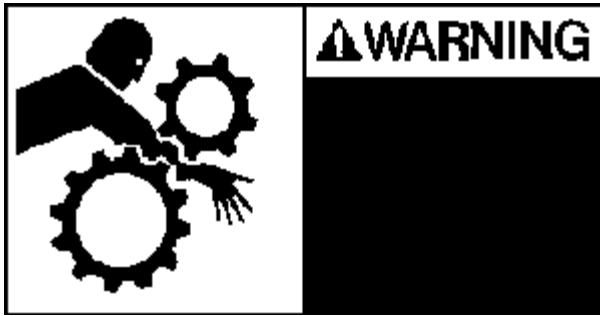
EH-UNITS



F-UNITS



VI-UNITS



TURN OFF AND LOCK OUT DRIVER BEFORE ENTERING COOLER

PRIOR TO RUN-IN

NOTE: Check all nuts and bolts for tightness, bolting will loosen during shipment.

Fans

Check fan blade bolts and hub set screws for tightness. Rotate fan by hand to insure that shaft, speed reducer, and driver turn freely. The fan should be checked for adequate tip clearance and blade pitch angle. Slight adjustment of the tip clearance can be made by loosening the fan shaft bearing bolts and moving the complete fan and fan shaft assembly until it is centered in the ring. To check the fan blade angle, use a level bubble protractor (this can be obtained from the factory). Loosen the nuts on the bolts and place the protractor on the angle setting mark or the clevis (refer to fan manufactures information for proper location). Using a mallet tap on the shank end of the blade to adjust the angle. Tighten fan blade bolts to the proper torque (refer to manufactures maintenance instructions) making sure to tighten evenly. Recheck blade angle. Some coolers are equipped with an automatic fan. These fans have blade angles controlled by varying the air supply pressure. Air pressure should be applied by to the fan before starting to check for proper operation. Before starting, the motor should be bumped to check for proper direction of fan rotation.

Bearings

Bearing mounting bolts and set screws should be checked for tightness. The manufacturer lubricates the bearings and no additional grease is necessary to start. When remote lube lines are provided check to insure they are full by loosening at the bearing end, then fill with grease from fitting end. This will insure that the grease lines are full of grease. During high-speed operation too much grease will cause over heating. To protect bearings against entrance of foreign material when dust and water are present the bearings should contain as much grease as speed will allow. Daily lubrication may be required to maintain a slight leakage at the seals. Under normal conditions use the following table as a guide. However, certain conditions may require a change of lubrication periods such as the ones described above.

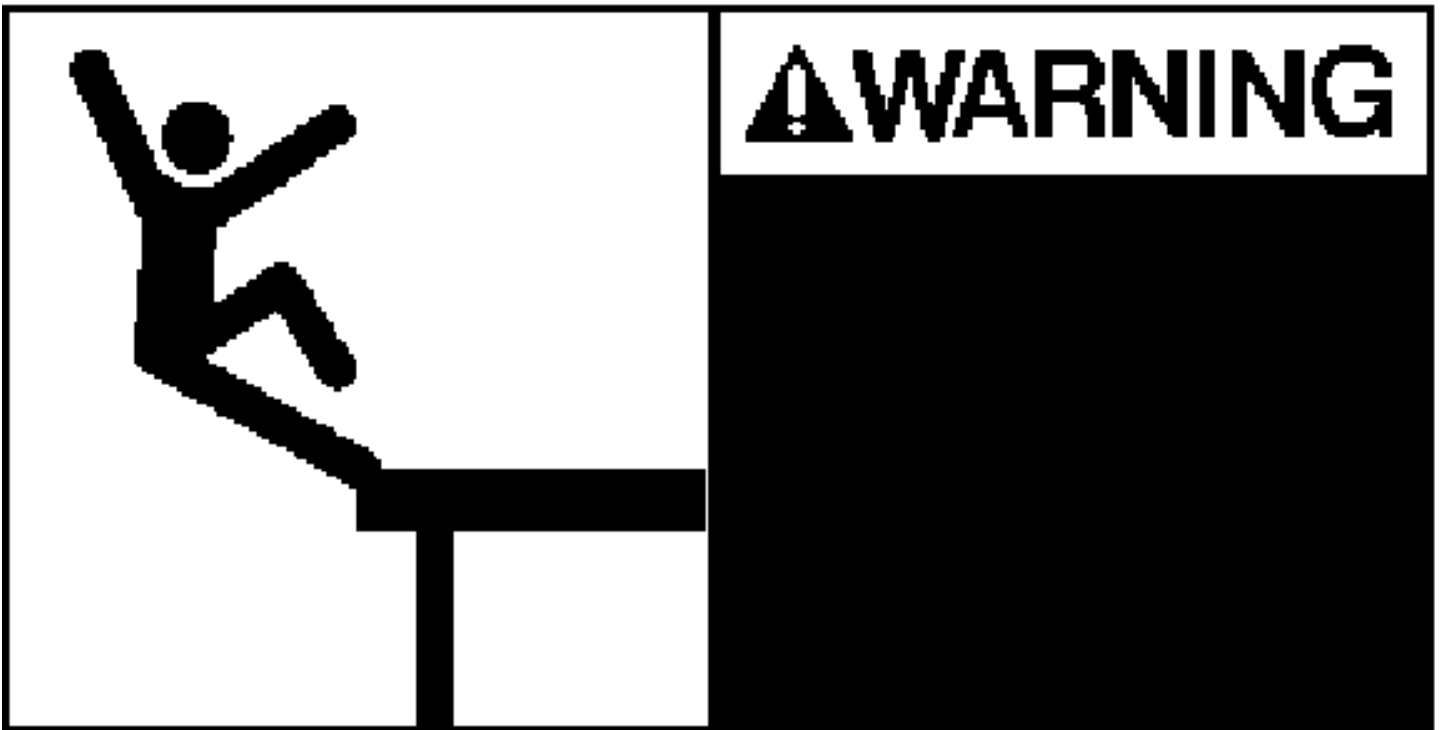
Read preceding page before establishing lubrication schedule

LUBRICATION GUIDE

	Suggested Lubrication Period in Weeks							
HOURS PER DAY	1 TO 250 RPM	251 TO 500 RPM	501 TO 750 RPM	751 TO 1000 RPM	1001 TO 1500 RPM	1501 TO 2000 RPM	2001 TO 2500 RPM	2501 TO 3000 RPM
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	1	1
24	10	5	3	2	1	1	1	1

Louvers

Check all mounting brackets and bolts for tightness. On manually operated louvers, to insure that the linkage is adjusted properly, operate blades from a fully open position to a fully closed position. On automatic air motor (optional) operated louvers, air should be applied to actuator to check for proper linkage adjustment, free operation, and sufficient air supply. See manufacturer maintenance instructions for further information on air motors.



**DO NOT WALK ON LOUVERS
OR USE AS A LADDER!!**

U-Joints

Relubrication cycles vary depending on the service requirements and operating conditions of the drive. Under normal conditions, a maximum relubrication cycle of 30 to 60 days is recommended. Consult the manufacturer service manual for specific grease and lubrication requirements.

RUN-IN

Vibration Switch (optional) (Murphy & Nelson)

After the switch has been installed, adjust by turning the adjustment screw in a clockwise direction until the starting torque does not trip the vibration switch. For other brands see manufactures information.

Process Start-up

The process start-up should be conducted in a manner that will minimize thermal shock of the tube bundles. Over cooling of fluids during periods of low ambient temperature and low heat loads should also be avoided during start up.

Plugs

Header plugs are installed at room temperature in our plant. To correct any minor leaking, it may be necessary to tighten the plugs when the bundle is at operating temperature. **WARNING:** Do not tighten plugs while the bundle is under pressure. If any plugs are removed, the gasket (for shoulder plugs only) should always be replaced. Replacement gaskets should be ordered from the factory. When installing the plugs, a thread lubricant and antigalling compound should be used.

LONG TERM

Fin Cleaning

Fins should be kept free of dirt and lint, which can be removed by directing compressed air perpendicular to the tubes in a direction opposite to the normal airflow. Do not use steam or chemicals to clean fins.

Tube Cleaning

The internal cleaning of tubes can be done three different ways:

1. **Mechanical Cleaning**

This consists of using drills, (or wire brushes), on long rods. And rotating them with air or electric motors. This is normally followed by a water wash or air purge.

2. **Chemical Cleaning**

This consists of circulating hot chemical solution through the tubes. The solution contains inhibitors to avoid corrosion of the tube walls.

3. **High Pressure Water Sprays**

This consists of placing a high-pressure water jet head at the end of the hollow rods and pushing through the individual tubes.

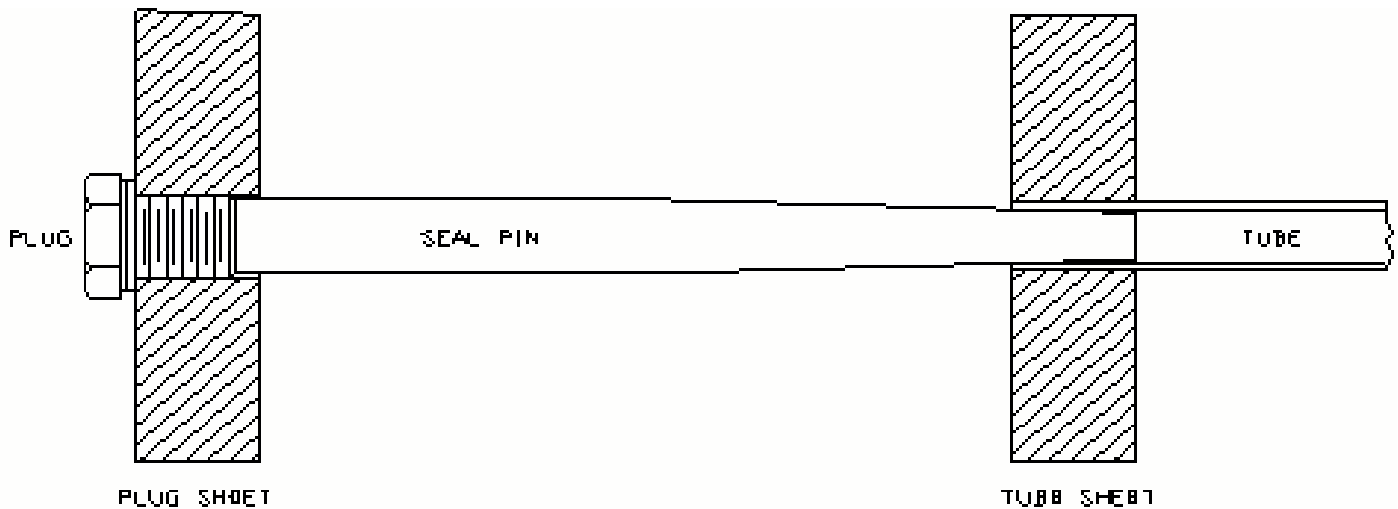
NOTE: The last two processes will not work on tubes that are plugged, they must be drilled out mechanically.

Leaking Tubes

Tube leaks can be two types: (1) leaks through the tube wall and (2) leaks in the tube attachment. In the first case it is most practical to plug both ends of the tube. Only a limited number of tubes can be sealed off in this manner before performance is affected. When performance drops below acceptable limits, tube bundle must be retubed. If leaks develop in the tube end attachment, rerolling of the tube will be necessary. Care must be taken in selecting the proper tube expander for the size and gauge of tube to be rolled. When rolling a tube, over-rolling must be avoided. Consult the factory for information on taper pins to plug the tubes and roller tube sizes.

INSTRUCTIONS FOR USING TAPER PINS FOR SEALING LEAKING TUBES

1. Remove plug from one end of leaking tube (do not switch plugs in holes).
2. Insert taper pin through plug hole into tube and tap lightly with hammer until seated firmly, but not too tight to be removed.
3. Measure plug for depth it was originally screwed into the plug sheet.
4. Measure the distance that the taper pin protrudes from the plug sheet in seated position.
5. Add the distance measured in Steps 3 and 4 then subtract $\frac{1}{8}$ ". This will be the length which should be cut off the large end of the taper pin



6. Remove the taper pin from the end of the tube.
7. Saw a piece off the large end of the taper pin, the length figured in Step 5. Be careful not to cut the pin too short.
8. Re-insert the taper pin in the tube and drive well into place.
9. Lubricate plug (see PLUGS page 12) and replace in plug sheet. Run up tightly. The plug should now seat and help hold the taper pin in place.
10. Repeat operation on opposite end of tube.

NOTE: If the plug removed does not seal replace it and the gasket if so equipped.

Recommended Spare Parts

We suggest that one each of the parts, which are designated by an asterisk (*) on the parts list be carried in your stock of spare parts. The down time caused by waiting for delivery of a spare part usually cost more in lost production or service than the cost of the part itself.

Spare parts orders should be specified in accordance with the parts list description and the Job number of the unit.

P.O.	QTY.	DESCRIPTION OF COMPONENTS
	—	SECTIONS IN ACCORDANCE WITH SPECIFICATION SHEET DATED: _____
	—	— STRUCTURE(S): _____
	—	SET(S) SHUTTERS: _____
	—	SET(S) TURNING VANES: _____
	* —	FAN (S) ____" DIA. ____ BLADES ____ HAND ____ MAKE ____° ANGLE AT ____ ____ "BORE WITH ____"X ____" KEYWAY. _____
	* —	FAN SHAFT(S): ____" DIA. X ____" LONG WITH ____" SQ. KEYS ____ END, KEYWAY LENGTH ____"
	* —	____" FAN BEARING(S): _____
	* —	____" IDLER BEARING(S): _____
	* —	IDLER SHAFT(S) ____" DIA. X ____" LONG WITH ____" SQ. KEY ____" LONG ONE END.
	* —	IDLER PIVOT SHAFT(S) ____" DIA. X ____" LONG, CRS, WITH ONE HOLE DRILLED FOR ¼" COTTER PIN ¼" FROM THE END.
	—	SET(S) _____ TYPE IDLER FRAME PARTS; PULLROD LENGTH ____", MINIMUM THREAD LENGTH _____
	—	VIBRATION SWITCHES ____ MAKE _____ MODEL
	* —	V-BELTS: _____ TYPE, ____" CENTER DISTANCE, ____ HP EACH, MATCHED SETS OF ____
	—	SHEAVE SET(S): _____ ____ GROOVES, FAN SHEAVE: ____" OD, ____" BORE WITH ____" X ____" KEYWAY ____ PITCH, MOTOR SHEAVE: ____" OD, ____" BORE WITH ____" X ____" KEYWAY
	* —	MOTOR (S): _____ HP, ____ RPM, ____ PHASE, ____ HZ, ____ VOLTS, ____ ENCL., VARIABLE TORQUE, SINGLE WINDING, ____ SHAFT, ____ MOUNTING, ____ FRAME, ____ SLIDEBASE, CUST. SPECIFICATIONS __, MOTOR DATA REQUIRED __, WIRING DIAGRAMS ____
<p>* RECOMMENDED SPARE PARTS</p>		

INSPECTION

Tubes

Tubes are to be inspected for internal and external corrosion and/or erosion periodically. This depends on the severity of service and atmosphere that the tubes are in. Inspection of the tubes should be performed every six months. Tube wall thickness can be checked externally using the ultrasonic technique.

Fans

Fans should be inspected for wear (pitting, cracks and corrosion) on all surfaces. These inspections should be performed every six months. In addition to surface inspections, all bolts and nuts must be checked for proper torque.

Bearings

In addition to bearing checks as recommended by the manufacture; the mounting bolts should be checked for proper torque and alignment. These checks should be done at least every six (6) months.

Structure

A general inspection of the structure should be performed every six (6) months. This inspection should include checks for corrosion, damaged members and sheeting, and for loose bolting.

Headers

Headers should be inspected for corrosion. This corrosion should not be allowed to proceed past the stated corrosion allowance as stated on the specification sheet.

WARRANTY

Air-x –changers warrants that the apparatus it manufactures is free of defects in material and workmanship, when operated in accordance with conditions stated, for a period of one (1) year after start-up not to exceed fifteen months from shipment. Such warranty shall not apply to any equipment, which has been altered or repaired by other than the Company's personnel. The Company's obligation under this warranty is limited, however, to repairing or, if in the Company's judgement it seems more appropriate, to furnishing without charge, F.O.B. the Company's factory, a similar part to replace any part which after examination shall, to it's own satisfaction be determined to have been defective at the time it was shipped. This warranty applies only if the Company received an immediate written notice upon discovery of such defect. The Company makes no warranties covering deterioration or failure due to corrosion, erosion or fouling or due to improper installation or operation. EXCEPT AS SPECIFICALLY STATED ABOVE, AIR-X-CHANGERS HEREBY DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, OR OTHERWISE.

LIMITATION OF LIABILITY

THE REMEDIES SET FORTH HEREIN ARE EXCLUSIVE. AIR-X-CHANGERS SHALL NOT BE LIABLE, IN EXCESS OF THE PURCHASE PRICE OF THE EQUIPMENT, FOR ANY DAMAGES, WHETHER IN CONTRACT, IN TORT OR ON ANY OTHER BASIS, SUSTAINED BY THE CUSTOMER OR ANY OTHER PERSON ARISING FROM OR RELATED TO THE DELIVERY, USE OR FAILURE OF THE EQUIPMENT OR FOR ANY DELAY, SPECIAL, INCIDENTAL, CONSEQUENTIAL, INDIRECT OR COMMERCIAL DAMAGES WHETHER DUE TO LOST PROFITS OR OTHERWISE RESULTING FROM THE DELIVERY, USE OR FAILURE OF THE EQUIPMENT.

IF IT IS EVER NECESSARY TO CONTACT OUR PLANT FOR SERVICE OR REPLACEMENT PARTS, IT IS ESSENTIAL THAT OUR JOB NUMBER AND OTHER IDENTIFYING DATA BE OBTAINED FROM THE METAL NAMEPLATE ATTACHED TO THE COOLER, OR THE NAMEPLATE ATTACHED TO THE TUBE BUNDLE HEADER BOX, WHICH ALSO CONTAINS THE DESIGN PRESSURE, TEMPERATURE, AND SERIAL NUMBER.

AIR-X-CHANGERS
P.O. BOX 1804
Tulsa, OK 74101
(918) 266-1850

SPARE PARTS

ITEM	DESCRIPTION	PRICE	AMOUNT
SEAL PINS	USED TO SEAL LEAKING TUBES		\$24.00 ea.
HAND TUBE ROLLER	USED TO ROLL TUBE IN BOX		\$134 ea.
V-BELT TENSIONER SOCKETS FOR PLUGS TOOL KIT	USED TO SET BELT TENSION		\$15.00 ea.
PROTRACTOR	USED TO CHECK FAN BLADE ANGLE		
PROTRACTOR BASE	USED ON VERTICAL FANS		
FIN COMB			\$20.00 ea.
PLUG GASKETS			\$0.20 ea.
TAPER PLUGS (BR)	TAPERED BRASS		\$1.50 ea.
TAPER PLUGS (STL)	TAPERED STEEL		
SHOULDER PLUGS			\$2.00 ea.
THEAD LUBE	LOK-CEASE COMPOUND		
THEAD LUBE (SS)	LIQUID-O-RING #404		
NOTE: PRICE INCLUDES ALL SHIPPING AND HANDLING			TOTAL FROM ABOVE
			TAX
			TOTAL ENCLOSED

PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE AND WITHOUT INCURRING OBLIGATION.

WHEN ORDERING PROVIDE FOLLOWING INFORMATION.

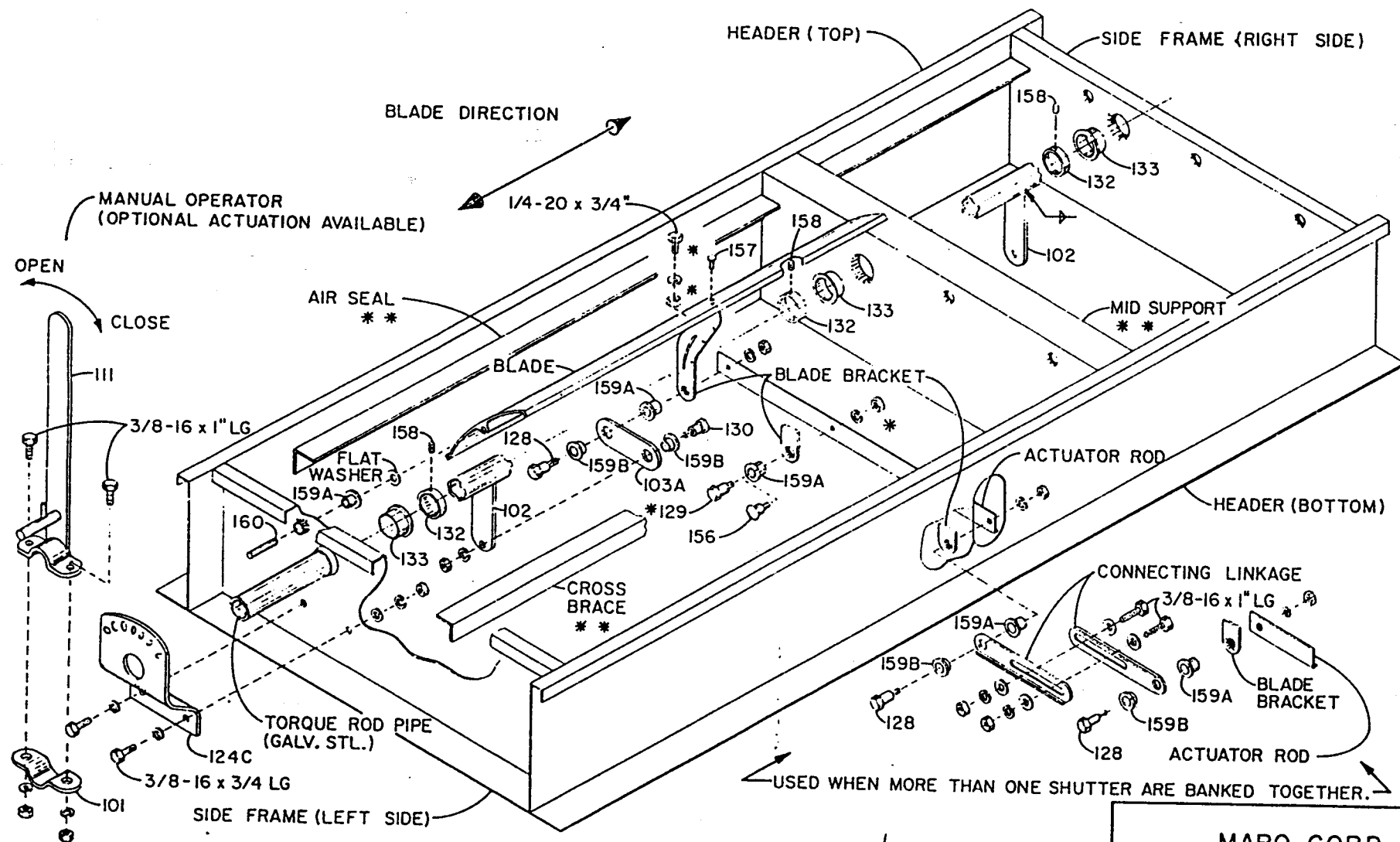
JOB NUMBER _____

MODEL TYPE _____

ORIGINAL CUSTOMER _____

AIR-X-CHANGERS STANDARD CONDITIONS OF SALE

1. **PRICES...**Unless otherwise specifically provided, all prices are F.O.B. the Company's plant at the Port of Catossa, Oklahoma and are subject to withdrawal or change without notice at any time prior to the Company's acceptance of a purchase order, as provided in Paragraph 3 of these Standard Conditions of Sale. After the Company's acceptance of a purchase order, prices are subject to the timely receipt of all required information and material from the Purchaser and to the timely approval of prints by the Purchaser.
2. **TAXES...**Prices do not sales, use, excise or similar taxes. Consequently, in addition to the price, the amount of any present or future sales, use, excise or other tax applicable to the sale or use of the Company's product or equipment shall be paid by the Purchaser unless the Purchaser shall have provided the company with a tax exemption certificate acceptable to the taxing authorities.
3. **ACCEPTANCE...**Acceptance of all purchase orders will be by authorized personnel at our general offices, subject to review of purchase order documents and credit approval.
4. **DELIVERY...**All delivery terms and dates are subject to: (i) the prior sale of the product or equipment of any part thereof: (ii) causes beyond the Company's reasonable control: (iii) acts of God, fires, floods, epidemics, riots, wars, priorities and acts of civil or military authority: (iv) strikes, labor difficulties and shortages of labor: (v) delays in transportation, car shortages and shortages in fuel, power, materials and supplies: (vi) acts of the Purchaser and receipt of all required information and materials from the Purchaser.
5. **TERMS OF PAYMENT...**The Terms of Payment shall be those set forth in the Company's quotation.
6. The Company warrants that the apparatus covered by this quotation is free of defects in material and workmanship, when operated in accordance with the conditions stated in this proposal, for a period of one year after start-up not to exceed fifteen (15) months from shipment. Such warranty shall not apply to any equipment, which has been altered or repaired by other than the Company's personnel. The Company's obligation under this warranty is limited, however, to repairing or, if in the Company's judgement it seems more appropriate, to furnishing without charge, F.O.B. the Company's factory, a similar part to replace any part which after examination shall, to its own satisfaction be determined to have been defective at the time it was shipped. This warranty applies only if the Company received an immediate written notice upon discovery of such defect. The Company makes no warranties covering deterioration or failure due to corrosion, erosion or fouling or due to improper installation or operation. EXCEPT AS SPECIFICALLY STATED ABOVE. AIR-X-CHANGERS HEREBY DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WHETHER OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR OTHERWISE.
7. **LIMITATION OF LIABILITY...**THE REMEDIES SET FORTH HEREIN ARE EXCLUSIVE. AIR-X-CHANGERS SHALL NOT BE LIABLE, IN EXCESS OF THE PURCHASE PRICE OF THE EQUIPMENT, FOR ANY DAMAGES, WHETHER IN CONTRACT, IN TORT OR ON ANY OTHER BASIS, SUSTAINED BY THE CUSTOMER OR ANY OTHER PERSON ARISING FROM OR RELATED TO THE DELIVERY, USE OR FAILURE OF THE EQUIPMENT OR FOR ANY DELAY, SPECIAL, INCIDENTAL, CONSEQUENTIAL, INDIRECT OR COMMERCIAL DAMAGES WHETHER DUE TO LOST PROFITS OR OTHERWISE RESULTING FROM THE DELIVERY, USE OR FAILURE TO THE EQUIPMENT.
8. **CHANGES...**The Purchaser may change the specification of their order only upon written notice. Any additional charges accrued as a result, will be for Purchaser's account.
9. **CANCELLATION...**Should the order require cancellation, written notice should be forwarded to Air-X-Changers main office immediately. A review of all costs incurred on the Purchaser's behalf, will be made, to establish cancellation charges.
10. **WAIVER AND MODIFICATION...**No waiver or modification of any of the companies terms shall be effective unless acknowledged in writing and signed by an authorized Air-x-changers' employee.
11. **SITING/INSTALLATION...**Siting of cooler(s) is the responsibility of the purchaser. Purchaser must insure that cooler air intake areas are free from obstruction to airflow, and sources of hot air (including other coolers). Spacing of air coolers should be adequate to avoid hot air recirculation. Raising units should compensate for effects of grouping coolers together.



NOTE:

1. * INDICATES REPLACEMENT PARTS ONLY.
2. ** INDICATES ITEMS USED ACCORDING TO SHUTTER SIZE OR CUSTOMER SPEC'S.
3. PART NUMBERS 128, 129, 130 USE 1/4-20 NUT AND LOCKWASHERS.

MARO CORP.
TULSA, OKLAHOMA

650 SERIES SHUTTER

DWG. NO. 161

SPRING OPPOSED LINEAR DIAPHRAGM OPERATORS

GARZO LINEAR DIAPHRAGM OPERATORS ARE SMALL DIAMETER SPRING OPPOSED ROLLING DIAPHRAGM OPERATORS SUITABLE FOR GAS COMPRESSOR APPLICATIONS. THE SERIES 501 OPERATORS ARE DESIGNED SPECIFICALLY TO BE USED IN VARIOUS INDUSTRIAL APPLICATIONS. THE ROLLING DIAPHRAGM CREATES THE PERFECT SEAL FOR FRICTION FREE CYLINDERS. IT IS A DURABLE, FLEXIBLE MEMBRANE SHAPED LIKE A TOP HAT WITH THE PEAK OF THE HAT RESTING AGAINST THE END OF THE PISTON AND THE BRIM CLAMPED BETWEEN THE FORWARD AND REAR CYLINDERS. INSIDE THE CYLINDER THIS FORMS A LONG-LASTING FRICTIONLESS SEALED CUSHION OF AIR BETWEEN THE PISTON HEAD AND THE CYLINDER WALL. THE FABRIC REINFORCED ELASTOMER ROLLING DIAPHRAGMS ARE PRODUCED EXCLUSIVELY FOR GARZO TO OUR EXACTING STANDARDS. STANDARD DIAPHRAGM MATERIAL DESIGN ALLOWS FOR OPERATION OF THE CYLINDERS IN TEMPERATURES FROM -31°F TO 248°F. CUSTOM DIAPHRAGM MATERIAL DESIGN ALLOWS FOR OPERATION OF THE CYLINDERS IN TEMPERATURES FROM -121°F TO 500°F.

THE OPERATORS ARE DESIGNED TO WITHSTAND MANY CORROSIVE ELEMENTS. THE PISTON AND BODY

OF THE OPERATORS ARE MADE FROM 100% ALUMINUM CASTINGS WHICH RESIST GALVANIC CORROSION AND ELIMINATE THE NEED FOR PAINTING. THE DIAPHRAGM IS A DACRON FABRIC, BUNA-N IMPREGNATED, MOLDED ROLLING DIAPHRAGM. THE DIAPHRAGMS ARE DESIGNED AND MANUFACTURED TO WITHSTAND REPEATED USE IN INDUSTRIAL APPLICATIONS, AND THE FABRIC PREVENTS THE ELASTOMER FROM STRETCHING IN OVER PRESSURE CONDITIONS. THE SPRING HAS BEEN ELECTRO ZINC PLATED. THE PISTON ROD IS A LARGE DIAMETER 300 SERIES STAINLESS STEEL. ALL OTHER PARTS ARE EITHER PLATED OR STAINLESS STEEL, MAKING THE OPERATOR SUITABLE FOR OFFSHORE SALT WATER, NATURAL GAS, AND SOUR GAS SERVICE.

GARZO LINEAR DIAPHRAGM OPERATORS ARE DESIGNED USING INSTRUMENT SOCIETY OF AMERICA RECOGNIZED SPRING RATES. THE GARZO OPERATORS HAVE STROKES THAT FOLLOW A TRUE LINEAR PROGRESSION. A PROPERLY SIZED GARZO SPRING OPPOSED DIAPHRAGM OPERATOR HAS AS MUCH FORCE ON THE FORWARD STROKE AS IT DOES ON THE RETURN STROKE.

GARZO INCORPORATED

4430 STEFFANI HOUSTON, TEXAS 77041 (713) 466-8679 FAX (713) 466-8686
TOLL FREE (800) 729-8807 E-MAIL PAFFORD@PHOENIX.COM

501 LINEAR DIAPHRAGM OPERATORS



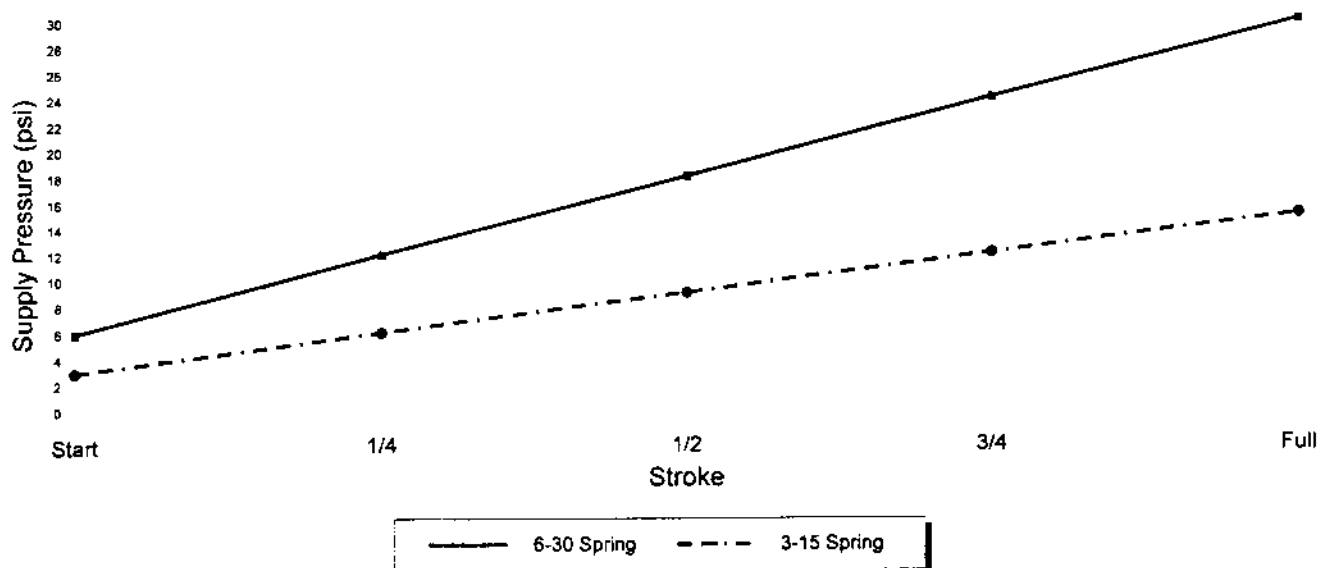
FEATURES

- SUPER SENSITIVITY
- ABSOLUTELY NO LUBRICATION REQUIRED
- LOW HYSTERESIS
- NO BLOW-BY LEAKAGE - 100% LEAK TESTING
- SOLID ALUMINUM CONSTRUCTION
- EASE OF MAINTENANCE
- WIDE TEMPERATURE VARIATIONS
- DESIGNED FOR USE WITH AIR OR SOUR GAS

SPECIFICATIONS

- CYLINDERS
100% CAST ALUMINUM
- PISTON
100% CAST ALUMINUM
- ROD
303 STAINLESS STEEL
- DIAPHRAGM
BUNA-N WITH DACRON FABRIC
- SPRING
ZINK PLATED

MODEL NUMBER	EFFECTIVE AREA (IN ²)	STROKE (IN)	FORCE AVAILABLE (LB)	NOMINAL SUPPLY PRESSURE	MAXIMUM SUPPLY PRESSURE
501-4-315	4	3	12	20	100
501-4-630	4	3	24	40	100
501-6-315	6	4	18	20	100
501-6-630	6	4	36	40	100
501-12-315	12	6	36	20	100
501-12-630	12	6	72	40	100
501-25-315	25	10	75	20	100
501-25-630	25	10	150	40	100



GARZO INCORPORATED

4430 STEFFANI HOUSTON, TEXAS 77041 (713) 466-8679 FAX (713) 466-8686
TOLL FREE (800) 729-8807 E-MAIL PAFFORD@PHOENIX.COM



4430 STEFFANI • HOUSTON, TEXAS 77041 • (713) 466-8679

INSTALLATION AND OPERATING INSTRUCTIONS

MODEL 501-12- (315, 630) -SUR-O

1. Determine how operator is to be mounted. Care should be taken to utilize the full 6" stroke of operator. Operator should be mounted in a shaft down or inclined position.
2. Mount operator by means of the four mounting pads and bolts furnished.
3. Lengthen or shorten clevis assembly furnished to attach to primary device. Note that the all thread rod furnished can be cut to a shorter length if required.
4. Remove plastic plug and connect operator to air or natural gas supply signal line. Normal supply pressures are 20 psig with a 3-15 psig spring and 40 psig with a 6-30 psig spring. Limit maximum supply to 100 psig.



4430 STEFFANI

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HOUSTON, TEXAS 77041

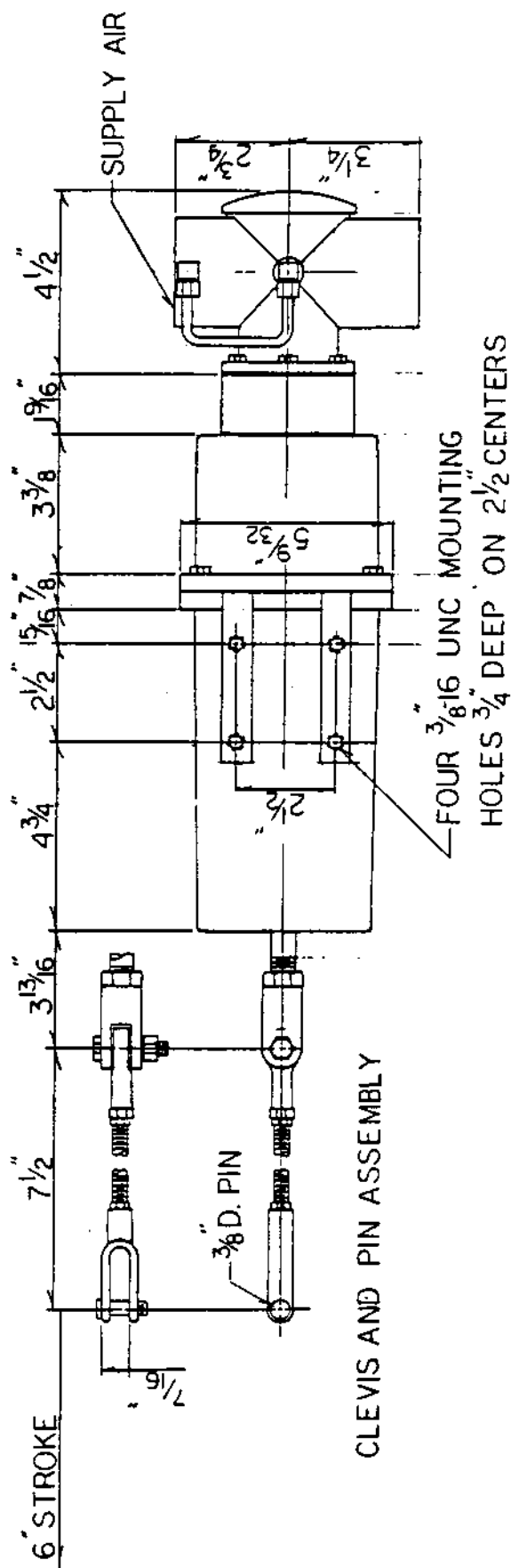
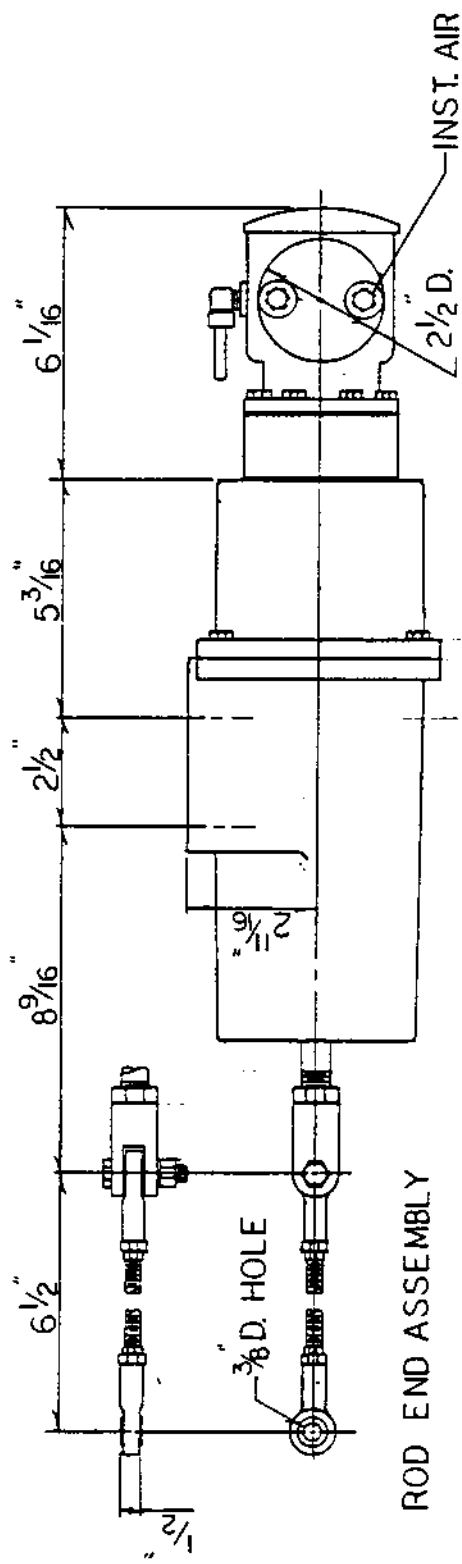
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(713) 466-8679

PARTS LIST

MODEL 501-12- (315, 630) -SUR-0

Item	Req'd	Part #	Description
1	1	00405	Forward Cylinder
2	1	00407	Rear Cylinder
3	1	00408	Piston
4	1	00125	Diaphragm
5	1	00112	Piston Rod
6	1	00409	Retaining Ring
7	1	00120	Spring, 3-15 psig Range
	1	00121	Spring, 6-30 psig Range
8	4	00134	1/4-20 x 1" Hex Head Cap Screw
9	4	00642	3/8-16 x 3/4" Hex Head Cap Screw
10	4	00136	3/8" Lock Washer
11	1	00124	1/2-13 Hex Head Jam Nut
12	1	01335	Clevis Link
13	2	00500	Brake Yoke
14	2	00499	Clevis Pin, 3/8
15	2	00578	Cotter Pin 3/32 x 3/4
16	1	00132	3/8-24 x 5-1/8" All Thread
17	2	00133	3/8-24 Hex Head Jam Nut
18	1	00127	3/8-16 x 1-1/2" Hex Head Cap Screw
19	1	00261	3/8-16 Hex Head Nut
20	1	00136	3/8" Lock Washer



GARZO INC.

REVISION: NONE
DATE: 3-3-83
APPROVED BY: [Signature]
DRAWN BY: D.H.

DIAPHRAGM OPERATOR

501-12 W/POSITIONER 00931



CONOFLOW REGULATORS & CONTROLS

P.O. Box 768
St. George, S. C. 29477-0768
(803) 563-9281 TELEX 4945706

WARNING

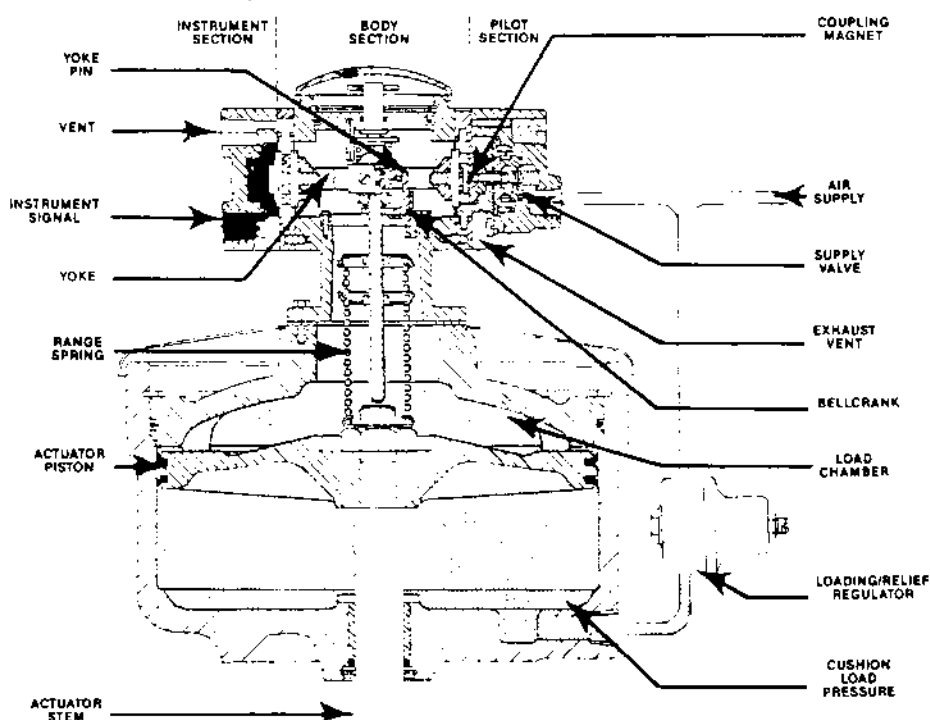
Conoflow's products are designed and manufactured using materials and workmanship required to meet all applicable industry standards. The use of these products should be confined to services specified and/or recommended in the Conoflow catalogs, instructions or by Conoflow application engineers (i.e. exceeding pressure-temperature rating or using device for services other than those specified).

To avoid personal injury or equipment damage due to misuse or misapplication of a product, it is necessary to select the proper materials of construction and pressure-temperature ratings which are consistent with performance requirements.



FOREMOST
IN
CONTROL
ELEMENTS

INSTRUCTION AND MAINTENANCE MANUAL GC31 COMMANDAIRE POSITIONER



PRINCIPLE OF OPERATION

The COMMANDAIRE Model GC31 positions the actuator by applying sufficient air pressure above the piston to overcome cushion-loading pressure (pressure below piston set by an adjustable pressure reducing/relief type regulator) plus any external forces or load acting on the stem. An increase in air signal creates a force on the instrument diaphragm moving yoke to right, closing exhaust port and opening supply valve. Air flows through supply valve into chamber

above piston and moves it downward. This extends a calibrated range spring causing bellcrank to pivot counterclockwise, exerting force against yoke pin, restoring yoke to normal balanced position. A decrease in instrument air pressure reverses the procedure, closing supply valve and opening exhaust port venting to atmosphere excess air pressure above actuator piston.

SUPPLY PRESSURE (20 to 100 PSI)

A regulated - filtered air supply should be used. A Con-flow Model GFH60 Airpak - Filter Regulator or equal is recommended.

ZERO ADJUSTMENT

Zero adjustment can be made by turning the zero adjust coupling (2) clockwise or counterclockwise. Connect supply and instrument air to the positioner. Set the instrument signal to the 0% value (e.g. 3 psi for a 3-15 psi range). Turn the zero adjust coupling to bring the actuator slightly off of the fully retracted position. The starting point may then be checked by reducing the instrument signal below the 0% value and then slowly increasing it. As the 0% input signal is reached, extension of the actuator stem plus an audible increase in the air flow through the positioner should be observed.

Next, increase the instrument signal to the 100% value (e.g. 15 psi for 3-15 psi range). Verify that the actuator stem moves to the fully extended position.

Set the instrument signal to the 50% value. Using a suitable measuring device such as a scale, and verify that the actuator stem has extended to 50% of full stroke.

SPAN

Positioner span determines the control range. A positioner with a 3-15 psi range has a 12 psi span and is set with a 3 psi startpoint (retracted position). Positioner span has been factory calibrated as specified. Instrument signals of 3-9, 3-15 and 6-30 psi are available. For field changes, refer to page 5.

REMOVING POSITIONER FROM ACTUATOR

Shut off supply and instrument air before performing any maintenance.

Piston or diaphragm should be in the fully retracted position. Disconnect tubing and bleed all air out of the actuator. Remove cap (1) from positioner and spirolox ring (3), so that headplate assembly (2) can be lifted out. Loosen setscrew (24) using $\frac{1}{8}$ " Allen Wrench and remove spring rod nut (16)*. Remove six capscrews (14) and lift positioner from actuator.

INSTALLING POSITIONER ON ACTUATOR

The Model GC31 Positioner is designed for actuators having a $2\frac{1}{4}$ " dimension between the lower face of the stem nut (8D) (refer to page 6) and the positioner mounting flange with the actuator stem in a retracted position.

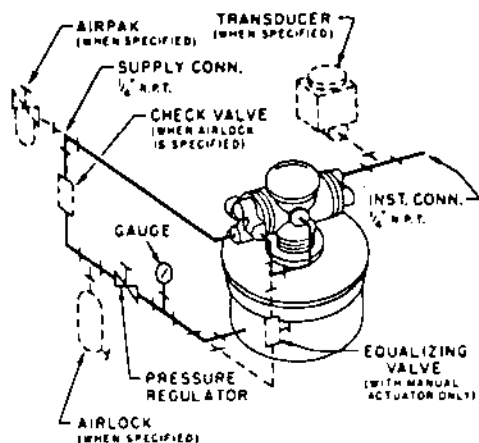
The range spring (8C) is adjusted and set at the factory for the proper range and spring rod (8A) extension as shown on page 6. With the actuator stem in the fully retracted position and the spring rod nut (16) removed from the spring rod (8C), thread the spring nut assembly (8D) onto the actuator stem. Hold the range spring assembly in a vertical position without applying any tension to the range spring (8C). Measure the distance between the positioner mounting surface on the actuator (without gasket) and the top of the spring rod (8A). This distance **must** be a $2\frac{1}{8}$ " \pm $\frac{1}{16}$ " for proper operation of the positioner. If adjustment is necessary, grasp the lower spring clip (8B) and range spring (8C) firmly in one hand. Loosen the upper spring clip (8B) making sure that the lower spring clip is not allowed to turn on the range spring (8A). If the lower clip is allowed to turn, the number of inactive coils on the range spring will have to be reset to obtain the proper range. After loosening the upper spring clip (8B), rotate the spring rod (8A) in the direction required to obtain the $2\frac{1}{8}$ " dimension. Continue holding the lower clip (8B) and range spring (8C) while retightening the upper clip securely. Measure the $2\frac{1}{8}$ " dimension again to make sure it is correct. Be sure that the actuator stem is fully retracted when making this measurement.

Remove the cap (1) from the positioner and, using a small screwdriver, remove the spirolox ring (3). Pull out the positioner headplate assembly (2) and set it aside. The zero spring (4) should be attached to the headplate assembly. If not, remove it also. Place the gasket (13) and the positioner on the actuator guiding the spring rod (8A) through the hole in the bellcrank (17). Install the six $\frac{1}{4}$ " - 20 screws (14) that secure the positioner to the actuator.

Turn the set screw (24) in the spring rod nut (16) such that the head of the screw is flush with the top of the nut as shown. Install this assembly onto the spring rod finger tight. Hold the spring rod nut with a wrench or suitable tool to prevent it from turning and tighten the set screw securely. It is important to make sure that the spring rod nut does not turn while tightening the set screw to maintain calibration of the range spring assembly.

*For positioner removal kit, order 6385266.

Insert the zero spring (4) onto the headplate and install the headplate assembly (2). Make sure the zero spring (4) is properly centered on the spring rod nut (16) when inserting this assembly. Replace the spirolox ring (3) and the cap (1). Install the necessary piping per the schematic below. Proceed with the zero adjustment procedure outlined previously.



MODEL GC31

OPERATING CHECKS

With positioner installed and adjusted in accordance with the preceding instructions, the actuator stem should react to variations in input control signal. By removing the cap (1) and the depressing zero adjustment of the headplate assembly (2) while the control signal is applied, step excursions of the stem should take place and the stem should return accurately to its previous position. If the actuator does not appear to function properly, it is advisable to check the following.

SUPPLY AIR

A regulated - filtered air supply should be used. Check to make sure that the supply pressure and cushion loading pressure, where applicable, are set properly.

CAUTION: Before the positioner headplate assembly (2) is removed for inspection, bleed all air from the actuator. Disconnect the supply air and instrument air connections.

INSTRUMENT AIR SIGNAL

Verify that the proper instrument signal is being applied using a pressure gauge or digital pressure readout.

YOKE (18) AND BELLCRANK (17) RELATIONSHIP

Remove the cap (1) and headplate assembly (2) by removing the spirolox ring (3). Inspect the parts visual-

ly for proper arrangement and connection. Note carefully that the diaphragms (20) are not twisted. When replacing the headplate assembly, make sure that the zero spring is properly located on the spring rod nut.

DISASSEMBLY

The Commandaire Positioner consists of three main units: the body, the instrument section, and the pilot section.

Important: Remove all air supply lines to the positioner before performing any maintenance.

BODY SECTION

After disconnecting all air supply lines, disconnect any remaining tubing connections to the positioner. To examine the body diaphragms (20), remove the instrument cap (9) and the pilot assembly (26) by removing the four fillister head screws on each end. Use caution when removing the pilot assembly to avoid damage to the exhaust plunger.

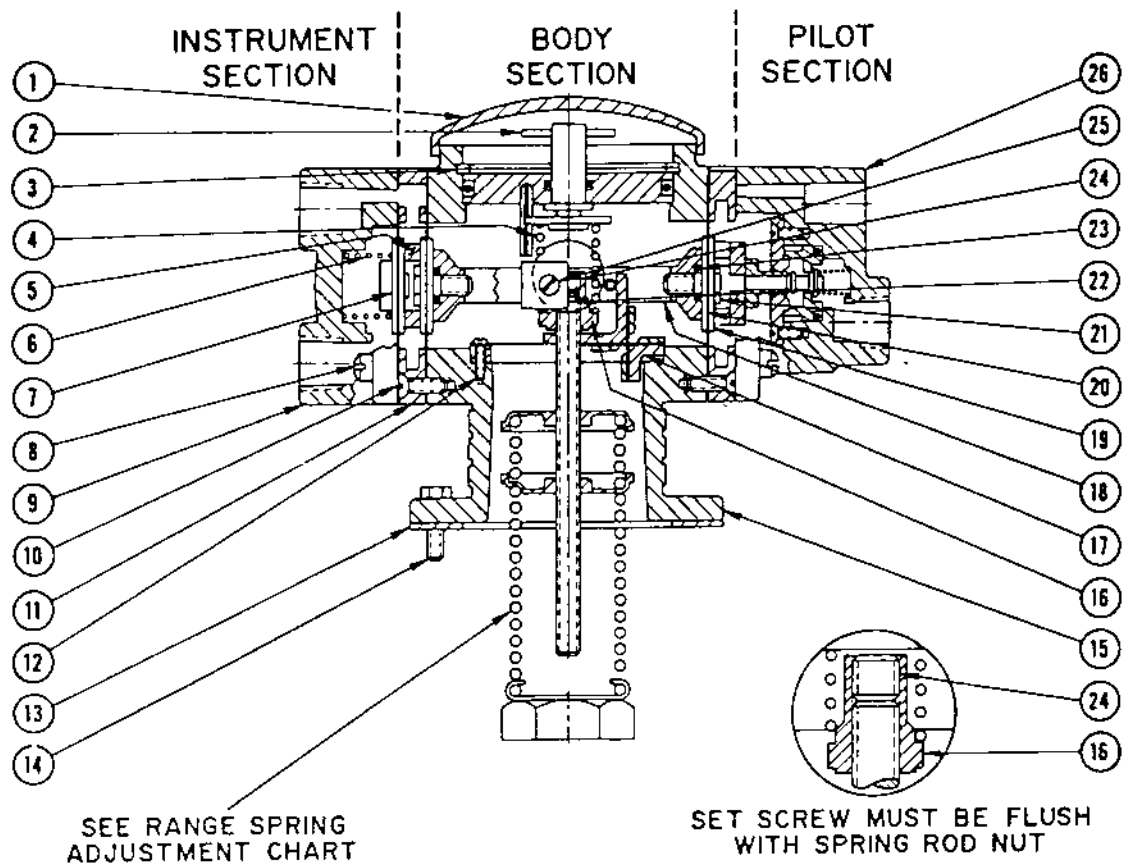
To replace the yoke (18) or bellcrank (17), first remove the cap (1) and headplate assembly (2). Use a small screwdriver to remove the spirolox ring (3) then pull the headplate assembly (2) out of the positioner along with the zero spring (4). With the instrument cap and pilot assembly removed, carefully remove the magnet (5) and exhaust plunger from the pilot section and set these parts aside. Also remove the zero spring (4), magnet (5), and diaphragm assembly (7) from the instrument section. Remove both diaphragm screws (21) and then unscrew the three flat head screws on each side of the positioner. The spacers (11) in both the instrument and pilot sections can now be removed. Also remove both diaphragms (20) and diaphragm spacers.

Next, rotate the yoke (18) to provide access to the inside stop block (22). Unscrew the two round head screws and remove the stop block. Slide the yoke through the instrument end of the positioner.

The flexure ring assembly (17) is now accessible and may be removed by unscrewing the three round head retaining screws.

INSTRUMENT SECTION

To examine the instrument section only, remove all air supply lines and the piping connections to the instrument section. Unscrew the four fillister head screws in the instrument cap (9) and remove the cap. Be careful not to lose the instrument spring (6) when removing the cap. Inspect the diaphragm for damage (continued on page 6)



Item No.	Description	Qty. Req'd.	Part No.	Item No.	Description	Qty. Req'd.	Part No.
1	Top Cap	1	6025969	14	Hex Hd. Capscrew 1/4" - 20 x 3/4" Lg.	6	6900095
2	Head Plate Assembly	1	6027130	15	Body	1	6026751
3	Spirolox Ring	1	6004691	16	Spring Rod Nut	1	6025803
4	Zero Spring	1	6025811	17	Flexure Ring Assembly (Bellcrank)	1	6025753
5	Magnet	1	6078307	18	Yoke Assembly	1	6026579
6	Instrument Spring	1	6026843	19	Diaphragm Plate	4	6026686
7 ⁽¹⁾	Instrument Diaphragm Ass'y	1	6026652	20 ⁽¹⁾	Diaphragm	2	6026553
8	Fillister Hd. Mach. Screw #10-32 x 3/4" Lg.	8	6900061	21	Diaphragm Screw	2	6026546
9	Instrument Cap	1	6026801	22	Inside Stop Block	1	6026538
10	Flat Hd. Mach. Screw #8-32 x 1/2" Lg.	6	6900033	23 ⁽¹⁾	"O" Ring	2	6076608
11	Spacer	2	6026785	24	Socket Setscrew (Dog Point) 1/4"-28 x 1/4" Lg.	1	6900113
12	#4 Self Tap Screw x 3/8" Lg. (Slotted Head Type)	3	6900545	25	Round Hd. Mach. Screw #4-40 x 1/2" Lg.	2	6900007
13 ⁽¹⁾	Gasket	1	6001762	26	Pilot Assembly	1	6027148

- NOTES: 1. Recommended spare parts can be purchased individually or as a spare parts kit, under number 6385464 — Spare Parts Kit — GC31 (Consists of items 7, 13, 20 and 23).
2. When ordering spare parts, specify complete catalog no., item no. and part no. This will permit positive identification and rapid handling of order.
3. For body assembly order 6026504
Consist of items 10 thru 12 and items 15 thru 25.
4. For tapped exhaust use
6026819 for item 9
6027155 for item 26.

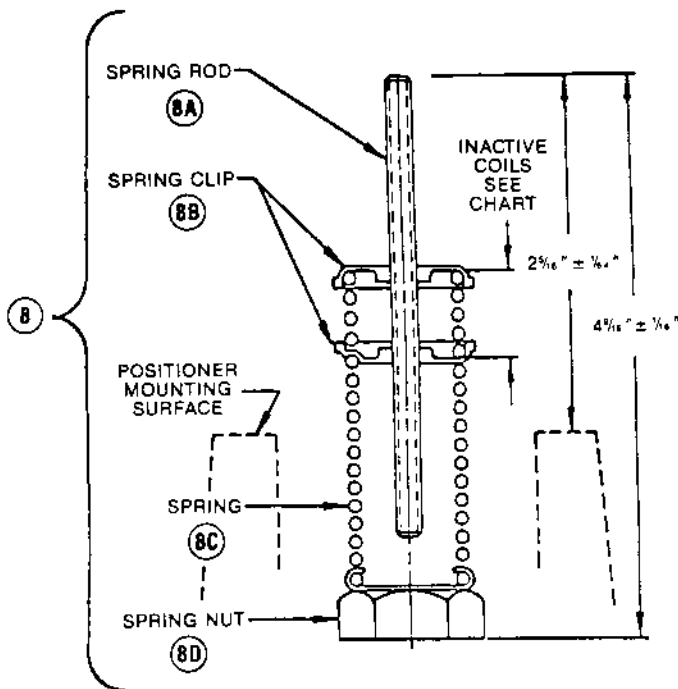


TABLE #1

STEM NUT IDENTIFICATION

STEM NUT ASSY NO.	THREAD	ACTUATOR	CYLINDER BORE O.D.
1	3/8" - 24	GB50 1/2" STEM DIA.	3"
2	1/2" - 20	GB50 3/4" STEM DIA.	2 1/4"
3	1/2" - 20	GB51	4"
4	5/8" - 18	GB52	6"
5	5/8" - 18	GB53	8"
6	3/4" - 14	GB54 GB55	10" 12 1/2"
7	NOT THREADED	—	—

ORDERING INSTRUCTIONS AND RANGE SPRING ASSEMBLY IDENTIFICATION

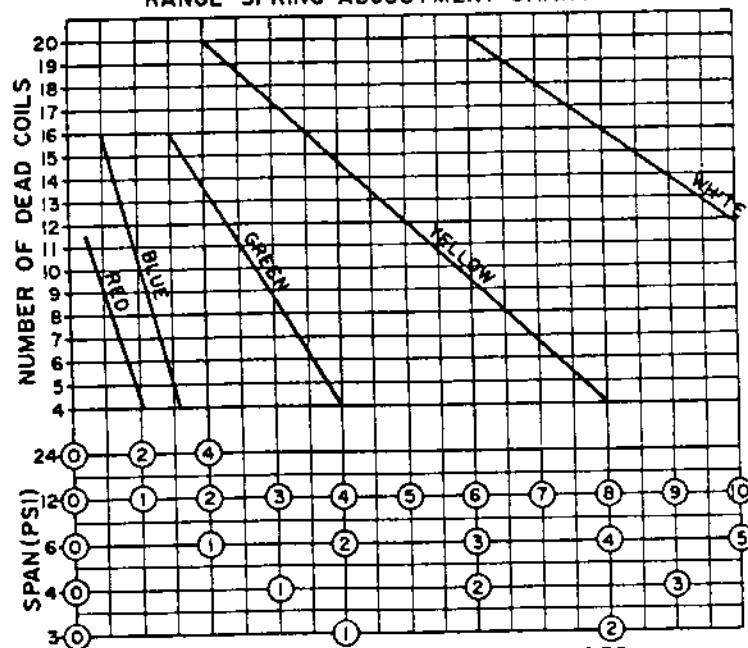
EXAMPLE:

Basic No. Stem Nut Ass'y No. Stroke Length in 1/16" Units Instr. Span in psi

RANGE
SPRING
ASSEMBLY: J800 5 96 12

This is basic J800 Assembly with #5 Stem Nut Assembly (5/8" - 18" thread); 6" Stroke: 12 psi Instrument Span. A Yellow Range Spring is selected (See Chart Below) and lower clip is turned to provide 9.5 inactive coils. Spring Rod Dimension from Positioner Mounting Flange is 2-5/16" \pm 1/16".

RANGE SPRING ADJUSTMENT CHART



TRAVEL IN INCHES FOR SPAN REQUIRED
Note: For travels greater than 10", consult the factory.

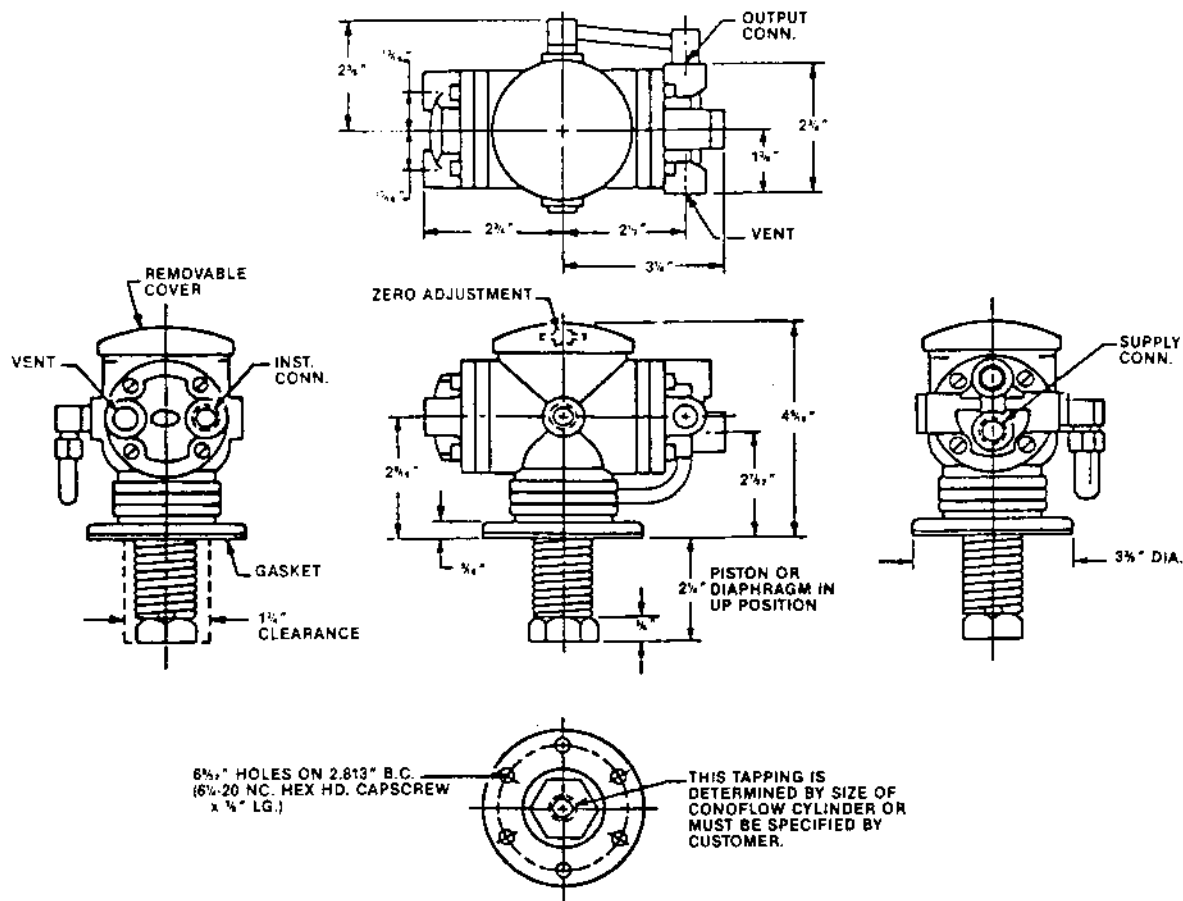
and replace if necessary. When re-assembling the instrument section, be sure the magnet (5) and instrument spring (6) are properly located. Also make sure the diaphragm holes are oriented correctly. The index grooves on the spacer, instrument cap, and diaphragm must be in line.

PILOT/INSTRUMENT SECTION

Remove the pilot assembly by unscrewing the four fillister head screws in the pilot assembly. Carefully remove the pilot assembly to avoid damaging the exhaust plunger. Remove the exhaust plunger from the magnet. Check the operation of the exhaust plunger and pilot valve by inserting the exhaust plunger into the center hole inside the pilot assembly. Gently depress the plunger and allow it to return. The plunger

should move freely with no binding or sticking. Free movement of the exhaust plunger and pilot valve is essential to proper operation of the positioner. If there is any indication of wear on the end of the exhaust plunger or of the center hole in the pilot assembly, the parts should be replaced. Also inspect the diaphragm for damage and replace if necessary. The diaphragm may be removed by referring to the procedure for disassembly of the body section.

When re-assembling the pilot section, make sure the magnet is centered on the diaphragm plate and the exhaust plunger is centered on the magnet. With the grooves in the diaphragm, spacer, and pilot assembly aligned, carefully guide the pilot assembly over the exhaust plunger. Insert the four fillister head screws and tighten them securely.



NOTES:

- 1-ALL CONNECTIONS ARE 1/4" N.P.T. UNLESS OTHERWISE NOTED.
- 2-WHEN ORDERING SPECIFY MODEL, RANGE & TRAVEL.
- 3-FOR PIPING SCHEMATICS SEE A50-48.
- 4-VENT CAN BE TAPPED 1/4" N.P.T. FOR GAS SERVICE.



CLASS 10000 FANS OWNER'S MANUAL

INSTALLATION

MAINTENANCE

OPERATION

Contents

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2.3	INSTALL AND ADJUST BLADES	4
2.4	START-UP PROCEDURES	5
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INSTALLATION

ABOUT THIS MANUAL

Moore is as interested as are its customers that Moore fans operate at top efficiency for many, many years. This manual has been written to achieve that result and is based on more than 50 years of experience as a manufacturer of axial flow fans.

Moore fans represent the highest degree of axial fan development and are in all respects, regardless of price, the finest obtainable for their intended purpose. As for any fine equipment, certain precautions are necessary and certain abuses must be avoided in order to insure the best performance over the longest period of time. If you have any questions regarding the installation or operation of your Moore fan(s), please contact the Company for assistance.

INSPECTION

All Moore units are carefully balanced, inspected and packed at the factory. If any damage is evident

before or after unpacking, the delivering carrier should be promptly notified so that an inspection may be made by the claims adjustor. It is the responsibility of the consignee to file damage claims with the carrier. Although Moore will not be responsible for shipping damage, it is requested that any damage, even of a minor nature, be reported to the factory at once.

IDENTIFY YOUR FAN'S FEATURES

Section 1 consisting of your unit's specifications will be found on the Order Information Sheet attached. Section 2 Getting Started should be read carefully before installation begins. Moore fans have several unique features.

2.0 INSTALLATION

2.1 GETTING STARTED

2.1.1 FAN IDENTIFICATION

Every fan, or group of identical fans, is assigned a Job Number. This number will be found on the Order Information Sheet showing fan specifications. A copy is attached to this manual. If non-identical fans are shipped together, a Job Number is assigned to each fan or group and a set of Information Sheets will be included for each Job Number.

The Job Number is written in semi-permanent ink on each blade, hub and air seal. All fan parts bearing the same Job Number are entirely interchangeable. (Blades of the same Series and Diameter are also interchangeable between Job Numbers.)

Fan components covered by more than one Job Number may be crated together. The Job Number that is written on each part, however, will make sorting simple.

Each individual fan produced by Moore is assigned a Serial Number. This Serial Number is embossed on a permanent metal tag and attached to each fan hub. The Fan Information Sheet provided for each Job Number lists all of the individual Serial Numbers of the identical fans covered by that Job Number so that, in future years, reference to the fan specifications provided will identify the characteristics of each individual fan.

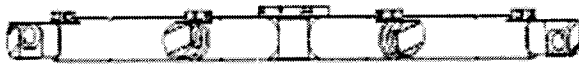
Moore keeps records indexed by serial and job numbers of all fans produced for at least forty years in order to provide proper maintenance advice and information on spare parts and replacements.

2.1.2 PLANNING THE INSTALLATION

The sequence given for the installation may be changed if the conditions warrant. For example, the air seal may be installed on the hub before the hub is installed on the drive shaft. (In fact, for inverted fans, it is necessary to install the air seal first.) The installation should be planned before beginning so that the steps required are taken in the most convenient order. If you need information not found here, please contact Moore.

Class 10000 fans are suitable for horizontal or vertical mounting, for electric motor or engine drive and may be designed for clockwise (right hand) or counterclockwise (left hand) rotation. Some drawings illustrating the installation assume vertical mounting and need to be mentally rotated for horizontal mounting. Be sure to refer to the dimensional drawing(s) provided. These will illustrate the proper orientation of the fan and the rotation direction.

2.2 INSTALL HUB AND AIR SEAL



Hub Only Without Air Seal



Air Seal Installed on Hub

Hub installation instructions

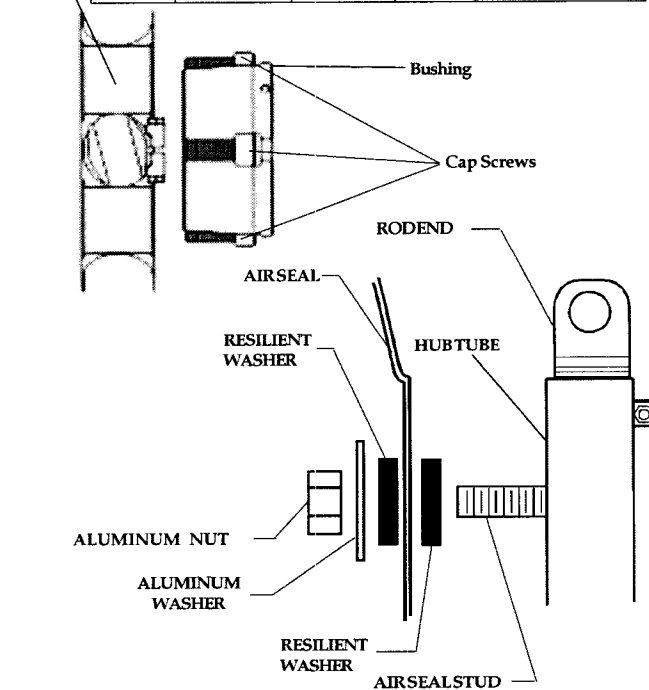
Some Moore Class 10000 hubs are shipped with Moore Hi-Torque (HT) Aluminum Bushings. The following paragraph details the installation procedure for these hubs.

Lubrication:

If the bushing was pre-installed in the hub at the factory, no further lubrication is required prior to installation. If the bushing was not installed in the hub at the factory, it is imperative to apply high quality grease to the following surfaces:

1. The cap screw threads
2. The underside of the cap screw heads
3. The bushing taper / hub bore

Bushing TYPE	Bushing OD	Allen Head Bolt	Hex Key Size	Required Torque
T	3"	12 mm	10 mm	50 ft-lb (6.9m-kg)
U	4"	12 mm	10 mm	50 ft-lb (6.9m-kg)
W	5.5"	16 mm	14 mm	90 ft-lb (12.5m-kg)
X	5.5" Long	16 mm	14 mm	135 ft-lb (18.7m-kg)
Z	7"	16 mm	14 mm	135 ft-lb (18.7m-kg)



AIR SEAL INSTALLATION ON HUB

DO NOT apply lubricant between the bushing bore and the shaft.

Installation:

Install the bushing in the hub by aligning the threaded holes on the I.D. of the hub with the slots on the OD of the bushing with the cap screws captured between the bushing and the hub. Insert the bushing in the hub. Using a hex key wrench, sequentially tighten the sockethead cap screws until the bushing is almost fully engaged in the hub. Leave slight play between the bushing and hub to facilitate installation on the shaft.

Place the hub/bushing on the shaft. (Preferably cap screw heads will be towards free end of shaft.) Insert the key, and tighten the setscrew to secure the hub and key to the shaft. Now begin sequentially tightening the socket head cap screws (approximately 2-3 turns per cap screw initially) to firmly engage the bushing in the hub and seat the bushing on the shaft. Once the bushing/hub is firmly seated on the shaft, continue tightening the cap screws sequentially until the specified torque, shown in the following table, is reached. DO NOT over-tighten cap screws as this could cause damage to the hub.

Caution:

If bushing is expected to see frequent oscillating loads (Greater than 50% of nominal expected Static Torque), Fan should be operated for approximately 15 minutes and then re-torque bushing cap screws.

To install the airseal:

If the airseal is to be installed on the shaft side of the fan, cut out the center to provide clearance for the bushing.

Locate the air seal installation hardware in the plastic bag taped to one of the hub tubes. Install the air seal studs on the appropriate side of the hub tube. Finger tighten.

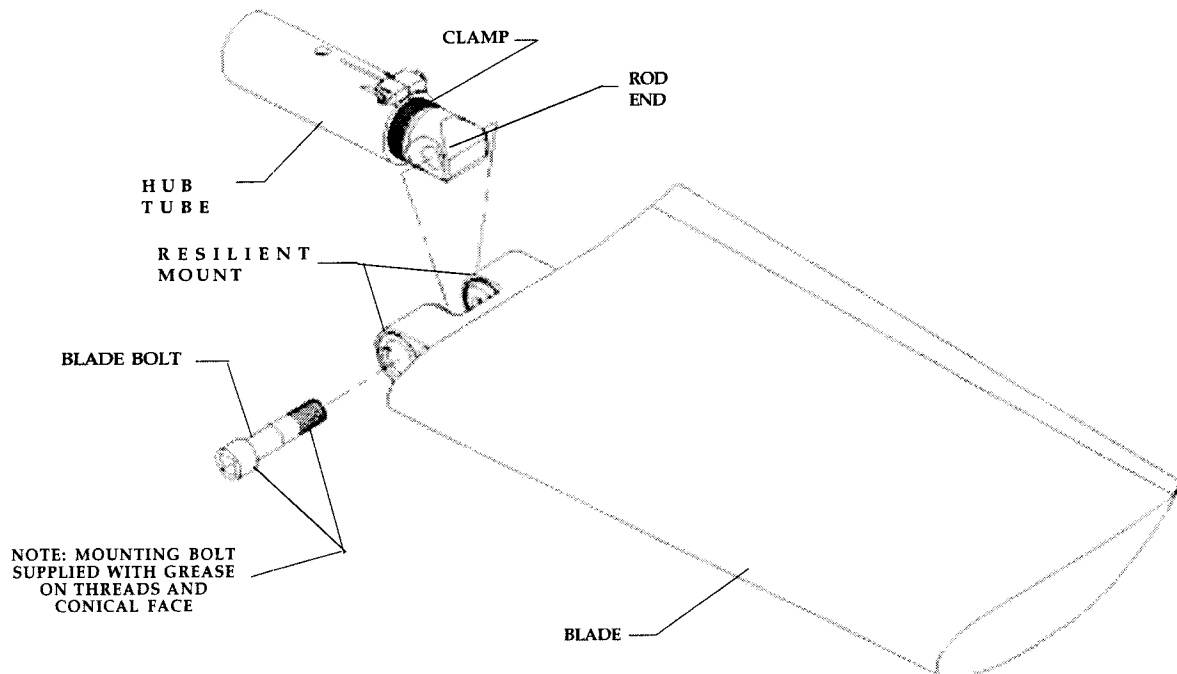
Place one resilient washer on each stud as shown in the drawings at left. Place the air seal onto the studs and install the remaining hardware, following the sequence shown in the drawings. Do not lubricate this end of the studs.

Note that the diameter of the resilient washers, before they are compressed, is slightly less than the diameter of the aluminum washer. Tighten each nut until the resilient washer's diameter is the same as the aluminum washer. Do not overtighten. Overtightness exists when the resilient washer has expanded in diameter larger than the diameter of the aluminum washer.

Note: Some air seals are provided with more mounting holes than may be required. This is done intentionally to make the air seals more interchangeable between units. For example, an air seal with 8 mounting holes can be used with either a 4-blade or an 8-blade unit.

2.3 INSTALL AND ADJUST BLADES

2.3.1 INSTALL BLADES



BEFORE INSTALLING BLADES....

Check to see that the hub is level. If the drive shaft is not truly horizontal (or vertical), causing the hub to be cocked, it will be difficult to adjust blade angles accurately. Eccentric rotation of the fan can also cause serious vibration problems.

If misalignment, vibration or unbalance in the system is present, it will be more easily identified and corrected at this time.

Moore fan blades are carefully balanced to the same moment at the factory. Any Class 10000 blade of the same series and diameter may be installed on any hub furnished on the job. They are completely interchangeable.

Moore Class 10000 Heavy Duty Fans are designed for engine drive and other applications with the more severe requirements of this service. Proper installation, with particular attention to tightening nuts to the specified torque, is essential to maintain the design integrity of these units.

Install one blade: Clean any dirt or grease from the rod end and the surfaces of the resilient mounts. Align the rod end hole with the holes in the resilient mounts and insert the blade mounting bolt first through the resilient mount with the recess to accept the bolt head, then through the rod end hole and screw

the bolt into the second resilient mount lightly. A 3/4" drive torque wrench with a short extension may be used. The blade mounting bolt is supplied from the factory with grease on the threads and conical face. **Do NOT clean the grease from the bolt.**

Complete the installation of one blade by holding the blade so that the blade extends straight out from the hub tube. Holding the blade in this position, **tighten the bolt using a torque wrench set to 200 ft-lb (28 m-kg) making sure the rod end and the resilient mounts seat.**

After installing the first blade, manually rotate the fan while moving the blade tip in and out to be sure the blade clears the ring or throat at all points. When the blade is held in alignment with the blade tube (that is, straight outward from the hub), it should clear the fan ring by a distance adequate to provide for any relative motion between the fan wheel and the ring. Excess clearance between the blade tips and the ring, however, should be avoided to prevent backflow which seriously reduces fan efficiency. If clearance is excessive, the diameter may be adjusted at this time. See Section 2.3.2.

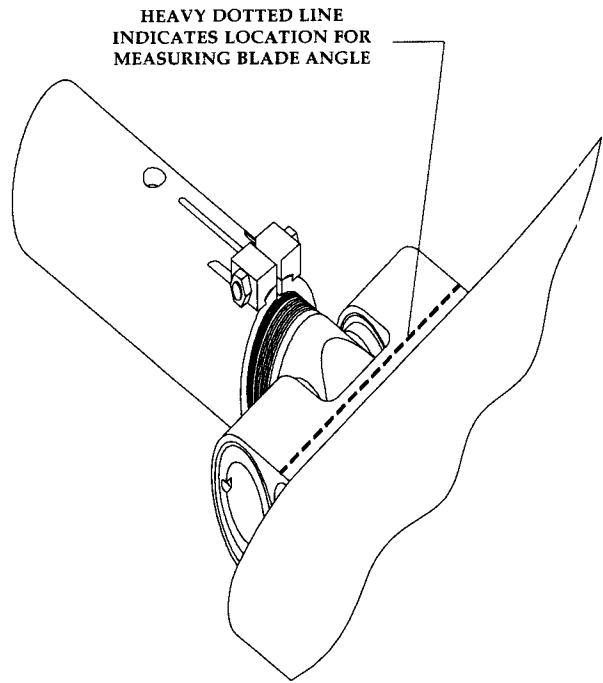
Install the rest of the blades so that they are identical with the first blade. **Torque all bolts to 200 ft-lbs (28 m-kg).** If blades are installed properly, they will return to their undisturbed position if the tips are pressed in the axial direction with moderate force (10 to 20 lb).

2.3.2 ADJUST BLADE ANGLE

Hubs are shipped from the factory with the rod end set for the blade angle indicated by the design performance. A change in blade angle is sometimes necessary, however, to adjust to actual site conditions. Failure to adjust the blade angle when required may result in blade overload. The causes of improper blade loading are explained in Section 4.3 of this manual. Section 4.4 "Checking Blade Load" provides a simple method of determining the maximum blade angle allowable in terms of static pressure vs blade angle. Please refer to these sections before increasing blade angle.

To adjust, loosen the Clamp Nut just enough to allow the blade to be turned. Place an inclinometer on the flat surface of the mounts end as shown in the illustration at right. Turn the blade until the desired angle is achieved. Make a permanent record of the final angle selected and take care that all blades on the fan are set at the same angle. A typical adjustment may be $\pm 3^\circ$. The maximum recommended blade angle is 30° .

Retighten the Clamp Nut to 18 ft-lbs (2.5 m-kg). Recheck each blade angle before tightening.



WARNING: The fan is designed to consume the horsepower stated on the Fan Specification Sheet. The engine drive typically produces far more power than the fan can absorb. Too great an increase in blade angle can cause serious blade overload which will stall the blades. In this condition, the fan will actually deliver less air and blade life may be shortened. Blade load considerations are discussed in Section 4.0 Operation in this manual.

2.3.3 ADJUST DIAMETER IF REQUIRED

At times it may be necessary to adjust the fan diameter to suit a particular ring. To do so, loosen the clamp nut so that the rod end can be rotated in the hub tube. One complete revolution will increase or decrease the radius of the fan by .059" (1.5 mm). Take care that the clevis is returned to exactly the factory-set angle unless it is intended that the blade loading be

changed as discussed in the previous section. A match mark may be made at a point on the threads and the tube before turning to assure that exactly one revolution is made. **Tighten the clamp nut to 18 ft-lbs (2.5m-kg).**

Maximum adjustment possible is about $\pm 0.75"$ (19 mm). At least 1.0" (25 mm) of rod end threads must remain in the tube.

2.4 START-UP PROCEDURES

Before starting the fan, manually check all bolts or nuts to see if they are tightened. Take care not to exceed the stated torque limits.

Manually rotate the fan while checking each blade for proper clearance.

Start the fan and watch it in operation. All blades should move to the same operating position, indicating that the blade angles are properly set and that all blades are equally loaded. If vibration or unbalance is evident, see Section 3.3.

After the fan has been operating for several minutes,

stop the fan and observe the blades as the fan comes to rest. All of the blades should return to their original position at the same rate.

Inspect the inner surface of the fan ring and the blade tips for any indication of scoring.

The horsepower given on the Fan Specifications is the calculated horsepower (at the fan shaft) that is required for the specified performance. Consult the factory or the fan curve before increasing the blade angle for the fan to consume more than the specified horsepower.

3.0 MAINTENANCE

3.1 PERIODIC INSPECTION

3.1.1 PURPOSE

Fan failure is most likely the result of destructive repetitive stress acting over a period of time. These stresses may be caused by mechanical abuse, e.g. rough gears or drive shaft imbalance, or by aerodynamic abuse such as blade overload or abnormal flow conditions. Fortunately, these stresses manifest themselves in typical ways that may easily be detected on inspection if one knows what to look for. The purpose of this section of this manual is to describe the symptoms of potentially damaging mechanical problems and how they can be corrected. Aerodynamic abuses are covered in Section 4.0 Operation.

3.1.2 FREQUENCY OF INSPECTION

The frequency of inspection varies widely in accordance with the severity of service and a suitable inspection schedule should be developed with experience over time. During the first week of operation, at least one inspection should be made. At these initial inspections, in addition to the items listed below, check all nuts for tightness to make certain that all were tightened properly at installation. Take care not to exceed the stated torque limits. Following the first week, it is probable that inspections of the fan need be made no more frequently than inspection of the drive.

3.1.3 BLADE ANGLE AND RUNNING POSITION

Turn off the unit and watch the blade tips. A looseness in the clamp bolt will permit a blade to flatten in angle. This usually can be detected by looking at the tips of the blades while the fan is slowing down. At the same time, before the unit comes to a complete stop, watch the track of the blade tips to see that all blades move to the same operating position. If one or more blades is at a substantially different position than the other blades, or if all of the blades are at a different position than at the last inspection, investigate further. This condition may be caused by a damaged resilient mount, requiring blade replacement.

3.1.4 CRACKS, DENTS AND CORROSION

Skin cracking may be caused by the tips dragging on the fan ring, or it may be the result of long-term fatigue due to continued operation under conditions of vibration or unbalance as discussed in Section 3.3 which follows. Skin cracking can also be caused by continued operation under overload conditions as discussed in Section 4.3 Causes of Blade Overload.

Cracking in air seals can occur if the airseal has been improperly installed. See Section 2.2. Check to be sure the resilient washers are present and the nuts properly tightened.

The fatigue strength of materials, whether metal or plastic, may be lowered by long-term exposure to water.

Dents in blades are caused by objects falling into the fan or the fan striking some obstacle. Minor dents may sometimes be repaired by drilling a small hole in the center of the dent and pulling outward on the blade skin. Blades may be ordered from the factory for replacement. If there is any evidence of this type of damage, the hub should be carefully inspected as discussed in Section 3.1.6 which follows.

The Type 5052 aluminum, a marine alloy, used as the blade material on Moore fans works well with either fresh or sea water. Waters that are acid, alkaline, or contain copper salts, however, should be avoided for all aluminum alloys. If you have questions regarding the suitability of the fan materials under certain water conditions, please contact the factory.

3.1.5 HUB INSPECTION

If damage to the fan has occurred, the hub should be carefully inspected since subtle damage may have been caused that is not readily apparent. Check the hub for any sign of bending or twisting of the hub tubes. Hub tubes cannot be replaced in the field on manual fans and a new hub should be ordered.

Bushings are frequently cracked during a fan wreck and should be carefully inspected. Damage may occur to the studs that attach the hub to the bushing. It is a good idea to replace the studs when replacing a damaged fan blade.



*As with any industrial equipment, before entry into fan chamber, strict adherence to **ALL** Lock-out/Tag-out procedures is well advised!*

3.2 ANNUAL INSPECTION

3.2.1 CLEAN BLADES IF INDICATED

A smooth blade surface is essential for efficient fan performance. If an incrustation forms on the blades it should be removed. Use steel wool as an abrasive along with a mild detergent or a very mild form of solvent. Lye must not be used because it attacks aluminum readily.

3.2.2 CHECK SYSTEM PRESSURE

Radiator sections may be effected by the accumulation of dust and dirt in some atmospheres. (Cottonwood seeds are particularly troubling.) These accumulations may significantly increase the static pressure. Adjust the blade angle if necessary as described in Section 4.4 Checking Blade Load.

3.2.3 CLOSE INSPECTION

The yearly inspection should be a very thorough one. All nuts and bolts should be checked and careful scrutiny given to all highly stressed areas.

Inspect the resilient mounts as follows: With the fan turned off, grasp each blade and feel for looseness at the mount. If in doubt, the blade should be removed and the mount assembly visually inspected. Wear is indicated by a fretting effect and the resilient mount material will show signs of extruding from the cavity. If these indications are not apparent, replace the blade and continue normal operations.

Inspect the blade tips for any signs of cracking and the fan ring for any scoring that might indicate that the blades have been striking or rubbing against the fan ring.

3.3 VIBRATION AND UNBALANCE

3.3.1 GENERAL

No piece of rotating equipment is perfectly balanced. It is always possible that the minute unbalances of the various components may combine to provide a noticeable lack of balance. This rarely occurs, since it is unlikely that all unbalanced components will become assembled with their heavy sides in the same direction. Nevertheless, if unbalance is noted, the various components should be rotated into different positions to see if this might cure the unbalanced condition.

If vibration or unbalance occur, either at the time of installation or later during the operation of the unit, its cause may be determined by following the directions below.

3.3.2 FAN UNBALANCE

Vibration is most likely to be caused by the fan if the blades are not set at the same angle. If the blades are properly set, the fan is the least likely cause of vibration. All fan components are balanced to within ± 0.2 ft-lbs.

If the fan is in an unbalanced condition, the frequency of vibration of the structure will be that of the RPM of the fan and is quite low. In the case of large fans, the frequency is often low enough to be mentally counted along with the rotation of the fan. A vibration of 500 RPM or less will be felt as a weave in the structure rather than a vibration. Below 400 RPM, the vibration may be mentally counted and above that point may be read with a frequency meter.

Before assuming fan unbalance, check for loose bearing seats or bearings journaling the shaft on which the fan is mounted. This condition will cause the shaft to rotate eccentrically, throwing the weight of the fan off-center, resulting in unbalance of the frequency of the fan RPM.

After all checks have been made and the fan is still determined to be unbalanced, field balancing may be accomplished as described below in Section 3.3.6.

It should be noted that the loads imposed on the drive shaft and its supporting bearings by fan unbalance

are negligible. A rotating centrifugal load of 100 pounds, due to unbalance, would be extremely objectionable and possibly even damage the structure on which the drive was mounted. By contrast, it would be unlikely that the drive shaft of a fan, of perhaps 25 HP, would be supported on bearings rated less than 2000 or 3000 pounds radial load. For higher horsepower, the bearing capacity would be correspondingly increased. From this it is evident that speed reducer or drive shaft bearing failure could never be caused by moderate or even objectionable fan unbalance.

3.3.3 BELT DRIVE UNITS

The more common causes of vibration in belt drive units are not the drives themselves but the result of shafts that are too flexible or non-rigid supporting members. Vibration can be caused by misalignment of the sheaves or poorly adjusted belt tension. Consult the manufacturer of the drives for information. The quickest way to identify the cause of vibration in belt drive units is to operate the fan with the blades removed.

3.3.4 ROUGH GEARS

Continued operation on rough gears and bearings is almost certain to develop cracks in the blade skins. Rough gears may be of two types:

1. Rough or failed bearings in the drives or gears will result in a high frequency vibration being transmitted into the fan where some areas of the skin will respond to the frequencies applied. Cracks will appear in the blade skin and eventually, in some areas, the skin may actually fall away.

2. The other type of rough gear occurs when the output shaft accelerates and decelerates with each pinion tooth engagement. With a six tooth pinion and a motor speed of 1800 RPM, or 30 cycles per second, this gear misalignment impresses upon the fan a vibrating frequency of $30 \times 6 = 180$ cycles per second. If the engagement of teeth is also included, the frequency is 360 cycles per second. This type of high frequency vibration is at least as serious as that caused by bad bearings.

3.3.5 THROAT FLUTTER

Any fan that is effectively moving air at the tips of the blades will develop a reduced pressure area (or suction) on the fan throat or ring at the tip of the blade. This suction tends to draw the throat toward the tip of each blade, which means that a four blade fan would tend to draw the throat into something approaching a square while a six blade fan would draw it into something resembling a hexagon, etc. Since the fan is rotating, the effect on the throat is that of continually drawing it into a rotating polygon. The resulting throat flutter is frequently mistaken for fan unbalance.

A substantial throat or ring will be sufficiently rigid that flutter will not exist. A weak or flexible throat, particularly when used with a fan of a low number of blades, will be greatly affected by this type of vibration. Throat flutter is easily detected due to the fact that it is invariably of a frequency of the fan RPM times the number of blades on the fan.

Throat flutter will cause no damage to the fan so long as the throat does not disintegrate and fall into the fan blades. It may be eliminated by stiffening or bracing the throat.

If in doubt that throat flutter is the cause of vibration, reduce the angle of the blades until the fan is doing little or no work. If the vibration ceases under this condition, it is certain that throat flutter is present when the blades are loaded.

3.3.6 FIELD BALANCING

Unbalance in older fans may develop because of some structural change or by installing one new blade on an old fan where the existing blades had changed in weight in the course of operation.

Use wire to attach a small weight in succession to each of the air seal studs until the best location for the weight is found. The weight should then be increased or decreased until the best balance is achieved. The permanent weight may then be secured to the stud or hub tube, whichever is the most convenient for the type and shape of weight to be used. One or more pieces of metal shaped like a washer could be placed over the stud, on the hub tube, behind the stud, or over the threaded portion of the rod end. Aluminum or stainless weights should be used and weights should not be attached to the blade skin.

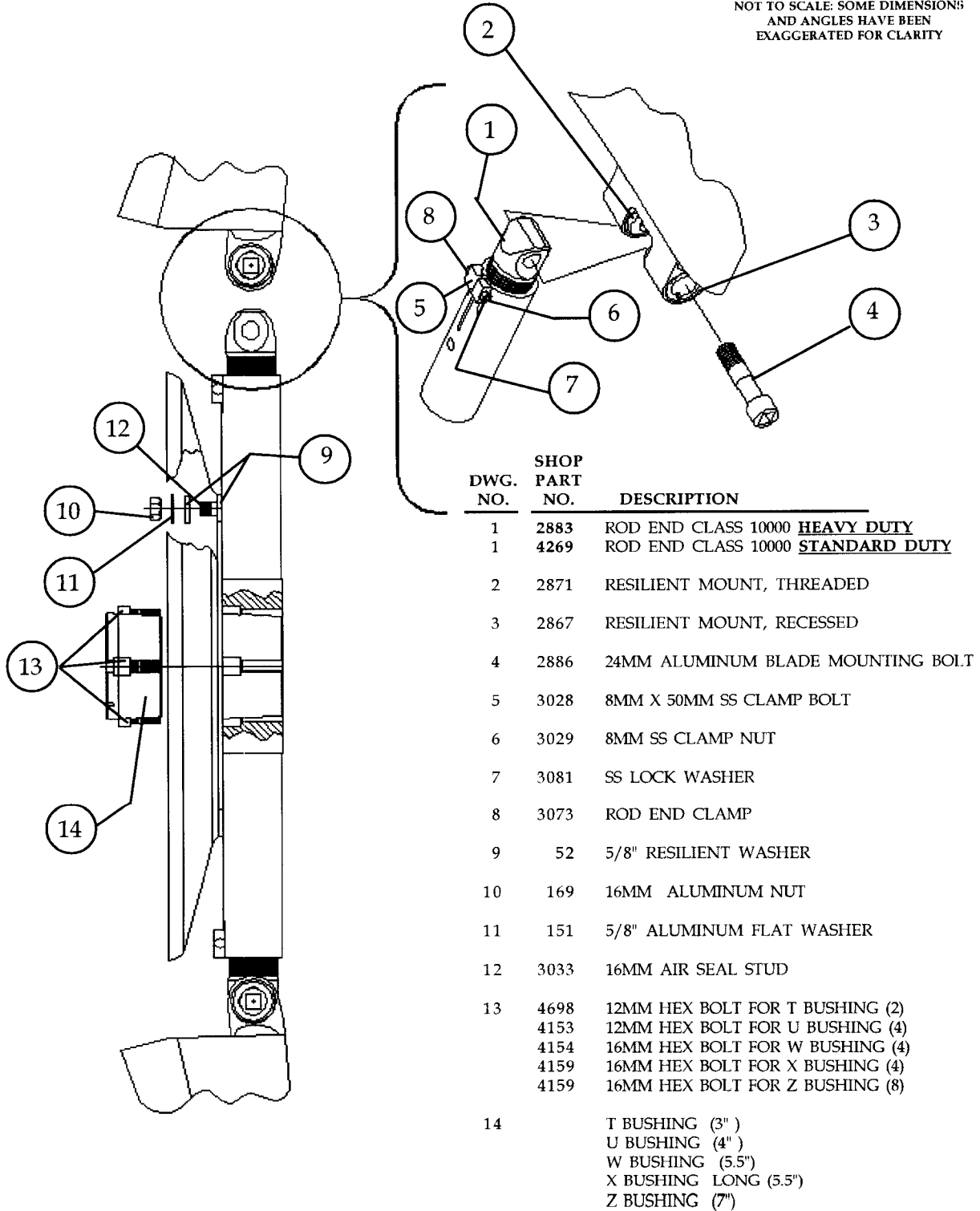
3.4 WARRANTY

MOORE FANS LLC (the Seller) warrants only to Buyer, as its purchaser for resale, that the fans manufactured and sold by Seller to Buyer under this Agreement will be free from all defects in material and workmanship under ordinary use for a period of two (2) years from the date of shipment or one (1) year from the date the fan is installed on a customer's premises, whichever occurs first. This warranty period shall apply only if Seller receives written notice of any defect within the warranty period. Upon receipt of such notice, Seller, at its option, may require Buyer to return the fan at Buyer's cost to Seller for inspection by Seller. If the fan is found to be defective on inspection by Seller, as a sole and exclusive remedy, Seller will, at its option, either repair or replace the fan. This warranty shall not apply to

damage on account of misuse, neglect or accident or shipping damage, or if repairs or part replacements have been made or attempted without Seller's prior written authorization. SELLER SHALL NOT BE LIABLE IN ANY EVENT FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES FOR BREACH OF THIS OR ANY WARRANTY. THIS WARRANTY IS IN LIEU OF ALL OTHER GUARANTEES OR EXPRESSED WARRANTIES AND ALL IMPLIED WARRANTIES, INCLUDING THE IMPLIED WARRANTIES OF MERCHANTABILITY AND OF FITNESS FOR A PARTICULAR PURPOSE. DUE TO THE VARIETY OF CONDITIONS UNDER WHICH THE FANS MAY BE USED, RISKS OF RESULTS OBTAINED FROM USE OF THE FANS, WHETHER USED ALONE OR IN COMBINATION WITH OTHER PRODUCTS, IS ENTIRELY BUYER'S. THE ABOVE LIMITATIONS ON DAMAGE AND EXCLUSION OR LIMITATION OF IMPLIED WARRANTIES ARE NOT APPLICABLE TO THE EXTENT PROHIBITED BY STATE LAW.

3.5 PARTS LIST

NOT TO SCALE: SOME DIMENSIONS
AND ANGLES HAVE BEEN
EXAGGERATED FOR CLARITY



4.0 OPERATION

4.1 AERODYNAMIC ABUSE

4.1.1 ABOUT THIS SECTION . . .

It is widely acknowledged that the kinds of mechanical abuse described on the preceding pages are destructive for all types of operating equipment. It is less well recognized that — for fans — aerodynamic stresses are an even more serious hazard. This section deals with the causes of destructive aerodynamic stresses and how they can be avoided.

Although this information is given primarily for the benefit of operators of Moore equipment, it may be applied to fans of any manufacture.

Unlike smaller fans, which are typically furnished complete with their surroundings, the large fan wheel is supplied as an unprotected component of the system and is installed in innumerable types of surroundings. Not only do the types and conditions of the drives for these fan wheels vary widely, but the entrance and exit conditions and the enclosure for the wheel assume a myriad of possible combinations. In designing his product, the manufacturer of fan wheels must anticipate the operating conditions based upon his knowledge of what is reasonable and customary for the industry. He may over-design for abnormal stresses only until the practical limit is reached to avoid excessive weight, cost and inefficiency.

4.1.2 NORMAL OPERATING CONDITIONS

The fan manufacturer assumes a fairly reasonable atmosphere for the operation of his product, including the following:

- The fan selection will be reasonably in line with the performance the unit is expected to maintain, with an adequate blade area for the pressure required at the given RPM. Blades will not be loaded beyond their capacity to maintain air flow.
- A fan ring will be provided that is round, rigid and of a depth at least sufficient to cover the tips of the blades. Tip clearances will be uniform and controlled.
- The approach air will represent a relatively uniform and axial flow with, of course, some unavoidable turbulence expected. Adequate open area will be provided at the inlet of the fan.
- Major obstructions will not be present at either the inlet or discharge of the fan.
- The RPM of the fan will be within the design limits.
- The relative direction and velocity of approaching air to the blades will be fairly constant and protection will be provided from extreme wind conditions.

Under such conditions, the unit stresses in the blades would not be expected to vary more than plus or minus 50%. Fan design based on such assumptions is entirely reasonable and, with proper drives and installation conditions, has proven highly successful.

4.1.3 ABNORMAL CONDITIONS

Abnormal operating conditions result in destructive repetitive stresses that can seriously shorten fan life. The aerodynamic abuses discussed in this section can cause repeated flexing of the fan blades and hub. Violent displacement of the resiliently mounted Moore fan blades may occur — a greater displacement than would occur in rigidly mounted blades. The resilient mounting, of course, minimizes the structural unit stresses which would be transmitted to the root of the blade and into the hub and drive. Although Moore units may be expected to resist greater stress than units of conventional design, such repetitive stresses may exceed the capability of the resilient mounts to absorb them. If so, fatigue of the mounts and metal may develop, adjusting linkages may wear, and ultimate failure becomes a possibility.

Some of the abuses set out in the following text are far less important than others. All of them may occur in varying degrees.

Specifically, abuse due to serious repetitive stresses can lead to mount failure and, if carried to extremes, can require blade replacement. In units of other manufacture with rigidly mounted blades, repetitive stresses of this type may lead to blade breakage, probably near the root or at the point of attachment to the hub where stresses are highest, or may lead to failure of the hub itself. The resilient mount design, unique with Moore fans, dampens these vibrational forces and results in a fan that is far less vulnerable to failure from these conditions than other units with rigidly mounted blades. Even so, extreme conditions can cause damage.

A well-designed fan can be expected to operate for many years without trouble under normal operation as described above. The extreme repetitive stresses described below, however, will certainly reduce the life of the fan, causing failure many years sooner than would occur if the fan were operated as intended. Fortunately, these destructive conditions are readily observable to someone who is knowledgeable about them, and they can be corrected with reasonable effort and expense once they are observed.

4.2 BLADE OVERLOAD

Of all the aerodynamic abuses to be avoided in the operation of a fan, the most important is that of overloading the fan blades. Blade overload occurs because of insufficient blade area. In other words, when there is an inadequacy in the number of blades on the fan selected.

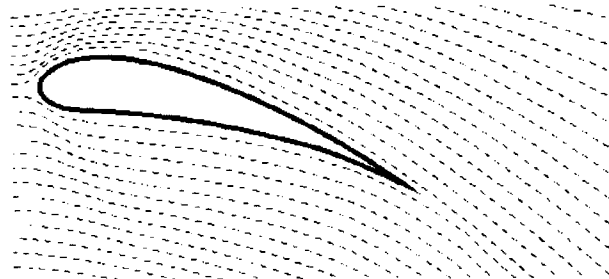
The Moore system of rating is based upon the pressure that each blade will produce at a given RPM with good efficiency. This pressure is called 100% blade load. When blade load exceeds 110%, the fan will not only operate at lower efficiency, it may be subject to structural damage as well.

In selecting a fan, the total pressure divided by the pressure to be produced by one blade determines the number of blades required for the anticipated performance. Whenever information is available, The Moore Company checks the selection. Even so, underestimation of the pressure requirements by the system designer, or changes in the operating conditions over time, may result in overload conditions.

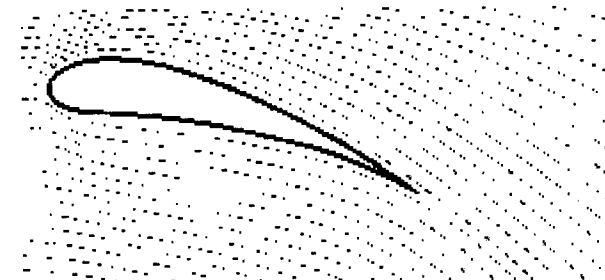
Why is a blade overload condition of such concern? We are all aware of the fact that an airplane traveling at a given speed can carry only a certain load. If the speed of the airplane is decreased or the load increased, stalling flow over the wing will occur. In the case of an airplane, approximately two-thirds of the lift provided by the wing is the result of the air flow over the top or convex portion of the wing. Lift is provided as a reaction to the flow of air being accelerated and deflected downward as it passes over the wing. A negative pressure area is thus formed on the top surface of the wing which tends to lift it upward.

So long as air flow over the wing is smooth and clings to the surface of the wing, little turbulence is present. When the load is increased, or the speed decreased, the angle of the wing to the air stream must be increased to a point where the air flow breaks away from the upper surface of the wing. This is known as stalling or burbling flow, since the air, instead of clinging to the wing, breaks away near the leading edge and leaves what might be called a turbulent void above the upper wing surface, nullifying the accelerated flow which was responsible for the greater part of the lift of the wing.

When this occurs, the wing loses a large portion of its lift. Flow, however, will re-establish briefly and break again, the cycle being repeated continuously, resulting in a severe vibration throughout the aircraft as the flow alternately makes and breaks. Anyone who has experienced a stall in an airplane will be familiar with this violent phenomenon.



AIRFLOW IN NORMAL FLOW
Downward flow provides lift to the wing



AIRFLOW IN STALLING FLOW
Note lack of air deflection downward.

A fan blade is no different than an airplane wing except that the air usually is being deflected upward rather than downward, the convex side of the blade being the lower surface rather than the upper surface as in the case of an airplane. The result of blade overload is identical: When blade load exceeds that allowable, a violent vibration will take place in the blade as the laminar, or uniform, flow makes and breaks perhaps many times a second.

Another way of looking at this problem is to consider that the available number of blades are set at too steep an angle to be able to move air at the axial velocity which is necessary to maintain a smooth flow over the convex surface. In other words, to move air at the velocity necessary for this blade angle, plus overcoming the static resistance of the system, the total pressure which would have to be maintained for an air flow corresponding to this angle is greater than the total pressure capability of the given number of blades at this RPM. Such a condition can only be corrected by decreasing the blade angle until smooth flow is obtained or by increasing the number of blades and the total pressure potential of the fan until the fan's pressure potential equals the pressure necessary to move the specified quantity of air through the system.

Continued operation under conditions of stalling flow, or blade overload, will significantly shorten the life of the fan. Operation under these conditions will also reduce efficiency to a ridiculously low figure. See the chart under Section 4.4 Checking Blade Load which follows. Note that although air flow remains constant or decreases, horsepower continues to increase with increased blade angle.

In conclusion, if a given fan, in a given installation, can only absorb forty horsepower, for example, the blades may be pitched up to consume fifty horsepower without any increase in air delivery, and possibly with a decrease. As a result, the extra ten horsepower is totally wasted -- perhaps worse than wasted. It is good practice to select a sufficient number of blades so that blade load will amount to slightly less than 100% of full blade load when consuming 100% of the rated fan horsepower. There are a number of reasons for allowing this safety factor which are set out in detail below.

4.3 CAUSES OF IMPROPER BLADE LOADING

4.3.1 VARIATION FROM PREDICTED CONDITIONS

Although those who design air coolers and cooling towers undoubtedly do their best to accurately state the calculated static resistance of the system, a number of factors may cause the actual conditions to vary from the design conditions. When a variation occurs, it may be found, upon testing, that the static pressure for a given volume through the system is higher than anticipated. In this case, the number of blades provided may be inadequate to meet the performance. On the other hand, the static pressure may have been overestimated and excess blade area provided, resulting in a fan with unutilized capacity operating at low efficiency.

Inadequate Blade Area: The blade angle is selected to move the anticipated volume of air and the number of blades is selected to maintain the total anticipated pressure required to move this volume at a given RPM. If the static pressure turns out to be higher than predicted, the fan may then be operating in an overload condition. If the RPM cannot be increased, the only solution to this condition is to reduce the blade angle until the fan can carry the then reduced volume at the originally anticipated pressure. Since reducing the volume, while holding the total pressure as originally anticipated, can only reduce the horsepower, it is then impossible to consume the horsepower originally intended without overloading the fan. This is one of a number of reasons for providing some safety factor in blade loading at the time of original fan selection.

Excessive Blade Area: Occasionally, an excessive number of blades may be specified in the interest of making a conservative selection. If the static pressure has been overstated, the theoretical number of blades will be greater than needed. This theoretical number of blades is usually a fractional number and the actual number of blades used must, of course, be the next larger integer, resulting in some "safety factor" in the selection. If, in addition, a blade or two is added as a "safety factor" or in anticipation of increased future requirements, it may be impossible to meet the original performance requirement efficiently. The only way to provide the original performance and draw no more than the original horsepower is to flatten the blade angle. There is a limit, however, in how far the blade angle may be reduced before further reduction will decrease airflow without a further reduction in horsepower. For belt drive units, the most practical solution to this problem is to reduce the RPM of the fan.

4.3.2 EXCESSIVE TIP CLEARANCE

Unless the fan ring is very close to the tip of the blade, air from the high pressure surface of the

blade will flow around the tip and nullify the negative pressure on the underside of the blade for some distance in from the tip. For a fan of, say, 12-ft diameter, the last 12 to 18 inches of the blade could be producing no pressure whatever and performing no useful function. The balance of the fan blade toward the hub then must produce a higher pressure to compensate for the portion near the tip.

Excessive tip clearance also leaves an unswept area between the tip of the blade and the fan ring. Air that has been pumped by the fan will return downward through this unswept area at a velocity greater than that at which it passed through the fan in the desired direction. This condition adds even further to the requirements of the portion of the blade which is doing the work and efficiency will be greatly reduced.

With the loss of a foot at the tips of the blades, plus the back flow between the tips and the ring, the 12-ft fan in this example might be considered an effective 10-ft fan. It would have to deliver sufficient air to satisfy the performance requirements of the installation, plus the amount of air which is returning in the void between the tips and the throat. Under such circumstances, excessive blade loading could occur even though the required system pressure is not achieved.

4.3.3 POOR ENTRANCE CONDITIONS

Air will approach the fan from all possible directions, increasing in velocity as it nears the opening, then accelerating rapidly as it enters. The air approaching from the side must be turned through 90° to enter a ring whose entrance terminates in a flat plate. If the inlet end of the ring projects some distance out, with approach possible from all directions, a portion of the air must be turned through 180°. The inertia of the approaching air prevents it from turning sharply and advancing parallel to the desired flow. It consequently swoops toward the center, leaving the outer area of the fan with reduced flow or even reverse flow near the ring.

The effect of poor entrance conditions is similar to that previously described for excessive tip clearance in that the effective diameter has been reduced and excessive blade loading could occur even though the required system pressure is not achieved. Efficiency will be greatly reduced.

4.3.4 EXCESSIVE DEFLECTION

The pressure which the fan can achieve is dependent upon the square of the velocity of the blades relative to the air. If the air could be moved into the fan in an axial direction and passed through the fan into the discharge without changing direction, the relative velocity of the blades to the air stream would be the true velocity of the blades at any point. This, of course, is not the case. For the blades to accomplish work upon the air, they must also deflect the air in the direction of rotation of the fan. The air when rotated with the fan is moving with a certain

velocity in the same direction as the rotation of the fan, which reduces the relative velocity between the fan blades and the air by some portion of this rotational velocity.

Moore fans are designed in contemplation of a maximum deflection of 50° at the hub, decreasing to a very small value at the tip. This deflection is considered in the determination of the pressure which may be provided by each blade over its full length. If fans are selected, or if conditions exist, which cause the deflection to exceed 50° at the hub, the velocity of the blades relative to the air is less than anticipated and the blades will not provide the rated pressure. The test below, however, will show the full allowable pressure capability of

the fan, even though it does not reach the full rated pressure.

4.3.5 CONCLUSION

As can be seen by the various points discussed in this section, there are a number of complex factors which tend to cause fans to be operated in a condition of improper blade loading which can shorten fan life or lower efficiency. When blade angles are set to consume the specified horsepower (at the fan shaft), the resulting performance should be very close to the specified performance. If this is not the case and the problem cannot be identified or corrected, please contact Moore for assistance.

4.4 CHECKING BLADE LOAD

One method of checking blade load is to run a complete field test on the fan. Although laborious, this method will provide ample proof so long as neither excessive tip clearance nor poor entrance conditions are present. If either are present, however, the conditions set out above under Section 4.3.3 would apply and the fan could be overloaded even though the total pressure indicated by the test was within the allowable blade loading.

A better, more convenient and simpler method of detecting blade overload, or determining maximum allowable blade angle, is set out below. The equipment needed is a wrench, a torque wrench, a protractor and a draft gauge (or manometer).

All fans are shipped with the blade angle set for the anticipated performance requirements furnished to The Moore Company by the purchaser. This blade angle is called out on the Fan Specification Sheet. This angle refers to the angle measured at the location shown in Section 2.3.3. Hubs are shipped with the clevises set at this angle.

To start the test, adjust the blades to an angle of approximately half that called out on the specifications or measured on the units. Connect the draft gauge to as quiescent a spot in the plenum as possible, preferably in the corner of the plenum and either ahead of or following the fan, depending upon whether the application is induced or forced draft. Since the figures obtained are purely relative, it is not necessary that accurate static pressure readings be obtained, but rather that the readings taken represent a consistent series of pressures at the point of reading chosen.

Start the fan and record on the chart provided the blade angle and the static pressure indicated. Advance the blade angle by one or two degrees and repeat the performance, recording again these read-

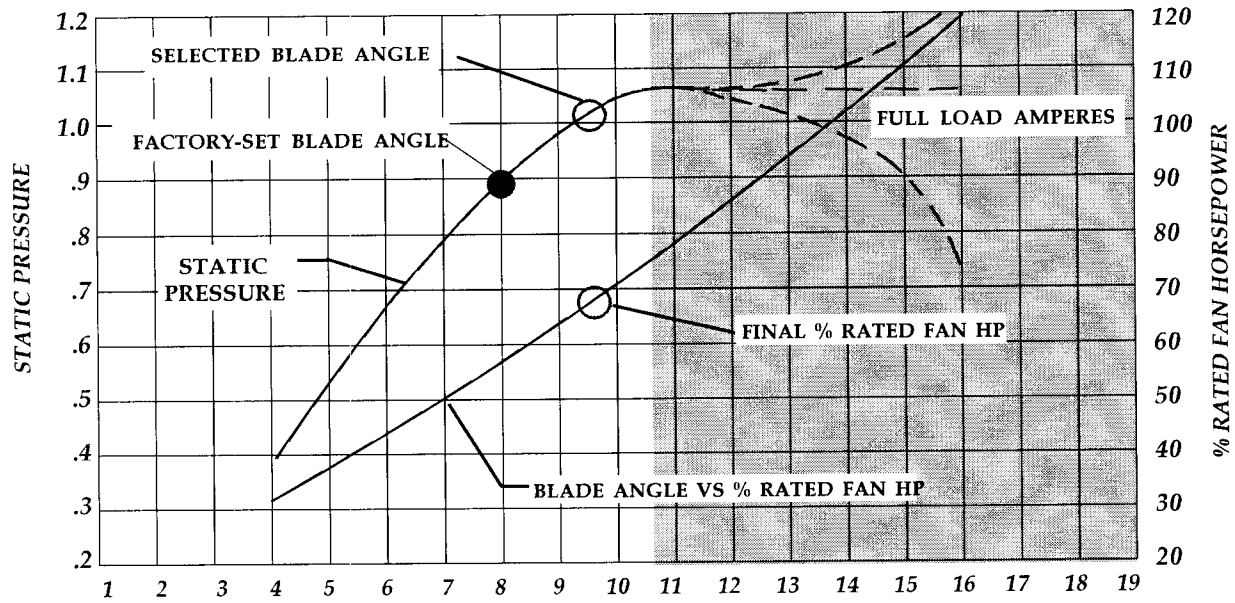
ings. Keep increasing the angle and following this procedure until the motor is fully loaded, in which case the fan is able to consume full rated fan horsepower without overload OR until the curve which will have started on a definite slope begins to approach the horizontal. It will be noted that the static pressure will be consistently increasing with increased blade angle until the blade loading reaches maximum, at which point it will level off.

Subsequent increases in blade angle may have quite different effects, depending on the individual installation. The static pressure curve may merely stay level or may drop off sharply. In rare cases, it may level off and again start rising as the fan begins operating as a centrifugal blower.

Typical examples are shown in dotted lines on the chart opposite. Operation beyond the first point of levelling, or in the area of the dotted lines, is indicative of blade overload. Note that power consumption load will continue to increase even though the fan has passed into overload condition. The maximum blade angle allowable is that which produces a static pressure about 5% below the point where the curve becomes level. This represents a safe loading, and the blades may be set and left at this angle regardless of the location on the chart, assuming the motor is not overloaded.

The point so selected will also approximate the point of the most efficient operation of the fan. Due to possible error in static pressure predictions, or in readings which are intended only to be relative, as well as other variables, the final blade setting chosen may fall below or above the specified static pressure.

A typical performance chart is shown opposite for a fan capable of a higher blade loading than originally specified. A blank chart is also provided for your use.

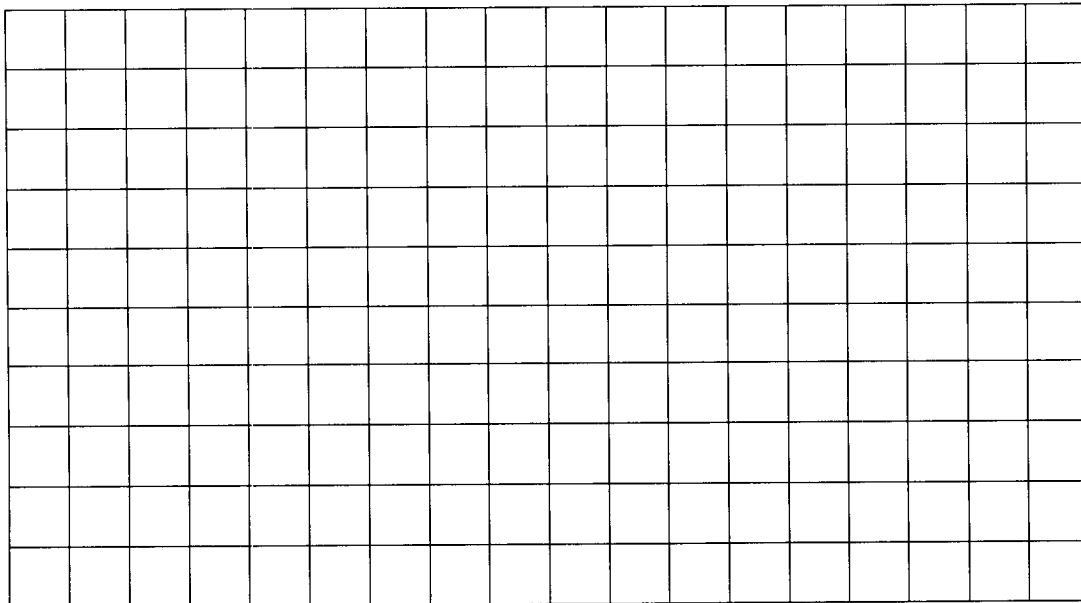


4.4.1 SAMPLE GRAPH of BLADE ANGLE IN DEGREES

Note in the chart above that static pressure (and air flow) has reached its maximum at an 11 degree blade setting and blade overload is beginning. With further increase in blade angle, anything may happen, as indicated by the dotted extensions into the shaded overload area. Note that the final selected blade

angle is 5% below the point where the static pressure curve becomes level. The horsepower curve has been added to illustrate the point that in an overload condition, horsepower will increase without increased performance.

STATIC PRESSURE



BLADE ANGLE IN DEGREES

BLANK CHART FOR CUSTOMER USE

4.5 DAMAGING OPERATING CONDITIONS

4.5.1 GENERAL

Any condition which causes repeated blade loading and unloading is detrimental to fan performance, both in terms of efficiency and structural durability. Normal obstructions, of course, must be expected in the air stream. There are certain conditions, however, which may be avoided by reasonable attention to the points briefly discussed in this section. Additional information on the importance of inlet and discharge conditions can be found in Moore's General Catalog.

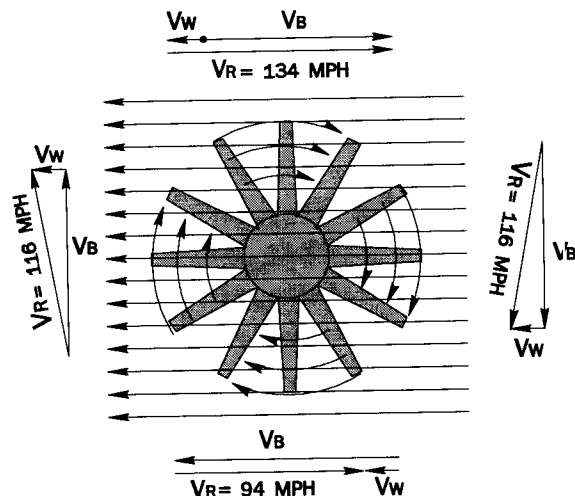
Ideally, air should approach a fan in an axial direction and at a uniform velocity over the area of the fan. Air approaching a fan at an angle tends to increase the relative velocity of the blades to the air on one side of the fan and decrease the relative velocity on the other side. This means that the fan blade during one-half of its revolution is picking up a heavier air load due to the higher relative velocity and, through the other half of its revolution, a lower air load as it goes "down wind". The net result is a repetitive loading and unloading of the blades at each revolution of the fan. This condition can be quite serious if the velocities are high and the angle of approach deviates considerably from axial.

4.5.2 WIND

With a vertically mounted fan blowing outward into the wind and surrounded by a short fan ring or stack, high winds may cause some concern. The farther the ring extends beyond the fan, the less effect would be expected from wind. It is a fact, however, that wind across the face of the ring will affect the direction of air flow well down into the ring. In the case of a fan installed near the outlet of the ring, the direction from axial of the fan discharge may be increased by as much as 45° under high wind conditions.

In the case of a fan blowing inward in a short ring, the condition is even more critical. In such an installation, the air on the inlet side of the fan has a horizontal velocity which may be quite high. It is necessary for the fan to pick up this air and direct it inward. In a strong wind, the angle of air moving through the fan may be increased more than 45° .

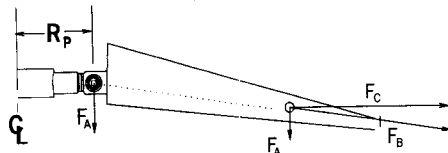
The illustration above assumes a fan operating with a tip speed (V_B) of 10,000 feet per minute (114 miles per



hour) with a horizontal component of wind velocity (V_w) of 20 miles per hour. Note that the velocity (V_R) of the fan blade relative to the air varies by a factor of 1.43. The blade load varies as the square of this velocity, or 2.05.

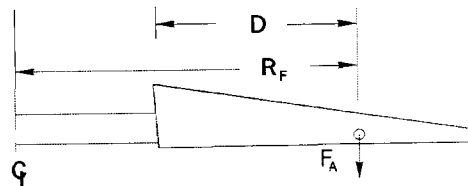
THE EFFECT OF AIR LOAD ON HUB AND DRIVE

Moore fan blades are attached to the hub by a pivot. As the fan rotates, centrifugal force causes the blades to rise (as do the blades of a helicopter). The air load (F_A) is uniform over the blade, but there is a point (shown on the blade in the drawing below) where, if the total load were applied at that point, the effect would be the same. The resultant of the air load (F_A), assumed in this example to be downward, and the horizontal centrifugal force (F_C) is the force on the blade (F_B). The blade automatically posi-



tions itself in the direction of this force with the result that the force is translated inward to the pivot point, as illustrated by the dotted line. The effect of this arrangement is exactly as if the total air load (F_A) were applied at the pivot point rather than at the point outward on the blade. The maximum bending moment applied to the shaft by the air load is equal to the load (F_A) multiplied by the distance from the fan centerline to the pivot point (R_p).

In conventional fans with rigidly attached blades, the bending moment at the shaft due to the air load is equal to the load (F_A) multiplied by the distance from the fan centerline to the point of application of the force on the blade (R_F). This moment will be from 2 to 4 times as great as that produced by the Moore fan under the same condi-



tions.

Also of concern with the conventional fan is the bending moment due to the air load at the point of attachment of the blades to the hub since this is usually the structurally weakest area of the fan. The moment due to the air load at this point is the load (F_A) times the distance (D). For the Moore fan, this moment is zero since the blades are attached at the pivot point.

A more complete discussion of the Moore fan design can be found in The Moore Company's General Catalog.

OPERATION

In this rather common wind condition, then, it can be seen that the blade load on the side where the blade is going against the wind will be double the load on the side where the blade is going with the wind. In a 40 mile per hour wind, the blade load would vary by a factor greater than 4. In a 60 mile per hour wind, the load would vary by a factor of more than 10! It is obvious that operation under such conditions will impose tremendous repetitive loadings on the fan blades.

In areas of unusually high wind velocities, it may be advisable to shield the fan in some manner.

4.5.3 OBSTRUCTIONS

Obstructions of one type or another in the air stream, ahead of or behind the fan, are to be expected. In fact, it would be virtually impossible to eliminate all obstructions. Structural supporting members, foundations and the like, need not be of serious concern although all obstructions, even small ones, will increase the static pressure and must be taken into consideration by the system designer in specifying the fan performance.

The total free area from which the fan can draw air should be twice the net area of the fan (fan area minus hub area). In other words, the air approaching the inlet of the fan should have no more than half the velocity of the air passing

through the fan. This area should be distributed reasonably uniformly. It would be unwise to attempt to operate a fan with one-half or one-third of the fan area completely blanked off. Such a condition would cause stalling of the fan blade through one-half the revolution but create a condition of overload in the half which was not blocked off. Excessive vibration would result. Any condition which forces the air to approach the fan in a non-axial direction should be avoided.

4.5.4 UNEVEN TIP CLEARANCE

Where fan rings are out of round or not centered with the fan, the tip clearance of each blade will vary as it makes a revolution. If tip clearance is tight at one point and excessive at another, proper flow will establish itself at the tight point, loading the blade to the very tip, while at the loose point the air will flow from the high pressure side of the blade through the opening between the blade tip and the ring and nullify the negative pressure on the under side of the blade. This will unload the blade near the tip within the area of excessive tip clearance. Under this condition, the blade will load and unload near the tip one or more times per revolution, resulting in an undesirable repetitive vibration. Every effort should be made to keep the tip clearance to a minimum and to have this clearance as constant as possible around the entire ring.

S-2000 page1

INSTRUCTION MANUAL FOR DODGE® S-2000 SPHERICAL ROLLER BEARINGS

INSTALLATION INSTRUCTIONS

NON-EXPANSION BEARING

WARNING

TO ENSURE THAT DRIVE IS NOT UNEXPECTEDLY STARTED, TURN OFF AND LOCK OUT OR TAG POWER SOURCE BEFORE PROCEEDING. FAILURE TO OBSERVE THESE PRECAUTIONS MAY RESULT IN BODILY INJURY.

1. Clean shaft and bore of bearing. The shaft should be straight, free of burrs and nicks, and correct size (see shaft tolerance table). If used shafting is utilized, then the bearing should be mounted on unworn section of shafting.
2. Lubricate shaft and bearing bore with grease or oil to facilitate assembly. Slip bearing into position. When light press fit is required, press against the end of the inner ring of bearing. Do not strike or exert pressure on the housing or seals.
3. Bolt bearing to support, using shims where necessary to align bearing so inner ring does not rub on seal carrier. Use full shims which extend across the entire housing base.
4. Determine final shaft position and tighten setscrews in the locking collar(s) of non-expansion bearing to recommended torque while the other bearings remain free. Rotate the shaft slowly under load, if possible, to properly center the rolling elements with respect to the raceways. Then tighten setscrews into the locking collar of the remaining bearings to the recommended torque.
5. Check rotation. If there is any strain, irregular rotational torque or vibration, it could be due to incorrect alignment, bent shaft or bent supports. Installation should be re-checked and correction made where necessary.

EXPANSION BEARING

Steps (1, 2, 3) Same as Non-Expansion Bearing.

4. Position expansion bearing in the housing. For normal expansion conditions, the bearing insert should be positioned in the center of the housing. To center bearing insert in housing, move bearing insert to extreme position and mark shaft. Then using bearing maximum total expansion table, move bearing insert in opposite direction one-half the total expansion to center bearing in the housing. If maximum expansion is required, move bearing insert to the extreme position in the housing to permit full movement in direction of expansion. After expansion bearing has been positioned in the housing, tighten the setscrews in the locking collar to the recommended torque.

5. Same as Non-Expansion Bearing.

FIELD CONVERSION (RE-OP) OF A NON-EXPANSION BEARING INTO AN EXPANSION BEARING

All non-expansion bearing sizes can be re-oped to become expansion bearings. To re-op a non-expansion to an expansion bearing follow these steps:

1. Move the snap ring, opposite from the collar side of bearing, to the outermost snap ring groove.
 2. Install bearing per Expansion Bearing instructions listed above.
- NOTE: Bearing nameplate has a non-expansion Part Number. When bearing is re-oped the bearing should be marked as expansion for future reference.

BEARING MAXIMUM TOTAL EXPANSION TABLE

SHAFT SIZE in.	TOTAL EXPANSION in.
1 ³ / ₈ - 1 ¹ / ₂	3/ ₁₆
1 ¹¹ / ₁₆ - 37/ ₁₆	1/ ₄
3 ¹⁵ / ₁₆	5/ ₁₆
47/ ₁₆ - 4 ¹⁵ / ₁₆	3/ ₈

WARNING: Because of the possible danger to persons(s) or property from accidents which may result from the improper use of products, it is important that correct procedures be followed: Products must be used in accordance with the engineering information specified in the catalog. Proper installation, maintenance and operation procedures must be observed. The instructions in the instruction manuals must be followed. Inspections should be made as necessary to assure safe operation under prevailing conditions. Proper guards and other suitable safety devices or procedures as may be desirable or as may be specified in safety codes should be provided, and are neither provided by Rockwell Automation nor are the responsibility of Rockwell Automation. This unit and its associated equipment must be installed, adjusted and maintained by qualified personnel who are familiar with the construction and operation of all equipment in the system and the potential hazards involved. When risk to persons or property may be involved, a holding device must be an integral part of the driven equipment beyond the speed reducer output shaft.

S-2000 page 2

LUBRICATION INSTRUCTIONS**OPERATION IN PRESENCE OF DUST, WATER OR CORROSION VAPORS**

This bearing is factory lubricated with No. 2 consistency lithium base grease which is suitable for most applications. However, extra protection is necessary if bearing is subjected to excessive moisture, dust, or corrosive vapor. In these cases, bearing should contain as much grease as speed will permit (a full bearing with consequent slight leakage through the seal is the best protection against contaminant entry).

In extremely dirty environments, the bearing should be purged daily to flush out contaminants. For added protection, it is advisable to shroud the bearing from falling material.

HIGH SPEED OPERATION

At higher operation speeds, too much grease may cause overheating. In these cases, the amount of lubrication can only be determined by experience. If excess grease causes overheating, remove grease fittings and run for ten minutes. This will allow excess grease to escape. Then wipe off excess grease and replace grease fittings.

In higher speed applications, a small amount of grease at frequent intervals is preferable to a large amount at infrequent intervals. However, the proper volume and interval of lubrication can best be determined by experience.

AVERAGE OPERATIONS

The following table is a general guide for normal operating conditions. However, some situations may require a change in lubricating periods as dictated by experience. If the bearing is exposed to unusual operating conditions, consult a reputable grease manufacturer.

Lubrication Guide

Read Preceding Paragraphs Before Establishing Lubrication Schedule

Suggested Lubrication Period in Weeks								
Hours run per day	1 to 250 rpm	251 to 500 rpm	501 to 750 rpm	751 to 1000 rpm	1001 to 1500 rpm	1501 to 2000 rpm	2001 to 2500 rpm	2501 to 3000 rpm
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	2	1
24	10	5	3	2	1	1	1	1

OPERATING TEMPERATURES

Abnormal bearing temperatures may indicate insufficient lubrication. If the housing is too hot to touch for more than a few seconds, check the temperature by applying a thermometer at the top of the pillow block with the thermometer tip surrounded by putty.

Because the thermometer reading will be approximately 10°F lower than the actual bearing temperature, add ten degrees to the reading and compare to the temperature rating of your grease. If the bearing temperature reading is consistent and operating within the recommended limits of your grease, the bearing is operating satisfactorily.

The recommended maximum operating temperature for No. 2 lithium base grease is 200 °F.

STORAGE OR SPECIAL SHUT DOWN

If equipment will be idle for some time, before shutting down, add grease to the bearing until grease purges from the seals. This will ensure protection of the bearing, particularly when exposed to severe environmental conditions. After storage or idle period, add fresh grease to the bearing before starting.

SET SCREW TORQUE TABLE

Shaft Size	Socket Set Screw Size	Tightening Torque
13/8 - 13/4 inches	5/16 inches	165 Inch Pounds
15/16 - 27/16 inches	3/8 inches	290 Inch Pounds
21/16 - 37/16 inches	1/2 inches	820 Inch Pounds
31/16 - 41/16 inches	5/8 inches	1325 Inch Pounds

RECOMMENDED SHAFT TOLERANCE TABLE

Normal Shaft Size	Low to Normal Equivalent Load and Catalog Speed*	
Up to 1 1/2 inches	+ .000 inches	-.0005 inches
Over 1 1/2 to 2 1/2 inches	+ .000 inches	-.001 inches
Over 2 1/2 to 4 inches	+ .000 inches	-.001 inches
Over 4 to 5 inches	+ .000 inches	-.0015 inches

On severe applications and where dynamic balance and minimum runout are important, a snug to light press fit may be required to obtain optimum bearing performance. Consult factory.

*Normal equivalent load .08C to .18C.

INSTRUCTION MANUAL FOR CC Ball Bearing Fan and Blower Pillow Blocks

INSTALLATION

1. Clean shaft and bore of bearings.
2. Loosen setscrews so that they do not protrude into bore.
3. Slip Pillow Block into position and tighten setscrews on one end to recommended torque in table below.
4. On the other end, push on the bearing inner ring while pulling on the shaft. Simultaneously tighten setscrews to recommended torque.
5. Retorque setscrews after 24 hours of operation.

Set Screws		Hold Down Bolts	
Size	Wrench-Torque (lb.-in.)	Size	Wrench-Torque (lb.-in.)
10-32	33	3/8-16	240
1/4-28	87	1/2-13	600
3/8-24	165	3/4-11	1200
1/2-24	290		

LUBRICATION

Storage or Special Shutdown — If exposed to wet or dusty conditions or to corrosive vapors, extra protection is necessary: Add grease until it shows at the seals; rotate the bearing to distribute grease; cover the bearing. After storage or idle period, add a little fresh grease before running.

High Speed Operation — In the higher speed ranges too much grease will cause over-heating. The amount of grease that the bearing will take for a particular high speed application can only be determined by experience — see "Operating Temperature" below. If excessive grease in the bearing causes over-heating, it will be necessary to remove grease fitting to permit excess grease to escape. The bearing has been greased at the factory and is ready to run. When establishing a relubrication schedule, note that a small amount of grease at frequent intervals is preferable to a large amount at infrequent intervals.

Operation in Presence of Dust, Water or Corrosive Vapors — Under these conditions the bearing should contain as much grease as speed will permit since a full bearing with consequent slight leakage is the best protection against entrance of foreign material. In the higher speed ranges too much grease will cause over-heating — see "High Speed Operation" above. In the lower speed ranges it is advisable to add extra

grease to a new bearing before putting into operation. Bearings should be greased as often as necessary (daily if required) to maintain a slight leakage at the seals.

Normal Operation — This bearing has been greased at the factory and is ready to run. The following table is a general guide for relubrication. However, certain conditions may require a change of lubricating periods as dictated by experience. See "High Speed Operation" and "Operation in Presence of Dust, Water or Corrosive Vapors" above.

Operating Temperature — Abnormal bearing temperature may indicate faulty lubrication. Normal temperature may range from "cool to warm to the touch" up to a point "too hot to touch for more than few seconds", depending on bearing size and speed, and surrounding conditions. Unusually high temperature accompanied by excessive leakage of grease indicates too much grease. High temperature with no grease showing at the seals, particularly if the bearing seems noisy, usually indicates too little grease. Normal temperature and a slight showing of grease at the seals indicate proper lubrication.

Kind of Grease — Many ordinary cup greases will disintegrate at speeds far below those at which Dodge bearings will operate successfully if proper grease is used. Dodge bearings have been lubricated at the factory with No. 2 consistency lithium base grease which is suitable for normal operating conditions. Relubricate with lithium base grease or a grease which is compatible with original lubricant and suitable for ball bearing service. In unusual or doubtful cases the recommendation of a reputable grease manufacturer should be secured.

Special Operating Conditions — Refer acid, chemical, extreme or other special operating conditions to RELIANCE ELECTRIC, Greenville, South Carolina.

Lubrication Guide

Read Preceding Paragraphs Before Establishing Lubrication Schedule.

Hours Run per Day	Suggested Lubrication Period in Weeks							
	1 to 250 RPM	251 to 500 RPM	501 to 750 RPM	751 to 1000 RPM	1001 to 1500 RPM	1501 to 2000 RPM	2001 to 2500 RPM	2501 to 3000 RPM
8	12	12	10	7	5	4	3	2
16	12	7	5	4	2	2	1	1
24	10	5	3	2	1	1	1	1

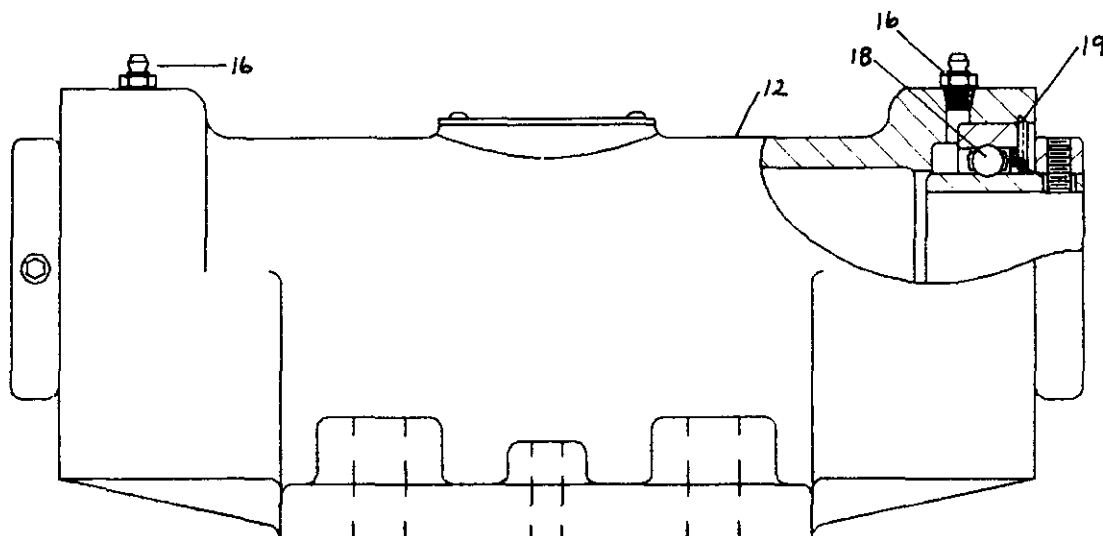
WARNING: Because of the possible danger to person(s) or property from accidents which may result from the improper use of products, it is important that correct procedures be followed: Products must be used in accordance with the engineering information specified in the catalog. Proper installation, maintenance and operation procedures must be observed. The instructions in the instruction manuals must be followed. Inspections should be made as necessary to assure safe operation under prevailing conditions. Proper guards and other suitable safety devices or procedures as may be desirable or as may be specified in safety codes should be provided, and are neither provided by Reliance Electric nor are the responsibility of Reliance Electric.

Dodge / Roper Ct., P.O. Box 499 / Greenville, South Carolina 29602 / 803-297-4800

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DODGE
RELIANCE ELECTRIC 

NOTE: The two digit numbers are for reference only. Order parts by the six digit numbers in the Parts List. Each six digit number is a complete identification of the part or assembly.



Reference	Name of Part	No. Req'd.	Part Numbers for Various Shaft Sizes					
			$\frac{1}{8}$, 1	$\frac{1}{8}$, $1\frac{1}{8}$	$\frac{1}{4}$, $1\frac{1}{2}$, $1\frac{3}{8}$	$\frac{1}{2}$, $1\frac{1}{2}$	$1\frac{1}{2}$	$2\frac{1}{2}$
12	Housing	1	134150	134151	134152	134153	134154	134155
14	Snap Wire	2	134180	134181	134182	134183	134184	134185
16	Lubrication Fitting	2	405015	405015	405015	405015	405015	405015

Reference	Name of Part	No. Req'd.	Part Numbers for Various Shaft Sizes					
			$\frac{1}{8}$	1	$\frac{1}{2}$	$1\frac{1}{8}$	$\frac{1}{4}$	$1\frac{1}{2}$
18	Ball Bearing with Collar and Screws	2	134161	134162	134164	134165	134166	134168

Reference	Name of Part	No. Req'd.	Part Numbers for Various Shaft Sizes					
			$\frac{1}{8}$	$1\frac{1}{8}$	$\frac{1}{4}$	$1\frac{1}{8}$	$2\frac{1}{8}$
18	Ball Bearing with Collar and Screws	2	134169	134170	134171	134172	134174