SHARPLES CENTRIFUGES

INSTRUCTIONS MANUAL

BINDER 1 OF 2

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

INSTRUCTION MANUAL CHECKLIST

INSTALLATION/CUSTOMER CITY OF WINNIPEG

Order No. 485594

Machine Model PM 76,000

Total Machines Supplied 1

Total Manuals Supplied 1

1 Manuals Shipped with Equipment

____ Manuals Shipped through Sales

____ Other ____

THIS INSTRUCTION BOOK IS A COMPILATION OF THE BASIC MACHINE INSTRUCTIONS AND SUPPLEMENTAL MATERIAL.

SUPPLEMENTAL MATERIAL IS INCLUDED TO:

1. **Supply you with as complete a manual as possible.**
2. **Act as Addenda so the instructions relate directly to your needs.**
3. **Inform you of Pennwalt's latest engineering changes and maintenance recommendations.**

These supplemental instructions supersede related information contained within the basic instructions.

THE FOLLOWING INSTRUCTIONAL MATERIAL IS ENCLOSED.

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	713	After-Sales Service
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	440-2	Motors and Motor Controls
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	572 S	Lube System Flow Switch
	11	Tuthill Lube Pump
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	465	DC Backdrive Theory
	698	DC Backdrive Assembly
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6	--	DC Motor Data
	3088-2	DC Motor Instructions
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	B3628-9	AC Motor Instructions
	8210-8211	Recommended Installation Drawing
	P-R601	Assembly Drawing
	SS-00-781-C	DC Backdrive - Spindlemate Fuseless

CHNICAL PUBLICATIONS GEE DATE 5/17/88

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

SAFETY PRECAUTIONS FOR SHARPLES CENTRIFUGES AND RELATED PROCESSING EQUIPMENT

PENNWALT BUILDS CENTRIFUGES WHOSE PARTS ARE PRECISION MACHINED AND ACCURATELY BALANCED. MANY YEARS OF EXPERIENCE HAVE RESULTED IN THE COMPILATION OF A SET OF RULES.

IT IS THE RESPONSIBILITY OF THE OPERATOR TO RECOGNIZE POTENTIAL HAZARDS THAT HAVE NOT BEEN MENTIONED, SINCE THESE HAZARDS MAY BE SPECIFIC TO HIS PARTICULAR PLANT.

FAILURE TO FOLLOW THESE RULES MAY RESULT IN SEVERE PERSONAL INJURY OR PROPERTY DAMAGE.

PENNWALT CORPORATION. . . 955 MEARNS ROAD, WARMINSTER, PA. 18974
SHARPLES-STOKES DIVISION

FAILURE TO FOLLOW THESE RULES
MAY RESULT IN SEVERE PERSONAL INJURY
OR PROPERTY DAMAGE

A. GENERAL:

1. Read all manuals and instruction sheets before attempting to install, repair or operate equipment, and follow all recommendations.

2. Use only those lubricants, procedures and schedules recommended in the equipment instructions.

3. Never operate or repair equipment with parts that have not been manufactured or approved by the orignal equipment manufacturer.

4. Before replacing any part, check the appropriate drawing to correctly position the part.

5. If nameplates are lost, damaged, or removed, replace them. They have been affixed to the equipment to provide warnings, instructions, etc., for the maintenance and operating personnel.

6. Do not operate belt driven equipment without guards. If equipment was purchased without guards, user is responsible for providing guards that meet all applicable safety codes.

7. Where the equipment is supplied with covers or guards, do not remove them until after the equipment has come to a complete stop.

8. Make periodic checks for loos bolts on rotating assemblies, the foundations and supporting structures, covers, hatches, and pipe connections.

9. Do not operate equipment if excessive vibration or abnormal noise develops.

B. HANDLING:

1. Safe practices for lifting and handling equipment should be followed.

   a. Hoists and slings should be of adequate capacity, inspected regularly, and in good repair.

   b. Never place hands, feet, or head where they may become trapped.

   c. Use only tools and methods recommended by the equipment manufacturer.

   d. Personal safety equipment such as eye shields, safety shoes, etc., must be used.

2. Use extra caution when lifting, moving, or holding worn parts, since these may be sharp, slippery, or weakened.

3. Provide a spacious cleared area around the equipment during maintenance.

C. CENTRIFUGE

1. Do not exceed the maximum speed, process material specific gravity process pressure, or temperature specified on the centrifuge nameplate.

2. Do not use a pipe wrench on any part of the centrifuge.

3. Do not interchange parts that have been balanced as an assembly.

4. Do not attempt to use the centrifuge for any application or process other than that stated on the original purchase order without first consulting the Sharples Process Engineering Department.

D. ROTATING EQUIPMENT:

1. Whenever removing material from equipment like grinders, conveyors, open throat pumps, etc., make sure all machine components are at rest and the power is shut off with the disconnect switch locked in the off position.

2. Do not get rags, loose clothing, sticks, etc., near rotating or moving parts.

3. The centrifuge must coast to a complete stop. Do not brake it by hand or in any other way force it to stop, unless it is equipped with a braking mechanism supplied by Sharples.

4. Do not operate the centrifuge unless the direction of the bowl rotation is as designated in the Instruction Manual.

5. If a rotating assembly must be turned by hand, use caution: Avoid sharp edges and close areas where fingers may be cut or trapped (Example: Pulleys).

E. PUMP:

1. If positive displacement pumps are used in the process, be sure the discharge line is unobstructed before starting the pump.

2. In plants using any type of grinder with the discharge directly connected to a pump, be sure the pump is in operation before putting any product into the grinder.

3. Do not run a positive displacement pump dry.

F. EXPLOSION PROOF EQUIPMENT:

1. Do not operate a centrifuge equipped with an explosion-proof motor and control until all seal fittings are sealed with "Chico X" fiber (or equivalent) and "Chico A" sealing compound (or equivalent), and tagged.

2. Follow manufacturer recommendations to prepare and use explosion-proof fibers and compounds for sealing.

3. All sealing surfaces should be smooth and free of corrosion. Never use abrasive material or a file to remove corrosion from explosion-proof equipment.

4. Cover screws, and bolts used to hold explosion-proof joints together must always be tight, and only of the type and material recommended by the component manufacturer.

G. MOTOR:

1. Be sure to check that the line voltage applied to the motor controller is the same voltage for which the motor is wired.

2. Always follow motor manufacturer's specifications on bearing lubrication.

3. Do not attempt to operate motor that has become overheated from frequent starts and stops. Allow motor to cool to ambient temperature (as designated on motor nameplate) before each restart.

H. ELECTRICAL:

General:

1. De-energize all power before working on any electrical equipment.

2. Install and ground all equipment (permanent and portable) in accordance with requirements of the National Electric Code and local electric codes.

3. Use circuit breakers or fused disconnects between equipment and power source.

4. Never touch electrical components with wet hands or when standing on a wet surface. Insulate yourself from ground.

5. When handling electrical equipment, take care to avoid contacting live parts. Assume all circuits are live. Check with a volt meter.

6. Label all control circuits clearly.

7. Keep electrical controls and motors clean and free of dust—dust prevents thorough air circulation, generating heat; heat in turn can ignite the dust or flammable vapors if present in the atmosphere.

8. Never wash, hose down, or direct a liquid stream at any electrical equipment unless it is constructed for that purpose. Never wash live electrical equipment.

I. ELECTRICAL:

Repair

1. Only qualified personnel, familiar with electrical safety procedures, and the construction and operation of the equipment, should make electrical repairs.

2. De-energize all power before opening any electrical enclosure, or before connecting and disconnecting test equipment and components. Provide a safety lockout at the power source.

3. On DC powered equipment, do not perform any inspection (mechanical or electrical) until the power has been turned off and disconnected, and all rotating assemblies have come to a complete stop. (DC voltage feedback may be generated by the moving motor.)

4. Use only approved safety eye shields, rubber gloves and mats and insulated tools when doing electrical work.

5. Periodically inspect and test by operating all the automatic shut-off devices and monitoring systems provided to make sure they will be functional when needed.

J. CHEMICALS:

1. If corrosive and/or toxic chemicals or solvents are used as part of the process or as cleaning materials:

a. Become thoroughly familiar with the properties of these products and their hazards, the precautions necessary to handle them safely, and follow all manufacturer recommendations for their use.

b. Use in a well ventilated area and keep employee exposure below permissible limits.

c. If flammable, take care to prevent fire or explosion.

d. Avoid contact with the skin and eyes—wear goggles, gloves, shields, etc., as required by the nature of the solvent or chemical.

2. If in doubt whether a product is dangerous or not—Assume it is. Take all necessary precautions to avoid personal injury and adverse health effects.

K. VENTILATION:

1. Toxic fumes, if present in the system, must not be permitted to escape to the operating area. They should be adequately vented away from the worker in accordance with applicable environmental regulations.

2. If in doubt whether any vapor is toxic or not—Assume it is. Take all necessary precautions to avoid personal injury and adverse health effects. Worker exposure should be maintained below the permissible limit at the lowest feasible level.

3. If it is necessary to enter an area where toxic vapors are present, consult with responsible authorities for recommendations concerning safety.

4. Use NIOSH approved breathing apparatus when working with toxic or hazardous materials, or with materials that reduce the oxygen concentration in the air, such as CO_2.

L. PRESSURE VESSELS:

1. Vessels operating under internal pressure should be maintained and inspected in accordance with manufacturer instructions and/or applicable local and state codes.

2. If corrosion or erosion is expected on pressurized equipment, frequency of inspection should be increased. If repairs are necessary, they should be made by qualified personnel.

3. Before attempting maintenance, reduce internal pressure to atmospheric pressure.

4. Vessels operating under internal pressure should be provided with a safety device to relieve excess pressure in accordance with the Unfired Pressure Vessels Code.

a. Safety devices should be in good operating condition at all times. It is recommended that they be inspected and tested frequently and maintained in accordance with manufacturer instructions and/or applicable local and state codes.

b. If any repair on a safety device is necessary, return it to the manufacturer. Inexperienced personnel should never attempt repair. Any adjustment should be made according to the recommendations supplied by the manufacturer.

c. The outlet connections of all safety devices should be installed in a manner that will not cause injury to personnel should discharge or actuation occur.

M. HOT/COLD PRODUCTS:

1. When working with very hot or very cold processes, extreme caution should be used to avoid personal injury.

N. LEAKAGE AND SPILLAGE:

1. Any leakage in the system should be quickly corrected.

2. Any type of spillage (oil, water, etc.) should be quickly cleaned off floors, walls, equipment, lines, etc., and the entire operating area kept clean.

O. DANGEROUS MATERIAL APPLICATIONS:

1. The Sharples-Stokes Division of Pennwalt Corporation makes both standard equipment and equipment furnished with certain explosion-proof accessories (motor, control, etc.), as specified by the purchaser.

2. Standard equipment not furnished with explosion-proof accessories must never be used with explosive, chemically unstable, or flammable processes of any kind. Severe personal injury, or property damage could result.

3. In some instances, it may be necessary for the user to equip the machine with safety devices not obtainable from Pennwalt. In other cases, the process for which the equipment is to be used may be so hazardous that the only prudent operating procedure is to isolate the equipment in an expendable building and operate it by remote control from a safe distance.

4. When Pennwalt supplies equipment furnished with explosion-proof accessories, we warrant that the particular accessories described as "explosion proof" comply with accepted industry standards for that term.

However, we do not guarantee that one of our machines furnished with explosion-proof accessories is safe for use with explosive, chemically unstable, or flammable processes under ALL conditions.

The user has the final responsibility for insuring that all precautions required by his particular method of operation have been taken.

5. If combustible products are used as parts of the process or as cleaning materials, become thoroughly familiar with the safety precautions necessary to handle them. Follow all manufacturer recommendations to avoid personal injury or property damage that could be caused by fire or explosion.

P. REPAIRS:

1. Do not attempt disassembly or make mechanical or electrical repairs unless the equipment has come to a complete stop, the power is shut off, and a safety lockout or other padlock is installed on the disconnected circuit. The locking device should be tagged to identify the working party.

2. Do not make any repairs until dangerous vapors and gases have dissipated, and the area is refreshed with clean air.

3. Major repairs to the centrifuge must not be made without first consulting with the Sharples Customer Service Department. This includes rebalancing of rotating parts. Under no circumstances should weld repair or other alterations be made to bowl shells, bowl tops, bowl hubs, coupling rings, shafts, spindles, conveyors, or other rotating parts, without prior written approval and instructions.

4. Bowl assemblies consist of components which are assembled at the Sharples factory and then balanced as an assembly to a high degree of accuracy. The individual components of the assembly are not balanced individually. For this reason Sharples does not offer for sale individual bowl components as replaceable spare parts items.

   If replacement of a bowl component is required on your centrifuge, the entire bowl assembly must be returned to Sharples for repair and precision balancing.

   If time does not permit the customer to return an entire bowl assembly, a component may be purchased *only* when a Sharples service engineer supervises its assembly and balance.

5. Repairs to hard-surfaced parts must be performed with strict quality control of materials and methods. Hard-surfacing materials are brittle, and can break off if improperly applied. After startup, periodic inspection of these parts is necessary to anticipate separation of material.

6. During repairs, when equipment may be physically or electrically unstable, post barriers or signs announcing hazardous conditions.

7. After repairs, and before restarting, reinstall all guards and reconnect all mechanical and electrical safety devices.

Q. CORROSION, EROSION AND PITTING:

1. To insure a high factor of safety under severe operating conditions, equipment manufacturing by Pennwalt is designed with a careful stress analysis made of highly stressed parts. A thorough control of metallurgical properties is maintained throughout manufacture, and all material is warranted as free from defects at time of shipment.

2. Users of high speed centrifugal equipment should recognize that equipment may deteriorate over a period of time, depending on the severity of exposure and/or possible misuse.

3. In the interest of longer and safer operation of equipment, Pennwalt recommends the customer maintain a periodic (at least monthly) inspection of such highly stressed moving parts as bowls, shafts, spindles, conveyor tiles, etc., against metal failure through misuse, impact, erosion and/or corrosion, chemical pitting, or stress cracking.

4. Do not operate equipment when moving parts show:
   a. Holes are wearing through
   b. Grooves greater than 1/16" deep
   c. Evidence of cracks
   d. Component surfaces covered with a light corrosion or etching.
   e. Chemical pitting of 1/16" depth or greater

5. Chemical Pitting Observed:

   All cases of chemical pitting, even under 1/16" depth, should be watched carefully. This action is almost always due to the breakdown of the passive film on stainless bowl shell walls in the presence of chlorides, occurring under a bowl cake that has not been cleaned from the shell wall. High temperature, low pH, and high acidity accelerate the action.

6. Contact Sharples Customer Service Department regarding the repair or replacement by Pennwalt of pitted bowl shells or other parts.

Pennwalt Corporation
Sharples-Stokes Division
955 Mearns Road
Warminster, PA 18974
215-443-4000

SHARPLES AFTER-SALES SERVICE

Congratulations on being an owner of a new Sharples Centrifuge! Your Sharples Centrifuge has been designed to give years of reliable, dependable performance. To assure that you obtain maximum performance over the years, we offer a complete package of after-sales services. These include:

Original quality replacement parts

Field repair service

Process application assistance

Factory repair service

When you need assistance, we would appreciate if you would contact the following:

1. REPLACEMENT PARTS

MAIL: Send your order to:

Sharples Parts Department
Sharples-Stokes Division
955 Mearns Road
Warminster, PA 18974

PHONE: Call Sharples Parts Department
215-443-4000

Emergency Weekend and Holiday Service
215-443-4200

FACSIMILE: (24 hours a day)
215-443-4234

Use the following procedure for ordering parts:

A. If you have part numbers, please supply the following:
   1. Part number
   2. Part name
   3. Machine type number
   4. Machine serial number

   } Located on nameplate

B. If the part number is not available, please supply the following:
   1. Machine type number
   2. Machine serial number

   } Located on nameplate

   3. From the Instruction Manual, provide the following:
      a. Figure number of assembly drawing or Instruction Bulletin number.
      b. Index number and item name.

2. FIELD REPAIR SERVICE

Customer Service Manager — 215-443-4298

The Sharples Field Service Group consists of factory-trained service engineers who are specialists on Sharples Centrifuges. To better serve you, we ask that you give us as much advanced notice as possible when requesting service. In case of an emergency, we will make every effort to have a Service Engineer available immediately.

3. PROCESS ASSISTANCE

Customer Service Manager — 215-443-4298

If you are having process problems, we offer free phone consultation service. In most cases, we will be able to diagnose the problem and offer suggestions to resolve the problem. If required, our staff of Process Engineers are available for plant visits.

4. MACHINE FACTORY REPAIR

Supervisor of Repairs — 215-443-4208

Sharples is a specialist in the repair of centrifuges. We maintain complete manufacturing records of every Sharples Centrifuge and will repair your unit to meet its original mechanical specifications. When possible, units will be updated to the very latest technologies in materials and design.

We wish you much success with your new Sharples Centrifuge and thank you for your confidence in our equipment. The entire Sharples Sales and Service Team is here for one purpose, and that is to make sure you obtain maximum results from your equipment. If you need assistance, please call immediately.

To keep you informed on the operation and maintenance of your Centrifuge, we send out various mailings. To assure you receive this information, please complete and return the attached card.

Name _____

Title _____

Company _____

Address _____

_____

Phone # _____

Equipment Type (Located on nameplate)

Equipment Type Number _____

Serial Number _____

PENNWALT CORPORATION

NO POSTAGE
NECESSARY
IF MAILED
IN THE
UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS PERMIT NO. 60 PHILADELPHIA, PA

POSTAGE WILL BE PAID BY ADDRESSEE

Sharples Division
Pennwalt Corporation
955 Mearns Road
Warminster, PA 18974

Attn: Mr. S. Pettinato

SHARPLES SALES OFFICES

Atlanta
30 Perimeter Center East
Atlanta, GA 30346
404-393-2087

California
1415 Rollins Road
Burlingame, CA 94010
415-348-3813

18700 Beach Blvd., Suite 235
Huntington Beach, CA 92648
714-964-7671

Chicago
2301 West 22nd St., Suite 310
Oak Brook, IL 60521
312-571-6120

Cleveland
Westgate Tower Bldg., Suite 305
20525 Center Ridge Road
Rocky River, OH 44116
216-333-4282

Houston
14340 Torrey Chase Blvd., Suite 190
Houston, TX 77014
713-586-0454

New York
690 North Broadway
North White Plains, NY 10603
914-428-0900

Philadelphia
Seven Wynnewood Road, Suite 105
Wynnewood, PA 19096
215-649-6700

Canada
Pennwalt Incorporated
365 Evans Ave., Suite 302
Toronto, Ontario, Canada M8Z 1K2
416-252-5441

PENNWALT
CORPORATION

PURPOSE OF THIS BULLETIN

This bulletin describes each part of your centrifuge with instructions for:

SAFER USE: To minimize risks of personal injury and property damage.

INSTALLATION: Instructions are intended for use by riggers knowledgeable in heavy equipment installation methods.

PENNWALT CORPORATION ASSUMES NO RESPONSIBILITY INSOFAR AS THE INSTALLATION OF THE EQUIPMENT IS CONCERNED. THE SUGGESTIONS REGARDING THE INSTALLATION OF THE EQUIPMENT HAVE BEEN MADE TO SERVE ONLY AS A GUIDE.

OPERATION: Instructions are intended for use by operators familiar with processing equipment, and trained for the type of centrifuge used.

MAINTENANCE:

MECHANICAL: Instructions (disassembly and assembly procedures) are intended for use by experienced mechanics (maintenance machinists).

ELECTRICAL: Instructions are intended for use by experienced electricians familiar with electrical safety procedures.

TROUBLESHOOTING: Instructions are intended for use by qualified operators and maintenance personnel.

"PERSONS WHO ARE NOT EXPERIENCED AS RECOMMENDED, MAY NOT UNDERSTAND THESE INSTRUCTIONS"

SUPPLEMENTAL MATERIAL

Because of the wide variation in types of equipment furnished by us, some of the details may not apply specifically to your equipment; therefore:

1. A certified wiring diagram and a certified dimension sheet are supplied with every order.

2. Supplemental material is included with this bulletin to supply you with as complete a manual as possible for your specific needs.

   That material performs the following functions:

   a. It acts as Addenda to the basic instructions so the instructions relate directly to your needs.

   b. It informs you of Pennwalt's latest engineering changes and maintenance recommendations.

THESE SUPPLEMENTAL INSTRUCTIONS SUPERSEDE LIKE INFORMATION CONTAINED IN THE BASIC INSTRUCTIONS

BULLETIN 459, REV. 1

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

RECOMMENDED SEATING TORQUES

PENNWALT CORPORATION . . . 955 MEARNS ROAD, WARMINSTER, PA. 18974
SHARPLES-STOKES DIVISION

The following charts are supplied to prevent overtorquing of screws.

(Socket Head Cap Screws on Rotating Assemblies must be properly torqued for the centrifuge to operate as designed, and safely).

If proper seating during installation requires exceeding the recommended torque, after the assemblies are installed, dispose of the overtorqued screws and replace with new ones at the proper torque.

RECOMMENDED SEATING TORQUES FOR LUBRICATED ASSEMBLY OF AUSTENITIC STAINLESS STEEL AND HASTELLOY "C" SOCKET HEAD CAP SCREWS USED ON ROTATING ASSEMBLIES

Nominal Size	Tensile Strength PSI	Yield Strength PSI	TORQUE – INCH POUNDS	
			Coarse Thread	Fine Thread
			*Lubricated	*Lubricated
1/4	80,000	40,000	75	90
5/16	80,000	40,000	135	150
3/8	80,000	40,000	240	275
7/16	80,000	40,000	390	435
1/2	80,000	40,000	600	680
9/16	80,000	40,000	770	880
5/8	80,000	40,000	1,070	1,220
3/4	80,000	40,000	1,900	2,120
7/8	80,000	40,000	3,180	3,510
1	80,000	40,000	4,780	5,230

**Lubricate with "Never-Seez" or equivalent.*

RECOMMENDED SEATING TORQUES FOR DRY OR LUBRICATED ASSEMBLY OF ALLOY STEEL SOCKET HEAD CAP SCREWS USED ON ROTATING ASSEMBLIES

Nominal Size	Tensile Strength PSI (Minimum)	Yield Strength PSI (Minimum)	TORQUE – INCH POUNDS*							
			Coarse Thread				Fine Thread			
			Dry		Lubricated		Dry		Lubricated	
			Plain	Cad. Plated	Plain	Cad. Plated	Plain	Cad. Plated	Plain	Cad. Plated
1/4	190,000	170,000	150	112	120	90	170	128	135	102
5/16	190,000	170,000	305	230	245	185	325	245	260	195
3/8	190,000	170,000	545	410	435	330	570	430	455	345
7/16	190,000	170,000	840	630	670	505	900	680	720	545
1/2	190,000	170,000	1,300	970	1,040	775	1,370	1,030	1,095	825
9/16	190,000	170,000	1,860	1,400	1,490	1,120	1,970	1,480	1,575	1,185
5/8	190,000	170,000	2,530	1,900	2,025	1,520	2,660	2,000	2,130	1,600
3/4	180,000	155,000	4,400	3,300	3,520	2,640	4,800	3,600	3,840	2,800
7/8	180,000	155,000	7,000	5,300	5,600	4,240	7,600	5,700	6,080	4,560
1	180,000	155,000	10,400	7,800	8,320	6,240	11,000	8,300	8,800	6,640

**Torques calculated to induce 100,000 PSI tensile stress in the screw threads.*

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

MAINTENANCE INSTRUCTIONS

FOR THE

SHARPLES CENTRIFUGE

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SHARPLES-STOKES DIVISION

SHARPLES
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CHAPTER 1
INTRODUCTION

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A. SAFETY PRECAUTIONS SPECIFIC TO THIS CENTRIFUGE

1. Vibration isolators must be used when installing the centrifuge and motor.
2. Use flexible connections in all piping at attachment point to centrifuge.
3. Allow sufficient clearance around discharge chutes.
4. Flush out the centrifuge during each shutdown.
5. The bowl should rotate clockwise when viewed from the pulley end.
6. Tighten the upper casing screws to 20 - 25 foot pounds before starting the centrifuge.
7. Make sure interlock is working so centrifuge cannot be started unless there is adequate oil flow to the pillow block bearings.
8. Do not start the centrifuge unless the tension bar nut is properly seated.
9. Do not operate the centrifuge unless all o-rings and seals are in good condition.

B. CENTRIFUGE DESCRIPTION

Figure 1-1:

Bowl Assembly

The bowl is suspended, horizontally, between two hubs which are supported in bearings enclosed in pillow block assemblies.

Conveyor Assembly

The screw conveyor is mounted concentrically inside the bowl and rotates on roller type bearings mounted in the bowl hubs. The conveyor is driven by a spline shaft connecting the conveyor to the gear box. The rear of the conveyor is supported by a tension bar which extends through the bowl rear hub to the pulley.

The conveyor rotates around the same horizontal axis as the bowl, but at a lower rpm. This difference in speed (differential) moves the solids towards the rear of the bowl. The liquid flows towards the front of the bowl.

Casing Assembly

The casing contains solids discharged from the rear of the bowl and liquid discharged from the front and then diverts them in separate streams away from the centrifuge.

Frame Assembly

The frame supports the rotating and casing assemblies.

Drive Assembly

This assembly drives the rotating assembly in a clockwise direction, as viewed from the pulley end, through a matched set of "V" belts and pulleys.

The high rotational speed produced is responsible for creating the centrifugal force in the bowl.

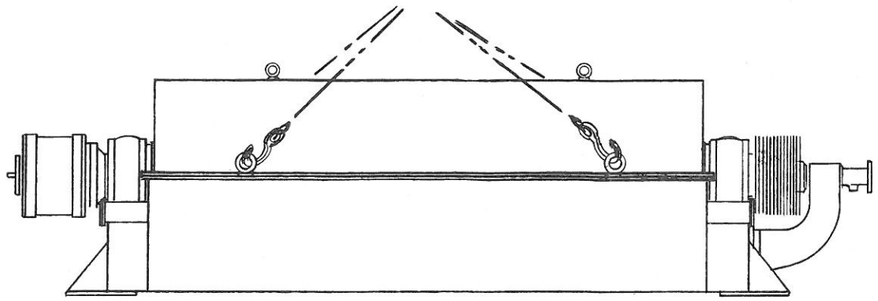
Gear Box Assembly

The ring gear housing of the gear box assembly is connected to the bowl front hub by an adapter and rotates at the same speed as the driven bowl.

The gear box second stage assembly is connected to the conveyor through a spline shaft and restricts the conveyor to a speed lower than that of the bowl. This restriction creates the "differential" between the bowl and conveyor.

Feed Tube Assembly

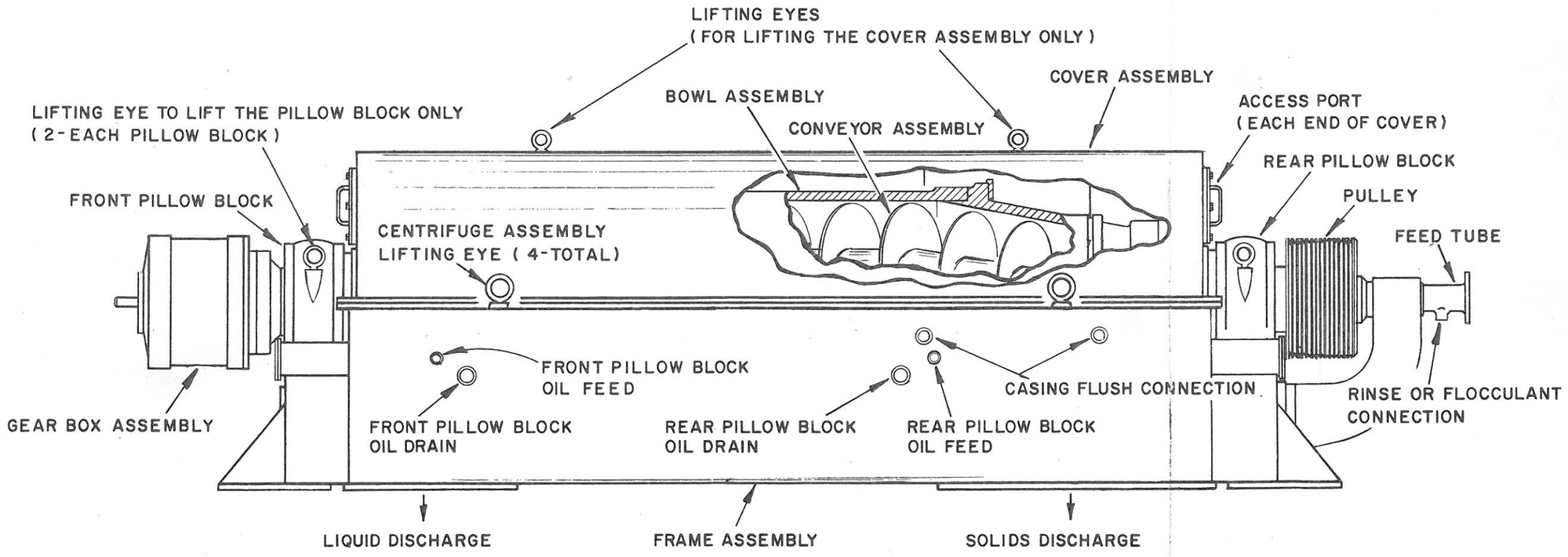
The feed tube is designed to introduce the feed to the feed zone of the conveyor. It is also designed to deliver liquid polymer, flush liquid, or rinse, as required to specific areas of conveyor.



CENTRIFUGE ASSEMBLY LIFTING
APPROXIMATE WEIGHT = 21,000 LBS.
15- TON OVERHEAD CRANE REQUIRED

ATTENTION

ALL REFERENCES MADE IN THIS MANUAL TO THE "FRONT" OF THE CENTRIFUGE ARE REFERENCES TO THE GEAR BOX END. REFERENCES TO THE "REAR" ARE TO THE PULLEY END.



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FIGURE 1-1
GENERAL ASSEMBLY

BULLETIN 5/2/3

CHAPTER 2
CENTRIFUGE OPERATION

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A. Theory 2-1
B. Pond Depth 2-1
C. Bowl Speed 2-2
Centrifuge Operation . . . . . Figure 2-1
Plate Dam Assembly . . . . . Figure 2-2

A. THEORY

Figure 2-1:

The feed slurry to be separated is introduced into the rotating screw conveyor feed zone through a stationary and axially mounted feed tube. It then discharges from ports, located around the periphery of the feed zone, into the bowl.

As the solids separate out of the slurry, they are carried by centrifugal force to the wall of the bowl where they are scrolled by the conveyor up the inclined beach and out the solids discharge ports. Conveyance of solids is accomplished due to the differential rotating speed between the bowl and conveyor. Clarified liquid flows to the front of the bowl where it discharges through ports in the plate dams.

B. POND DEPTH

Figure 2-2:

1. The bowl is equipped with plate dams that can be chosen to vary the depth (pond depth) of the liquid in the bowl. The pond number is stamped on each plate dam.
2. The amount of solids sedimenting in the centrifuge bowl for any specific application is a result of:
   a. The average retention time of the liquid phase in the bowl. (Determined by feed rate and dam size).
   b. The effective centrifugal force acting on the slurry.
3. The plate dams can be chosen to control the liquid holding capacity over a relatively wide range:
   a. The greatest pond depth, represented by the use of a dam carrying the highest number, usually will result in maximum clarification of the liquid discharge and reduced dryness of the solids discharge.
   b. The shallowest pond depth, represented by the use of a dam carrying the lowest number, usually will result in minimum clarification of the liquid discharge and increased dryness of the solids discharge.

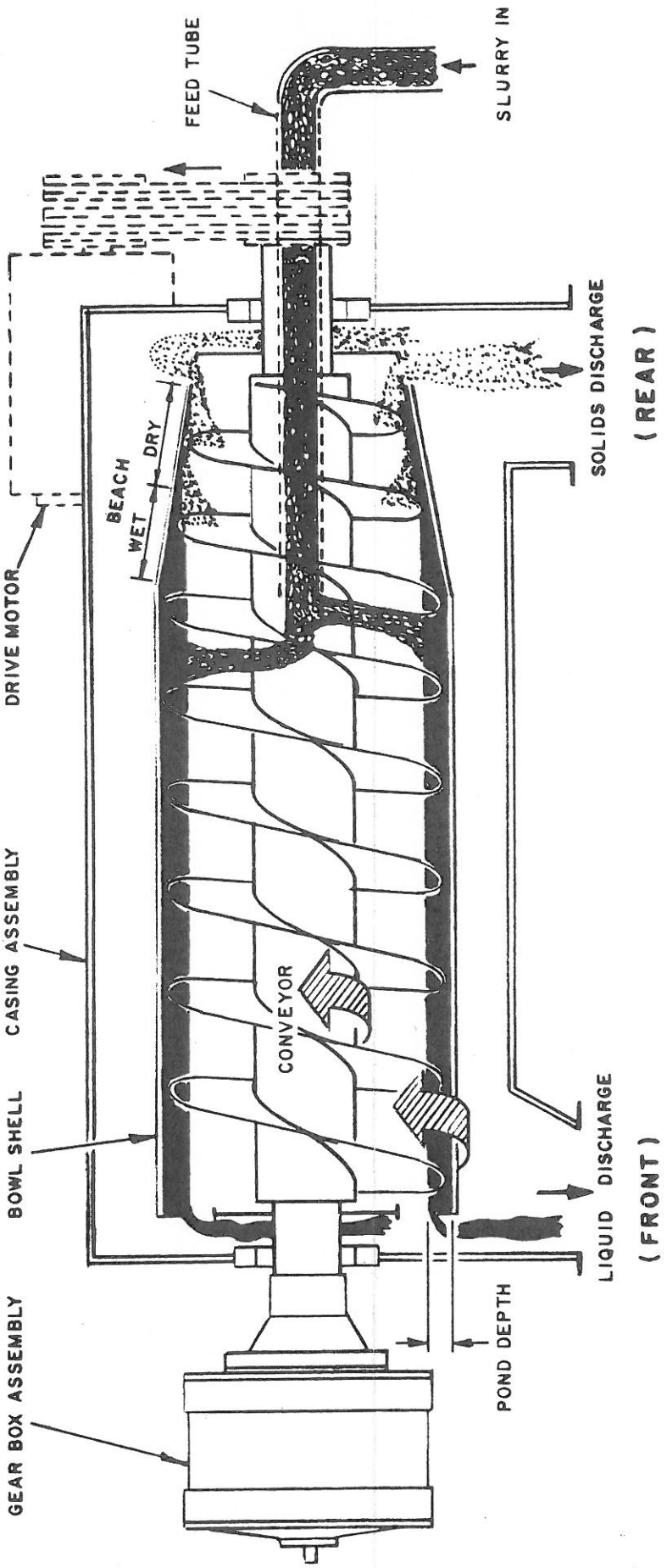
The optimum pond setting for each application can be determined only by taking into account the desired results, and by actual experience with the application.

C. BOWL SPEED

The centrifugal force of the bowl is a function of the product of the bowl diameter and the square of the rotational speed: Centrifugal Force = $(rpm)^2 \times$ (Bowl Diameter in inches) x (0.0000142). Since the diameter of the centrifuge bowl is fixed, the centrifugal force can be varied only by changing the rotational speed of the bowl.

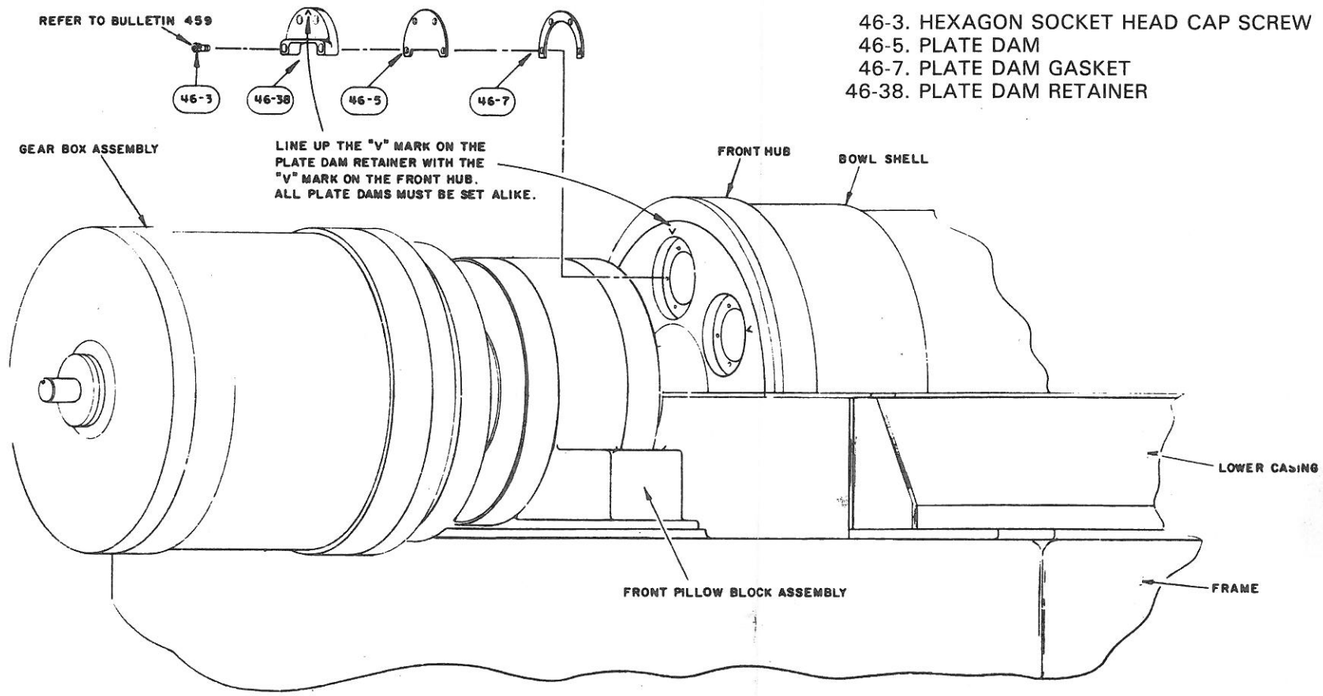
WARNING

THE MAXIMUM ROTATIONAL SPEED IS STAMPED ON THE NAMEPLATE OF EACH CENTRIFUGE AND MUST NEVER BE EXCEEDED.



5/2/1
5/2/2
5/2/3

CENTRIFUGE OPERATION
FIGURE 2-1



46-3. HEXAGON SOCKET HEAD CAP SCREW
46-5. PLATE DAM
46-7. PLATE DAM GASKET
46-38. PLATE DAM RETAINER

PLATE DAM ASSEMBLY
FIGURE 2-2

CHAPTER 3
INSTALLATION

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A. General Considerations 3-1
B. Installation of Centrifuge Vibration Mounts 3-2
C. Mounting of the Centrifuge 3-2
D. Connections and Piping Considerations 3-3
E. Electrical Considerations 3-4
Typical Feed Arrangements . . . . . Figure 3-1

A. GENERAL CONSIDERATIONS

Refer to typical installation drawing and Chapter 9.

1. Select a location where there is sufficient room around the centrifuge to safely disassemble it for maintenance, i.e., - end room to remove the feed tube, backdrive or torque control, gear box; and overhead room to remove the cover and lift the bowl assembly clear of any other machines and personnel.

2. Allow space on opposite sides of the centrifuge for the drive motor and lubrication system.

3. Provide an overhead track with a 7-1/2 ton hoist in line with the axis of the centrifuge for disassembly and reassembly of the gear box, bowl assembly, and pillow blocks during maintenance. Ideally, a bridge crane should be used to permit lifting of the drive assembly as well.

WARNING

THE 7-1/2 TON HOIST IS NOT ADEQUATE FOR LIFTING THE COMPLETELY ASSEMBLED CENTRIFUGE. A 15 TON HOIST IS NECESSARY FOR THIS.

4. Provide a level and adequate foundation of concrete or structural steel.

5. Vibration isolators are supplied and must be properly installed beneath the centrifuge frame and motor bracket.

6. All piping to centrifuge must have flexible connections at centrifuge.

B. INSTALLATION OF CENTRIFUGE VIBRATION MOUNTS

Refer to the certified dimension and installation drawings submitted earlier and Figure 9-1 of Chapter 9.

1. Locate the anchor bolts as recommended on the dimension drawing.

2. Loosen the snubber adjustment bolts on the vibration isolators until the side compression plate is not binding the snubber.

3. Position the two centrifuge mounting plates (128) on the foundation. Secure in place with anchor bolts. These plates must be level and on the same plane with each other within 1/32''.

NOTE
Shim under mounting plate if necessary.

4. Install the four vibration isolators (115) on the mounting plates (128). Secure with screws and washers (126,89).

C. MOUNTING OF THE CENTRIFUGE

(Refer to Chapter 9 for mounting of the drive motor).

1. If rotating assembly was shipped mounted on centrifuge frame, remove it—refer to Chapter 11.

2. Lower the centrifuge frame until it rests on the four vibration isolators. See figure 10-1 for proper lifting of frame.

   Figure 9-1:

3. Secure the centrifuge frame to the vibration isolators with screws and washers (116, 117).

   Figure 10-1:

4. Install frame liners (19), retainers (67,70), back-up plates (65), and associated hardware as shown on drawing.

5. Reinstall rotating assembly - refer to Chapter 11.

   Figure 9-2:

6. Screw the leveling bolt of the centrifuge vibration isolator until contact is made with the compression plate and the top plate starts to rise and lift the centrifuge frame.

   Do this alternately to all isolators until the clearance between the top plate and the base housing, dimension 'X' is a minimum of 3/8 inch.

7. Place a machinist level on top of the bowl at the center of its length and screw down the leveling bolt (s) until the lower corners of the centrifuge are brought up to level. Check for side-to-side levelness by placing the level on the diagonal corners of the machined surface of the frame.

8. After the centrifuge is level, the leveling bolts must be locked by jam nuts. The snubber adjustment bolts must be torqued to 20 ft. lb. and locked by jam nuts.

D. CONNECTIONS AND PIPING CONSIDERATIONS

Refer to the certified dimension and installation drawings submitted earlier, and Figure 3-1.

1. Select a slurry feed system to the centrifuge to suit the individual application requirements. Three typical systems are shown in Figure 3-1.

2. Use only flexible connections between the following:

   a. Customer feed line to centrifuge feed tube.

   b. Customer flush line to centrifuge casing flush connection.

   c. Customer rinse and polymer line (if supplied) to centrifuge feed tube.

   d. Customer extension to centrifuge liquid discharge port of casing.

   e. Customer extension to centrifuge solids discharge port of casing.

NOTE

Rigid connections will not stand up to the stresses created from the motions inherent in centrifugal operation and will crack if connected directly to the centrifuge. Rigid connections can also cause rough running and could possibly cause damage to the centrifuge, and structural damage to floors, etc. All flexible connections must allow ± 1/4 inch free vertical and horizontal movement at a rest position.

3. Vent in accordance with typical installation drawing. Consult Pennwalt Sharples process engineering for specific venting applications.

4. Piping connected to the lower end of the liquid discharge extension must have a minimum of 1/4 inch per foot downward pitch. See typical installation drawing for recommended run length.

5. If a casing flush or feed tube and polymer rinse is used, install a manual control valve in the customer flush lines. If desired, a flow meter may also be provided.

6. If the customer feed line includes a connection for flushing out the bowl and conveyor when the run is completed, this flush line should have a check valve to prevent solids from plugging it when not in use.

7. Piping and filtering must be installed to provide water circulation to and from the lubrication system heat exchanger and, if required, to backdrive. Refer to dimension sheet for specific requirements.

8. On outdoor installations, provide a drain on the heat exchanger. This is to enable the system to be drained of water if the temperature is below freezing and the centrifuge is at rest.

9. Supply oil and return oil flexible lines are provided between the oil lubrication system and the front and rear pillow block bearings. These must be connected before operating.

E. ELECTRICAL CONSIDERATIONS

Wire in accordance with Pennwalt wiring diagram submitted earlier, national and local electrical codes, and the following:

1. Because of the high starting current of the centrifuge motor, use wire a size larger than indicated by the motor's full load current rating. Select wire size in accordance with the local codes. Wiring to the centrifuge motor must permit motor to move on its sliding base.

WARNING

IF INSTALLATION IS IN A HAZARDOUS LOCATION, THE SEAL FITTINGS ARE LEFT UNSEALED SO THE PURCHASER CAN MAKE FINAL CONNECTIONS. CHICO X FIBER PACKING AND CHICO A SEALING COMPOUND ARE SUPPLIED WITH THE EQUIPMENT. IT WILL BE THE RESPONSIBILITY OF THE PURCHASER TO PROPERLY SEAL ALL EXPLOSION PROOF FITTINGS AFTER THE FINAL CONNECTIONS ARE MADE.

2. The control starts the centrifuge on Wye motor connections and an acceleration timer is set to shift to Delta connections when full speed is reached—a drop in current reading on the ammeter indicates that operating speed has been reached. Set the timer for approximately ten minutes for the first start. Reset timer after acceleration time is determined. Do not feed until the motor is on Delta.

NOTE

The motor is provided with thermal protectors against overheating as warranted by the motor manufacturer. They should open on too frequent starting of the motor.

3. The motor is capable of making two starts in succession:

   a. With the motor initially at ambient temperature, if a cold false start is made, the motor can be restarted while the centrifuge is still coasting or after it has come to a complete stop.

   b. A hot start can be made after the surface of the motor has cooled to an ambient temperature not exceeding its rated load operating temperature as listed on the nameplate. Care must be taken so the inertia of the load, the torque load, voltage, and the method of starting are those for which the motor was designed.

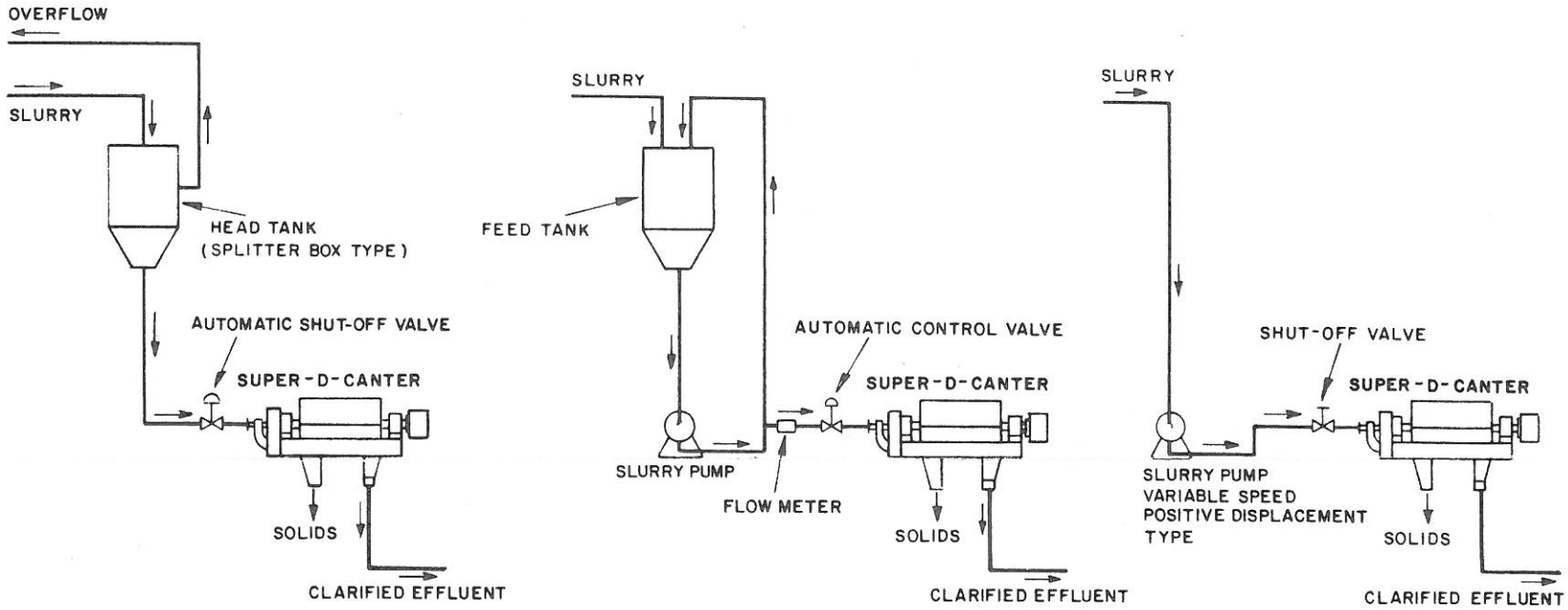
4. More than two starts within an hour may damage the motor i.e., between multiple starts allow one-half hour running time, or one hour rest time-rest time includes deceleration plus idle time.

5. Wire the control so the centrifuge motor cannot be started until the lubrication system is first placed in operation. The centrifuge feed system should be arranged to stop or divert the feed on the occurrence of a fault. An alarm system can be wired in the circuit to alert the operator in the event this occurs.

6. Make temporary wire connections first, then momentarily start the centrifuge motor to check the direction of rotation (which must be clockwise when viewed from the pulley end). If the direction is wrong, change the connections and recheck. Make permanent connections when direction is correct.

7. Wire the lubricating oil pump to rotate clockwise when viewed from the fan end of the motor.

8. It is advisable to connect two ammeters in the line to the motor. Locate one ammeter near the machine and mount the second in the door of the control unit. By checking the ammeter reading periodically, it is possible to determine whether the machine is overloaded or not. A higher than rated running current would mean overloading, and the feed should be reduced.



NOTE

1. FEED SYSTEMS IN ORDER OF PREFERENCE ARE :
   A. DIRECT FEED
   B. CIRCULATING FEED
   C. GRAVITY HEAD TANK

TYPICAL FEED ARRANGEMENTS
FIGURE 3-1

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CHAPTER 4
INSTALLATION CHECKLIST

After the centrifuge and associated equipment are installed, it is recommended that before actual startup, the following "Installation Checklist" be carefully reviewed and checked off, item by item, as complete and satisfactory.

Doing this will prevent oversights that could cause delay, or damage to the equipment.

Item	Date Approved	Inspector Initials	Remarks

A. GENERAL

1. Sufficient end room to remove gear box, feed tube, backdrive, etc.
2. Sufficient overhead room to hoist rotating assembly clear of other equipment and personnel
3. Foundation is level
4. Vibration isolators are properly installed and snubber adjusting screws are properly tightened
5. Recommended 5 ton maintenance hoist is available
6. Pulleys are aligned and parallel. Belts properly tensioned
7. Feed tube is secure
8. Backdrive assembly is properly installed
9. Jack shaft-gear box coupling is aligned
10. System has automatic feed shutoff

B. ELECTRICAL

1. Only flexible conduit is used for drive motor leads
2. Drive motor starts on Wye and shifts to Delta when full speed is reached (Acceleration timer properly set)
3. Motor direction, both Wye and Delta, is clockwise when viewed from pulley end
4. Fault detector system (if supplied) is operational
5. Lubricating oil pump direction is counter-clockwise when viewed from pump end. (Suction on left side)
6. Flow eye alarms are set
7. Backdrive panel is properly wired
8. Ammeter is connected only to delta line

Item	Date Approved	Inspector Initials	Remarks

C. PIPING AND CONNECTIONS

1. A steady flow of cooling water is supplied to heat exchanger
2. Customer discharge extensions are supported independently by the building structure
3. Customer discharge extensions are connected to the centrifuge only with flexible connections
4. All customer extensions are properly vented
5. All customer rinse and flush lines have flexible connections to the centrifuge
6. Nothing rigid connected to centrifuge

D. LUBRICATION

Refer to separate bulletin.

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CHAPTER 5
OPERATION CHECKLIST

To increase efficiency and prevent oversights that could cause delay or damage to equipment, it is highly recommended that operators become familiar with, and use the following checklist before beginning work.

NOTE

Greasing intervals for conveyor bearings vary with customer process. Refer to separate lubrication bulletin for specific intervals. At the same time grease backdrive jackshaft bearings and drive motor bracket hinge pins.

DAILY

1. Check for cleanliness around centrifuge—noting oil spills, grease spots, liquid spills, etc.
2. Check for excessive vibration with machine empty and machine on stream
3. Check for excessive bearing noise
4. Check for loose fasteners
5. Check that the lube oil flow eyes register proper flow—75% to 100%
6. Check that the pressure gauge registers approximately 15 psi
7. Check that temperature of oil to bearings does not exceed 100°F
8. Check that temperature of oil from bearings does not exceed 155°F
9. Check for oil leaks from gear box, hoses, etc.
10. Check ammeter readings
11. Check for general condition of vibration isolators—springs for breakage and snubber properly set
12. Check flexible connectors for deterioration
13. Check lamps of fault lights by depressing RESET/LAMP TEST pushbutton
14. Check that backdrive is operative

WEEKLY

Check lubricating oil reservoir level

MONTHLY

1. Check for abrasion on hydraulic hoses
2. Check that centrifuge is level. Readjust vibration isolators if necessary
3. Remove feed tube and check that it is not clogged. At the same time look into the interior of the machine and check for material packing

THREE MONTHS

1. Review operation procedures
2. Review and/or retrain maintenance and operating personnel
3. Initially check for conveyor wear. After this period experience should dictate inspection intervals. Each time conveyor is removed, conveyor bearings and seals must be replaced
4. Check gear box oil level

SIX MONTHS

1. Change gear box oil every six months for 24 hour per day operation; yearly for one shift per day operation—Refer to chapter 12
2. Change oil and filter in the lubrication system. Clean strainers
3. Check drive belt tension—Refer to chapter 9

YEARLY

Replace seals and bearings on conveyor

TWO YEARS

Clean gear box, replace seals, O-rings, and anti-friction bearings

THREE YEARS

Clean lubrication oil reservoir

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CHAPTER 6
CENTRIFUGE TROUBLESHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
1. Centrifuge will not start	Vibration switch tripped	Reset switch
	No power or blown fuse	Check power source; check fuse
	Motor starter failure	Repair or replace starter
	Motor failure	Repair motor
	Motor overheated	Cool, restart, trace cause
	Lubricating oil flow switch tripped	Refer to lubrication system remedies
2. Centrifuge shuts down	Blown fuse	Replace fuse
	Overload relays tripped	Reset relays
	Drive motor or backdrive motor overheated	Cool and trace cause
	Vibration switch tripped	Reset, trace cause
	Lubricating oil flow switches or oil temperature switches tripping	Refer to lubrication system remedies
3. Excessive vibration	Vibration isolator	Check for improper adjustment
	Flexible piping not used where required	Install flexible piping
	Conveyor flights plugged with solids	Flush out conveyor
	Gear box and gear box adapter misaligned	Correct alignment
	Pillow block bearings damaged	Replace bearings
	Conveyor bearings damaged	Replace bearings
	Loose components	Tighten components
	Bowl or conveyor out of balance due to wear	Repair; rebalance by Pennwalt

TROUBLE	PROBABLE CAUSE	REMEDY
4. Incomplete clarity or dryness	Wrong pond depth chosen	Re-evaluate
	Conveyor flights worn	Repair or replace
	Feed temperature too low	Adjust temperature
	Feed rate too high	Adjust feed rate
5. Centrifuge shutdown resulting from lubrication system	Filter element clogged	Replace filter
	Strainers plugged	Clean strainers
	Dirt in pillow block oil nozzles	Clean nozzles
	Oil temperature too high	Check for pillow block bearing failure
6. Torque monitoring device trips	Feed rate too high	Adjust feed rate
	Solids concentration too high	Reduce solids concentration
	Foreign material lodged in bowl	Remove all foreign matter

The following are supplied with the centrifuge:

1. Tension Bar Wrench:
   Removal and installation of tension bar nut
2. Bowl Rear Hub Nut Wrench:
   Removal and installation of rear hub nut
3. Bearing Puller:
   Removal of pulley thrust bearing
4. Dowel Pin Extractor
5. Dowel Pin Sleeve Extractor
6. Tension Bar Protecting Cap
7. Gear Box Adapter Removal Aids:
   Reducer, Hose, Adapter, Pump, Oil, Gauge
8. Pillow Block Bearing Removal Aids:
   Bearing Remover Assembly, Hydraulic Cylinder, Adapter, Pump, Oil, Gauge, Hoses, Tee, Eyebolt

The following are supplied as options:

1. Bowl Truck
2. Bowl Lifter
3. Conveyor Lifter
4. Puller for Conveyor Front Bearing Seal Holder

The following are hardened steel, square head, half-dog-point set screws to be used for jacking purposes mentioned in the disassembly procedures of the maintenance section:

SIZE AND USE	QUANTITY
5/8'' - 11 x 3½''	
Remove Pillow Block Covers	4
Remove Bowl Front Hub	4
¾'' - 10 x 6''	
Remove Rear Hub	6
Remove Gear Box Adapter from Gear Box	6
Remove Spline Bushing	6
½'' - 13 x 8½''	
Remove Pulley	4

SIZE AND USE	QUANTITY
$^{5}/_{8}$'' - 11 x 8½''	
Remove Gear Box Adapter from Front Hub	4
½'' - 13 x 3½''	
Remove Conveyor Front Bearing Hub	4
Remove Tension Bar	4
$^{3}/_{8}$'' - 16 x 1½''	
Remove Conveyor Rear Bearing Seal Holder	4

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CHAPTER 8
MAINTENANCE CAUTIONS AND GUIDELINES

A. GENERAL

1. Do not interchange components which are part of a balanced assembly.
2. Torque all screws used on rotating assemblies as recommended on the Seating Torque Chart, Bulletin 459.
3. Before reassembly, inspect all parts and replace as required.
4. Before disassembly and assembly, always refer to the drawing that illustrates the recommended lifting points and weight of each item.
5. Do not remove any parts by striking them with a hammer or other tool. All tight-fitting parts are designed to be removed using either jackscrews, pullers, or special Pennwalt tools.

B. BEARINGS

1. The inner race and outer race of a bearing must be replaced as a set.
2. Properly lubricate all bearings before placing the centrifuge in operation.
3. When heating bearings in oil to install, do not exceed a temperature of 212°F. Use a thermometer to check oil temperature.
4. New bearings are treated with slushing compound, carefully wrapped, and boxed to preserve this coating. Keep all spare bearings in their original container without opening in an environmentally controlled area. Do not wash with solvent before installing.

C. SEALS

1. Only Kimwipe tissue or equivalent and acetone may be used to wipe the mating faces of mechanical seals. Handle seals with care and AVOID TOUCHING the sealing surfaces. Keep wrapped in soft tissue until needed.
2. Be sure lip seals are installed in the proper direction. Make sure sealing surface is free of nicks.

D. LUBRICATION

For easier assembly, lubricate o-rings with Pennwalt Keystone grease before installing.

E. CLEANING

1. All assembly procedures, especially bearing and seal replacement, must be performed in a clean area; if possible, in a dust free room.
2. Opened bearings, or any parts that have been cleaned, should be kept covered until needed.
3. Before reassembly, all parts, except bearings and seals, must be cleaned in a suitable solvent.
4. Make sure all threads and pilot diameters are wiped clean of dirt. Apply "Never-Seez" or equivalent anti-galling compound to all screws and pilot diameters before assembling.

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1. Install Drive Assembly 9-1
2. Adjust Vibration Isolators 9-1
3. Inspect Pulleys 9-2
4. Align Pulleys 9-2
B. Drive Belt Installation and Tensioning Procedure (Power Bands Only) 9-2
C. Drive Belt Installation and Tensioning Procedure (Single Strand Set) 9-3
D. Belt Troubleshooting 9-4
E. Installation of Backdrive (If Supplied) 9-4
F. Sequence of Operation 9-4
Drive Assembly . . . . . Figure 9-1
Vibration Isolator . . . . . Figure 9-2
Belt Tensioning . . . . . Figure 9-3

A. INSTALLATION

Figure 9-1

1. Install Drive Assembly:
   a. Prepare the foundation for the drive assembly in accordance with the dimension sheet supplied. Anchor bolt hole layout is *critical.* Tolerance given on the dimension sheet must be adhered to.
   b. Position the two drive assembly mounting plates (127) on the foundation. Secure in place with anchor bolts. These plates must be level and on the same plane with each other within 1/32".

NOTE
Shim under mounting plate if necessary.

   c. With the rubber sound pads under the bases, install the four vibration isolators (35) on the mounting plates (127). Secure with screws and washers (126, 89).
   d. Lift the drive assembly and set it on vibration isolators (35). Secure with screws and washers (88, 89).

2. Adjust Vibration Isolators:

Figure 9-2:

   a. Screw the leveling bolt of the isolator until contact is made with the top plate and the top plate starts to rise and lift the motor bracket.

Do this alternately to the four isolators until the clearance between the top plate and the base housing, dimension "X", is a minimum of 3/8 inch.

b. Screw the leveling bolt of the isolators until the motor bracket is level.

c. After the motor bracket is level, torque the snubber adjustment nuts to 20 ft. lb. and lock with jam nut.

3. Inspect Pulleys:

   a. Worn grooves, burrs, rough spots, dirt, oil, rust, pitting, etc., can damage belts.

   b. Proper alignment of the centrifuge pulley and the drive motor pulley is essential to longer belt life.

   c. Keys must be seated.

   d. Bushings must be securely fastened.

4. Align Pulleys:

   Figure 9-1.

   a. Line up edges of drive motor pulley (51) with centrifuge pulley.

   b. If the pulleys are lined up properly, the straight edge will touch them at the points indicated by the arrows.

   c. Rotate each pulley to check there is no distortion of pulley or driveshaft.

B. DRIVE BELT INSTALLATION AND TENSIONING PROCEDURE (POWER BANDS ONLY)

Figure 9-1:

NOTE

When replacing belts, it is first necessary to remove guard assembly (31).

1. Loosen nuts (77) on T-slot bolts (5).

2. Loosen inner nuts of spherical flange assembly (65). Tighten each outer nut an equal distance until sheave center distance is reduced to a point where belts can easily be slipped on sheaves. Forcing the belts can damage the load carrying cords and cause premature belt failure.

NOTE

The belts are a matched set. Always check for matching before installing belts. When replacing belts, always replace the set.

3. Take up slack on belt. Do this by evenly tightening the inner nuts of the spherical flange assembly (65).

4. Measure belt span — see Figure 9-3, sheet 2.

Figure 9-3:

5. Mount a dial indicator as shown.

6. Set the dial indicator at zero.

7. With a person at each spherical flange assembly, simultaneously tighten inner nuts 1/2 turn or until 0.050 inch maximum travel on indicator dial is read.

8. Tighten nut (107) of tensioner assembly until dial indicator once again reads zero.

9. Repeat steps 7 and 8 as many times as necessary until proper tension is achieved. This is measured as follows:

   Figure 9-3, Sheet 2:

   a. Place a flat metal plate (3" x 2-3/4" x 1/8") on top of one belt, located at the center of the belt span.

   b. A 30 pound force applied to the center of the plate should deflect the belt 1/128 times center distance (measured from top of adjacent belt to top of belt being deflected downward) when proper static tension is reached.

10. Lock nuts of spherical flange assembly (65).

11. Snug only nuts (77) on bolts (5).

12. Maintain gaps of 1/8 inch to 1/4 inch between nuts (103) and cylinder assembly (98) and nut (103), and bracket (110). Tighten set screws (105).

13. Observe tension value indicated on belt tensioner assembly. Record this number. When retensioning or replacing belts, tension to this number. Procedure of measuring deflection and static force is not necessary once tension value is established.

14. Reinstall belt guard assembly (31).

NOTE

There is normally a drop in tension during the first 24 to 48 hours of operation. During this "run-in" period, the belts seat in the pulley grooves and the initial stretch takes place. After a day or two, the drive should be stopped and another check made for the correct amount of tension.

C. DRIVE BELT INSTALLATION AND TENSIONING (SINGLE STRAND SET)

Belt installation and tensioning is same as power bands (Paragraph B) except determine initial deflection and static force as follows:

Figure 9-1, Sheet 2:

1. Tension the belts until they are snug.

2. Measure the belt span as shown.

3. Multiply the span by 1/64 inch. The result is called dimension "X" for reference.

4. Using a spring scale, pull down on one of the belts at the midpoint of its span. Measure the force required to deflect the belt to the dimension determined in step 3. (dimension "X").

5. Typical belt deflection force for "5V" belt sections to derive at dimension "X" is 15 pounds.

D. BELT TROUBLESHOOTING

Problem	Possible Cause
1. Speed Loss	Improper Belt Tension
2. Abnormal Wear	Pulleys Misaligned Improper Belt Tension
3. Belt Softening	Oil or Chemical Contamination
4. Belt Hardening and Cracking	Excessive Heat or Cold Chemical Contamination
5. Belt Slap	Improper Tension Pulleys Misaligned

E. INSTALLATION OF BACKDRIVE (IF SUPPLIED)

Refer to separate bulletin.

F. SEQUENCE OF OPERATION

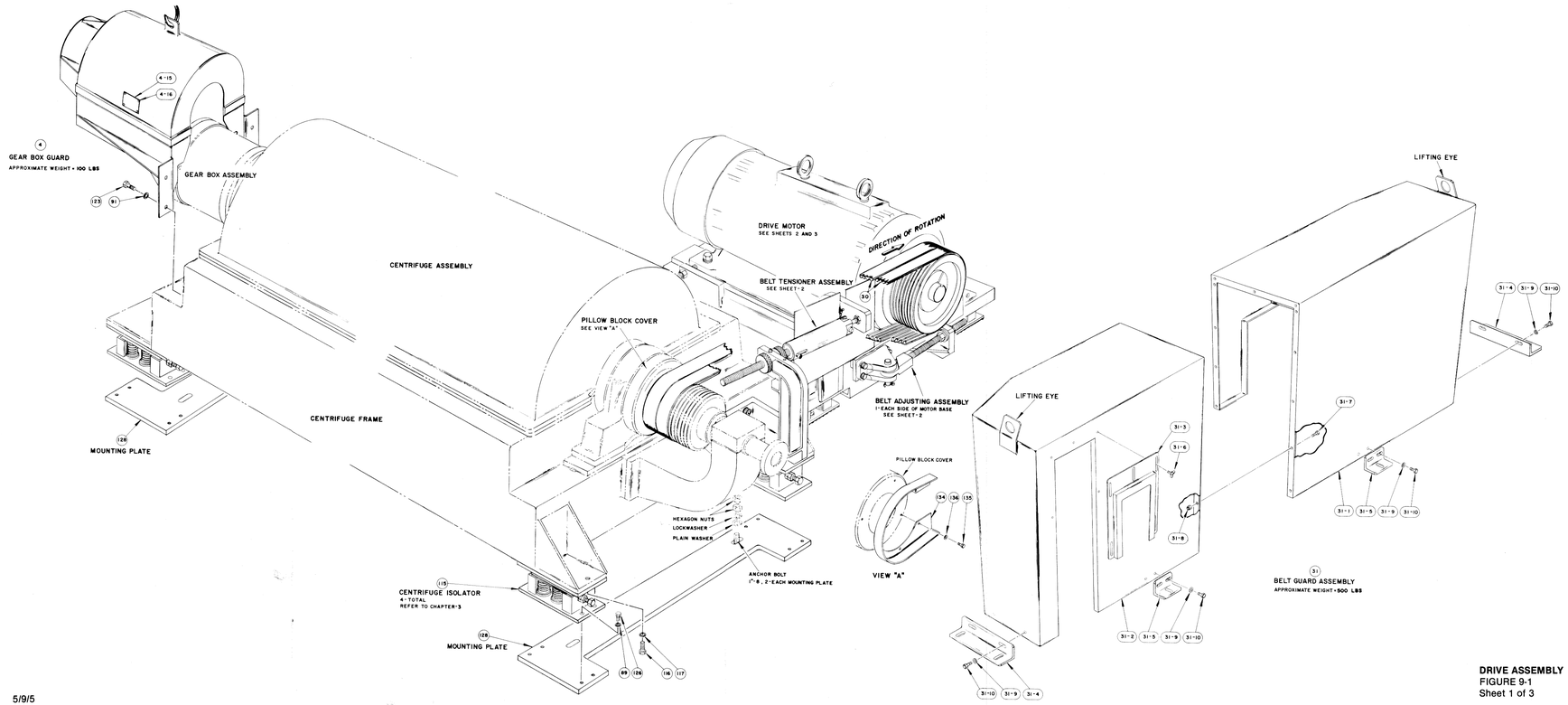
Refer to Bulletin 515.

REFERENCE
(F-3385)

30. Drive Belt Set
31. Belt Guard Assembly
31-1. Belt Guard Right Hand End
31-2. Belt Guard Left Hand End
31-3. Adjustable Side Cover
31-4. End Mounting Foot
31-5. Front Mounting Foot
31-6. Wing Screw (1/4" - 20 x 1/2")
31-7. Hexagon Head Cap Screw (3/8" - 16 x 3/4")
31-8. Hexagon Nut (3/8" - 16, "Flexloc")
31-9. Plain Washer (1/2")
31-10. Hexagon Head Cap Screw (1/2" - 13 x 1-1/4")
89. Lockwasher (5/8")
116. Hexagon Head Cap Screw (3/4" - 10 x 2")
117. Lockwasher (3/4")
126. Hexagon Head Cap Screw (5/8" - 11 x 1-1/2")
128. Centrifuge Mounting Plate
134. Pulley Guard
135. Hexagon Head Cap Screw (3/8" - 16 x 3/4")
136. Lockwasher (3/8")

REFERENCE
(R-601)

4. Gear Box Guard
4-15. Nameplate
4-16 Drive Screw (#6 x 1/4")
91. Lockwasher (3/4")
115. Centrifuge Vibration Isolator
123. Hexagon Head Cap Screw (3/4" - 10 x 1-3/4")



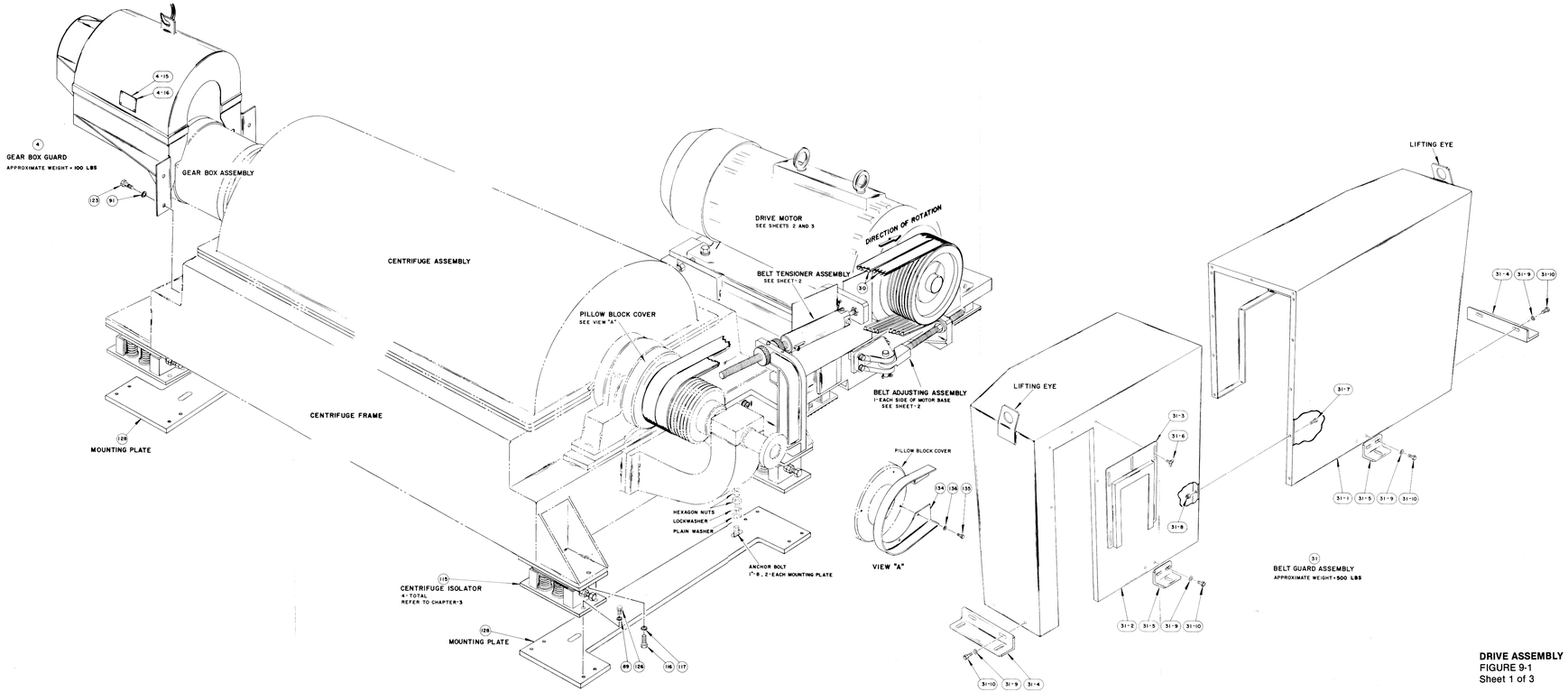
DRIVE ASSEMBLY
FIGURE 9-1
Sheet 1 of 3

REFERENCE
(F-3385)

30. Drive Belt Set
31. Belt Guard Assembly
31-1. Belt Guard Right Hand End
31-2. Belt Guard Left Hand End
31-3. Adjustable Side Cover
31-4. End Mounting Foot
31-5. Front Mounting Foot
31-6. Wing Screw (1/4" - 20 x 1/2")
31-7. Hexagon Head Cap Screw (3/8" - 16 x 3/4")
31-8. Hexagon Nut (3/8" - 16, "Flexloc")
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31-10. Hexagon Head Cap Screw (1/2" - 13 x 1-1/4")
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116. Hexagon Head Cap Screw (3/4" - 10 x 2")
117. Lockwasher (3/4")
126. Hexagon Head Cap Screw (5/8" - 11 x 1-1/2")
128. Centrifuge Mounting Plate
134. Pulley Guard
135. Hexagon Head Cap Screw (3/8" - 16 x 3/4")
136. Lockwasher (3/8")

REFERENCE
(R-601)

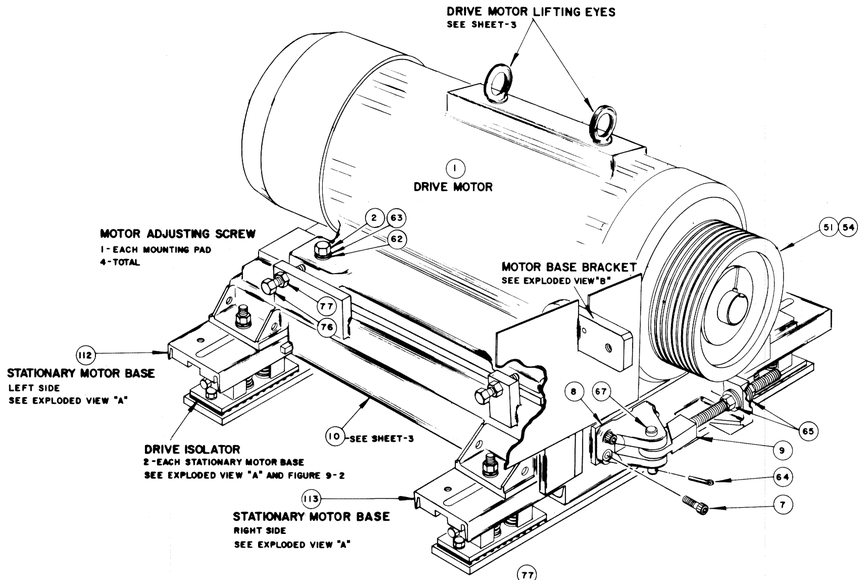
4. Gear Box Guard
4-15. Nameplate
4-16 Drive Screw (#6 x 1/4")
91. Lockwasher (3/4")
115. Centrifuge Vibration Isolator
123. Hexagon Head Cap Screw (3/4" - 10 x 1-3/4")



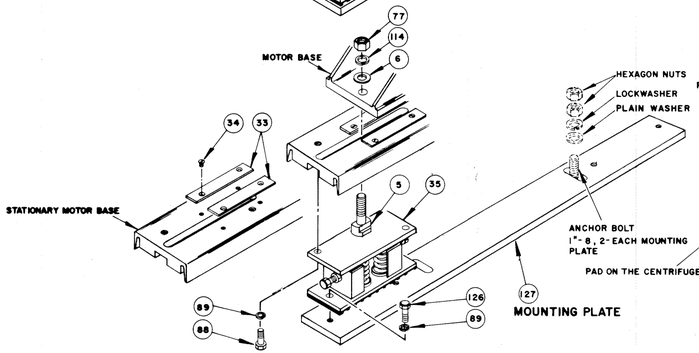
DRIVE ASSEMBLY
FIGURE 9-1
Sheet 1 of 3

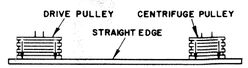
REFERENCE
(F-3385)

1. Drive Motor
2. Hexagon Head Cap Screw (7/8″ - 9 x 3-1/4″)
3. Lockwasher (3/4″)
5. T-Slot Bolt (1″ - 8)
6. Washer (1″, Special)
7. Hexagon Socket Head Cap Screw (3/4″ - 10 x 1-1/2″)
8. Adjusting Rod Bracket
9. Adjusting Rod
10. Motor Base and Bracket Assembly
33. Stationary Base Pad
34. Flat Head Machine Screw (1/4″ - 20 x 3/4″)
35. Drive Assembly Vibration Isolator
49. Dowel Pin (3/4″ Dia. x 2″)
51. Motor Pulley
54. Pulley Bushing
62. Plain Washer (7/8″)
63. Lockwasher (7/8″)
64. Cotter Pin (3/16″ Dia. x 1-1/2″)
65. Spherical Flange Assembly
67. Clevis Pin
76. Adjusting Bolt (1″ - 8, Special)
77. Hexagon Nut (1″ - 8)
88. Hexagon Head Cap Screw (5/8″ - 11 x 1-3/4″)
89. Lockwasher (5/8″)
91. Cotter Pin
92. Chain (8″ Long)
93. Nut (7/8″ - 14, Flexloc)
94. Spherical Rod End
95. Ball Loc Pin
96. Grease Fitting (1/8″ N.P.T.)
97. Sleeve
98. Cylinder Assembly
99. Belleville Spring
100. Spacer
101. Belt Tensioning Piston Bearing
102. Shoulder Screw (5/8″ Body x 1/2″ - 13)
103. Locknut
104. Nylon Plug
105. Hexagon Socket Headless Set Screw (3/8″ - 16 x 3/4″)
106. Belt Tensioning Piston
107. Hexagon Nut (1-1/2″ - 6)
108. Bearing Support
109. Spherical Bearing
110. Belt Tensioning Bracket
111. Hexagon Socket Head Cap Screw (3/4″ - 10 x 2-3/4″)
112. Stationary Motor Base (Left)
113. Stationary Motor Base (Right)
114. Lockwasher (1″)
126. Hexagon Head Cap Screw (5/8″ - 11 x 1-1/2″)
127. Drive Assembly Mounting Plate



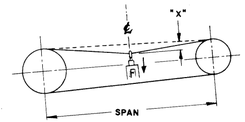
EXPLODED VIEW "A"



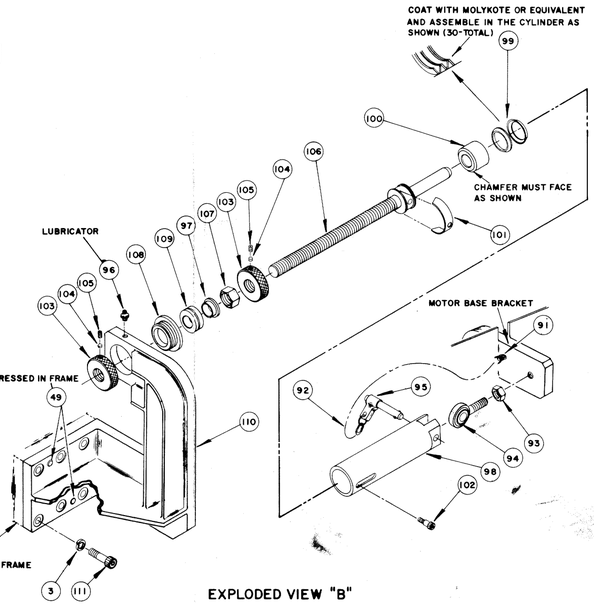


NOTE
IF THE PULLEYS ARE PROPERLY ALIGNED, THE STRAIGHT EDGE WILL TOUCH AT THE POINTS INDICATED BY THE ARROWS.

PULLEY ALIGNMENT



BELT TENSIONING

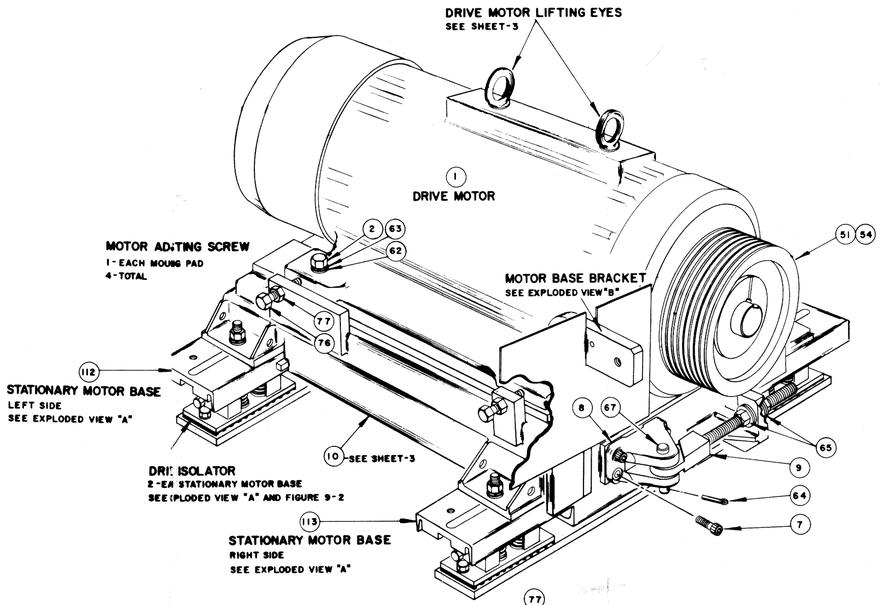


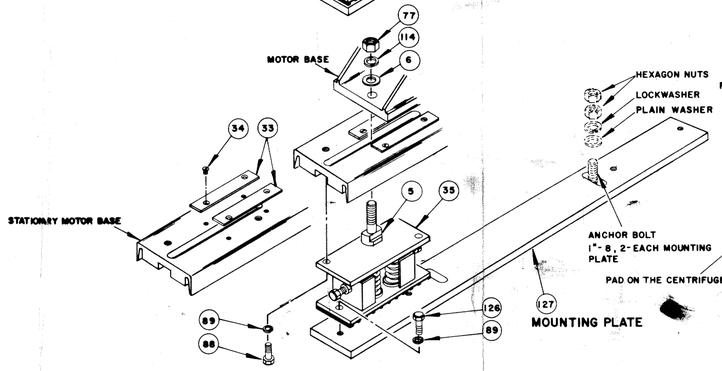
EXPLODED VIEW "B"

DRIVE ASSEMBLY
FIGURE 9-1
Sheet 2 of 3

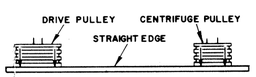
REFERENCE
(F-3385)

1. Drive Motor
2. Hexagon Head Cap Screw (7/8″ - 9 x 3-1/4″)
3. Lockwasher (3/4″)
5. T-Slot Bolt (1″ - 8)
6. Washer (1″, Special)
7. Hexagon Socket Head Cap Screw (3/4″ - 10 x 1-1/2″)
8. Adjusting Rod Bracket
9. Adjusting Rod
10. Motor Base and Bracket Assembly
33. Stationary Base Pad
34. Flat Head Machine Screw (1/4″ - 20 x 3/4″)
35. Drive Assembly Vibration Isolator
49. Dowel Pin (3/4″ Dia. x 2″)
51. Motor Pulley
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62. Plain Washer (7/8″)
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64. Cotter Pin (3/16″ Dia. x 1-1/2″)
65. Spherical Flange Assembly
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76. Adjusting Bolt (1″ - 8, Special)
77. Hexagon Nut (1″ - 8)
88. Hexagon Head Cap Screw (5/8″ - 11 x 1-3/4″)
89. Lockwasher (5/8″)
91. Cotter Pin
92. Chain (8″ Long)
93. Nut (7/8″ - 14, Flexloc)
94. Spherical Rod End
95. Ball Loc Pin
96. Grease Fitting (1/8″ N.P.T.)
97. Sleeve
98. Cylinder Assembly
99. Belleville Spring
100. Spacer
101. Belt Tensioning Piston Bearing
102. Shoulder Screw (5/8″ Body x 1/2″ - 13)
103. Locknut
104. Nylon Plug
105. Hexagon Socket Headless Set Screw (3/8″ - 16 x 3/4″)
106. Belt Tensioning Piston
107. Hexagon Nut (1-1/2″ - 6)
108. Bearing Support
109. Spherical Bearing
110. Belt Tensioning Bracket
111. Hexagon Socket Head Cap Screw (3/4″ - 10 x 2-3/4″)
112. Stationary Motor Base (Left)
113. Stationary Motor Base (Right)
114. Lockwasher (1″)
126. Hexagon Head Cap Screw (5/8″ - 11 x 1-1/2″)
127. Drive Assembly Mounting Plate



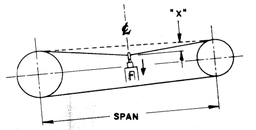


EXPLODED VIEW "A"

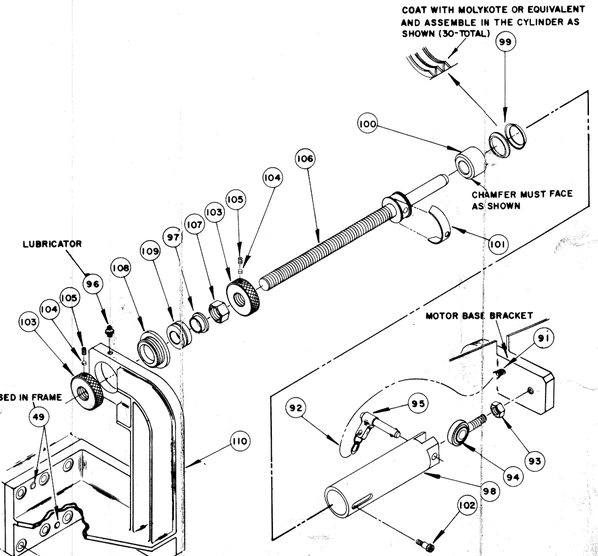


NOTE
IF THE PULLEYS ARE PROPERLY ALIGNED, THE STRAIGHT EDGE WILL TOUCH AT THE POINTS INDICATED BY THE ARROWS.

PULLEY ALIGNMENT

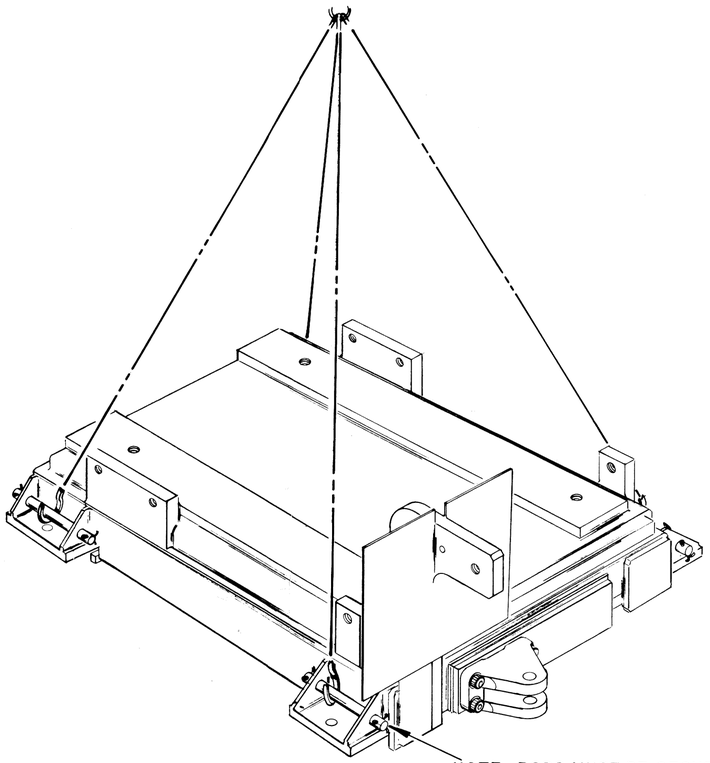


BELT TENSIONING



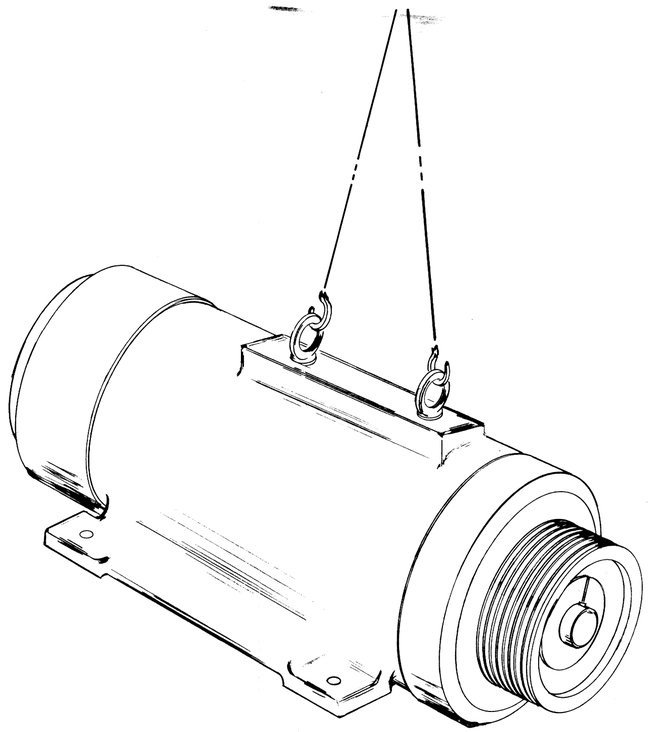
EXPLODED VIEW "B"

DRIVE ASSEMBLY
FIGURE 9-1
Sheet 2 of 3

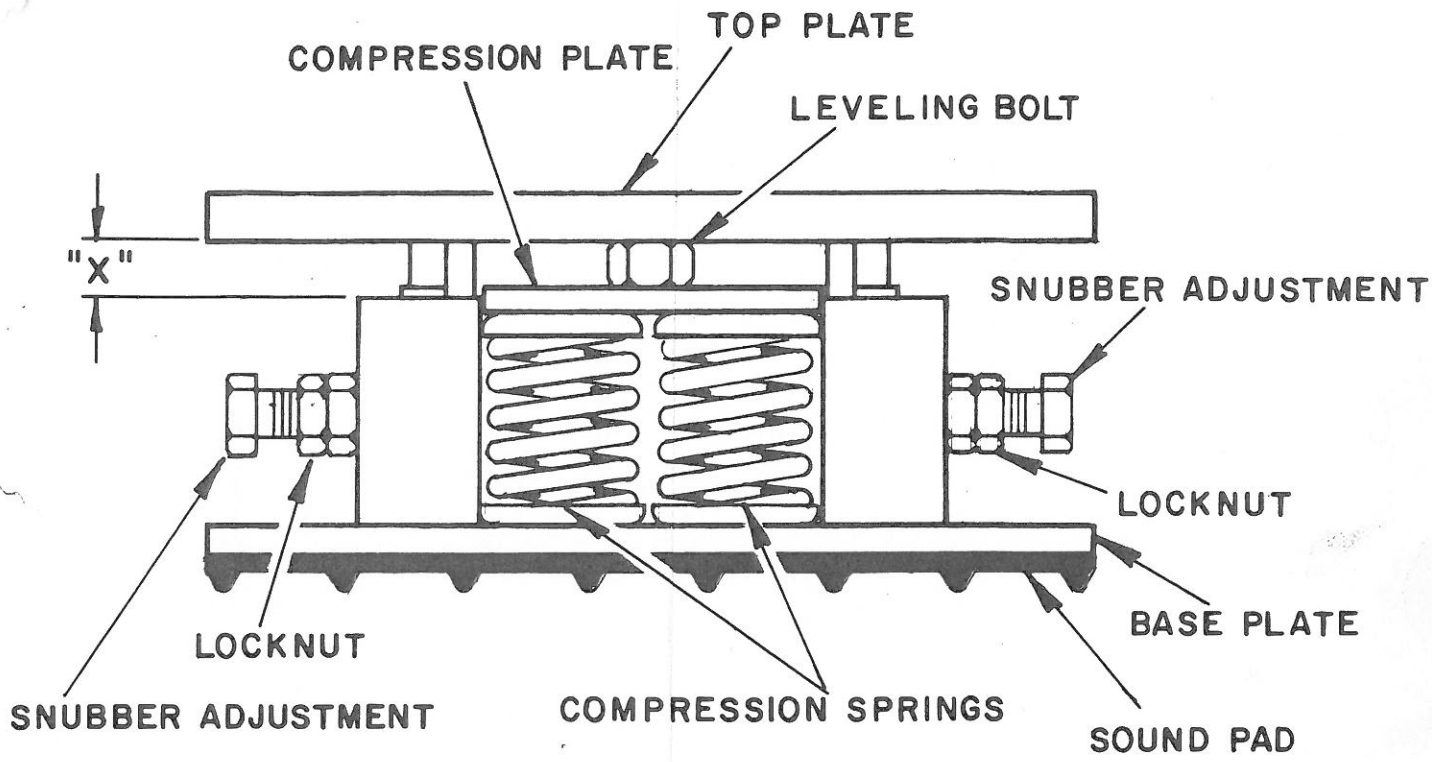


NOTE - RODS MUST BE SECURED WITH PINS AS SHOWN .
(TYPICAL FOR ALL 4 RODS)

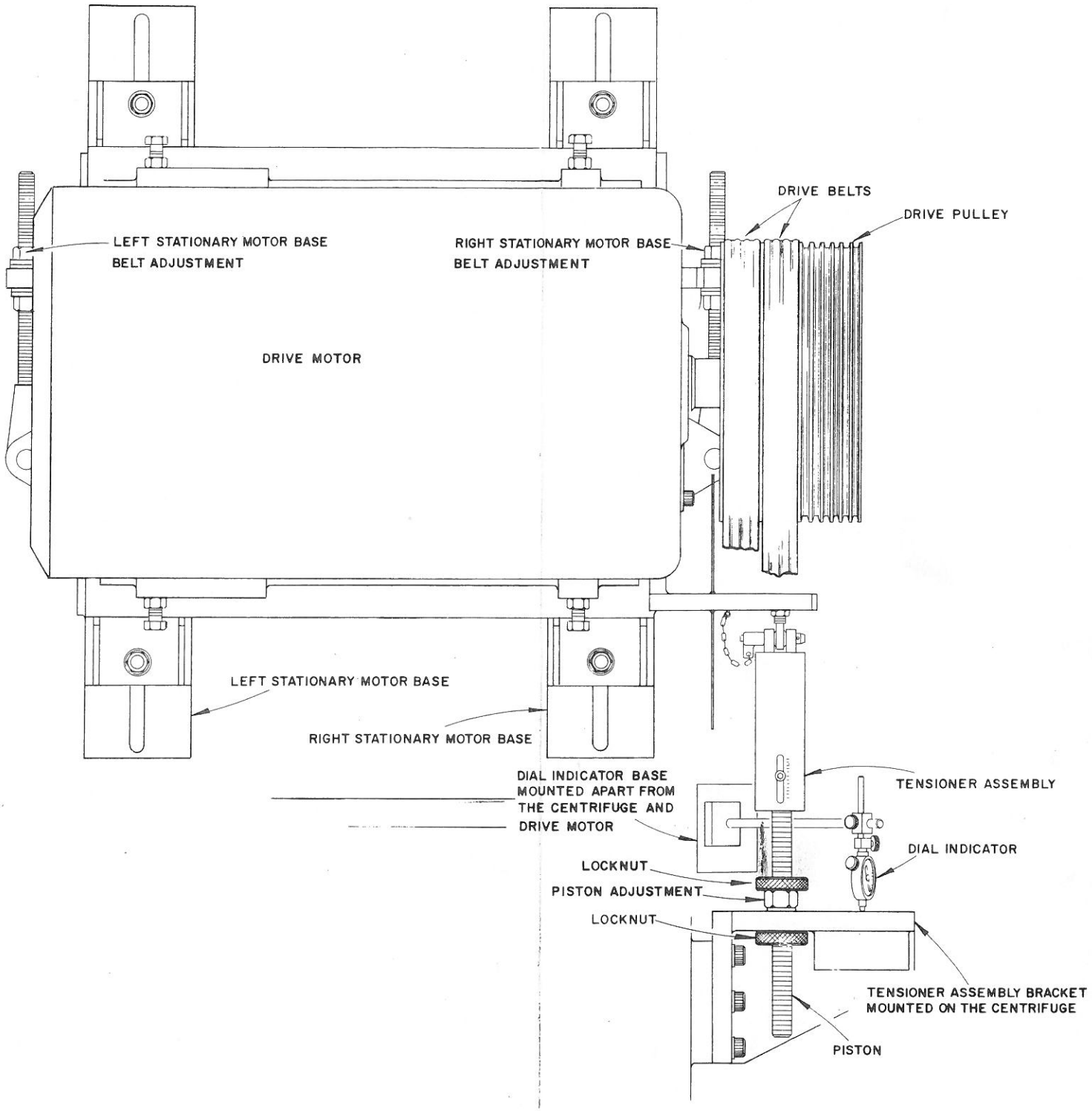
DRIVE MOTOR BASE
APPROXIMATE WEIGHT = 850 POUNDS



DRIVE MOTOR
APPROXIMATE WEIGHT = 6700 POUNDS



VIBRATION ISOLATOR
FIGURE 9-2



BELT TENSIONING
FIGURE 9-3
Sheet 1 of 2

5/9/5

BELT TENSIONING
FIGURE 9-3
Sheet 2 of 2

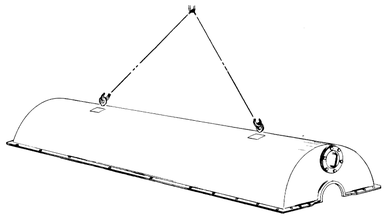
5/9/5

SHARPLES PENNWALT
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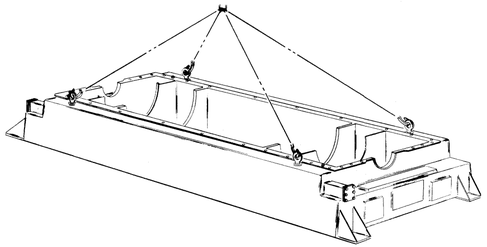
BULLETIN 5/10/9
CHAPTER 10
COVER AND FRAME ASSEMBLY

REFERENCE
(F-3399)

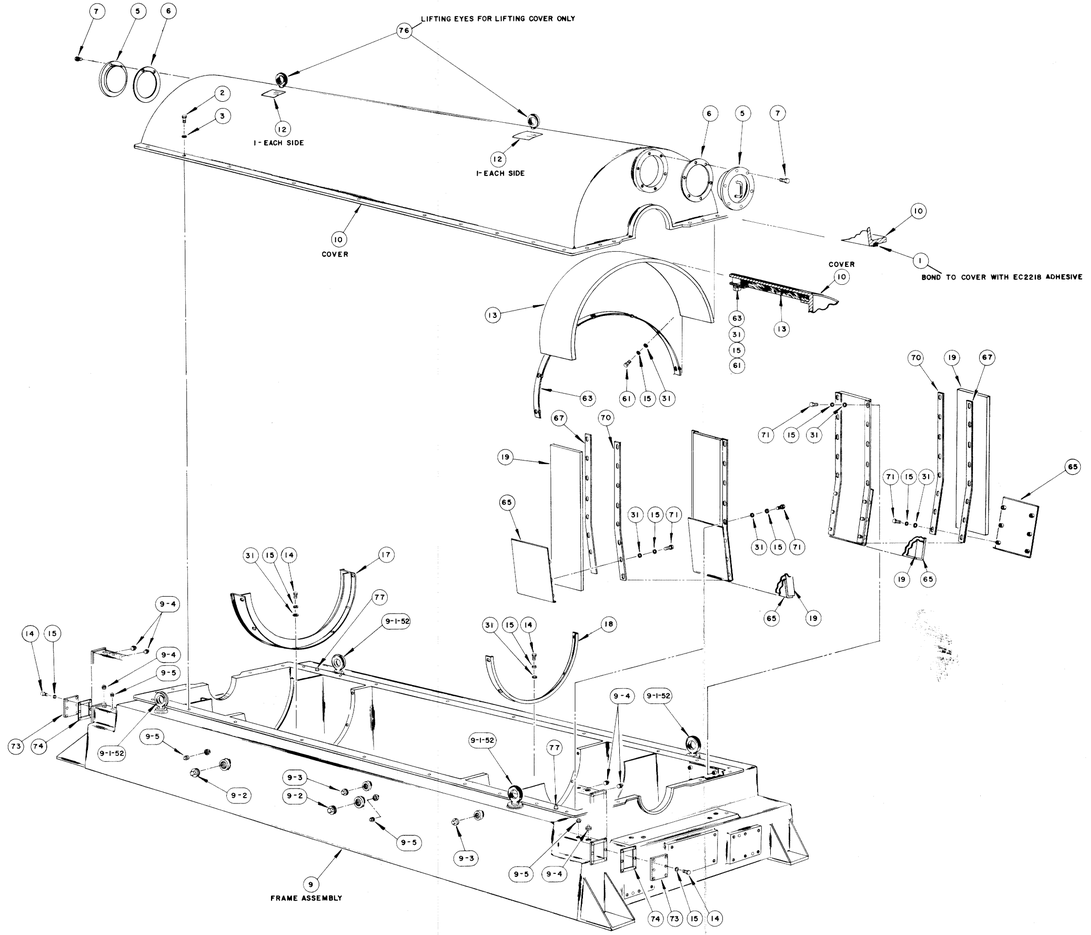
1. Gasket
2. Hexagon Head Cap Screw (1/2" - 13 x 1-1/2")
3. Lockwasher (1/2")
5. Inspection Cover
6. Inspection Cover Gasket
7. Hexagon Head Cap Screw (3/8" - 16 x 7/8")
9. Frame
9-1-52. Eyebolt (1-1/4" - 7)
9-2. Pipe Plug (2" N.P.T.)
9-3. Pipe Plug (1-1/2" N.P.T.)
9-4. Pipe Plug (1-1/4" N.P.T.)
9-5. Pipe Plug (3/4" N.P.T.)
10. Cover
12. Instruction Plate
13. Cover Liner
14. Hexagon Head Cap Screw (3/8" - 16 x 3/4")
15. Lockwasher (3/8")
17. Frame Baffle (Liquid)
18. Frame Baffle (Solids)
19. Frame Liner
31. Plain Washer (3/8")
61. Hexagon Head Cap Screw (3/8" - 16 x 1")
63. Liner Retainer
65. Back-Up Plate
67. Retainer
70. Retainer
71. Hexagon Head Cap Screw (3/8" - 16 x 1")
73. Manifold Cover
74. Manifold Cover Gasket
76. Eye Bolt (3/4")
77. Locating Pin



COVER ASSEMBLY LIFTING
APPROXIMATE WEIGHT = 1125 LBS



FRAME ASSEMBLY LIFTING
APPROXIMATE WEIGHT = 8500 LBS



COVER AND FRAME ASSEMBLY
FIGURE 10-1

BULLETIN 5/11/4

CHAPTER 11
ROTATING ASSEMBLY

CONTENTS

A. Remove Rotating Assembly from Frame 11-1
B. Install Rotating Assembly into Frame 11-1

Rotating Assembly . . . . . Figure 11-1

A. REMOVE ROTATING ASSEMBLY FROM FRAME

1. Remove retaining screws and raise upper casing—refer to Chapter 10.
2. Remove guards—refer to Chapter 9.
3. Disconnect backdrive or torque control coupling—refer to separate bulletin.
4. Disconnect oil feed and return lines to pillow blocks.
5. Remove:

   Chapter 13:
   a. Screws and washers (89-2, 89-3)
   b. Feed tube bracket clamp
   c. Feed tube (82)

   Chapter 9:
   d. Drive belts

   Figure 11-1:
   e. Dowel pin protectors (200)
   f. Dowel pins and sleeves (189)
   g. Screws, washers, and lockwashers (104, 118, 119)
   h. Rotating assembly—use the bowl lifter tool

6. Lower the assembly in a horizontal position onto a suitable, clean wooden surface.
7. Remove the lifter tool.

B. INSTALL ROTATING ASSEMBLY INTO FRAME

Figure 11-1:

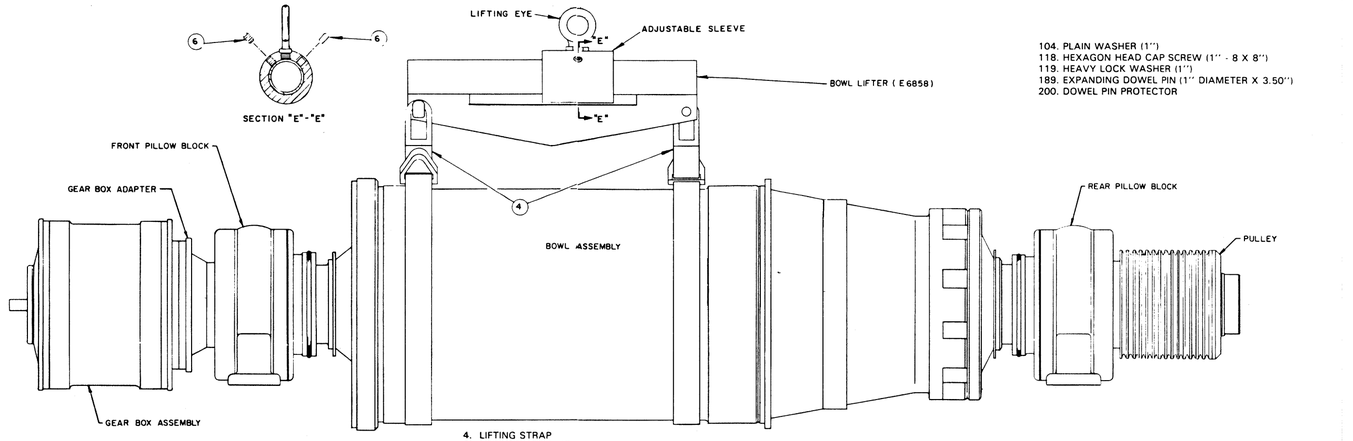
1. Lower rotating assembly until the pillow blocks are in line with, and just make contact with the mounting pads on the frame—use the bowl lifter. Make sure the mating surfaces of the pillow blocks and frame mounting pads are clean.
2. Use the dowel pin holes as guides to position the pillow blocks.
3. Install:

   Figure 11-1:
   a. Sleeves and dowels pins (189)
   b. Lockwashers, washers, and screws (119, 118, 104)
   c. Protectors (200)

Chapter 9:
d. Drive belts

Chapter 13:
e. Feed tube (82)
f. Feed tube bracket clamp
g. Screws and washers (89-2, 89-3)

4. Connect oil lines
5. Connect torque control or backdrive coupling—refer to separate bulletin.
6. Install the guards—refer to Chapter 9.
7. Lower the upper casing—refer to Chapter 10. Install retaining screws.



104. PLAIN WASHER (1")
118. HEXAGON HEAD CAP SCREW (1" - 8 X 8")
119. HEAVY LOCK WASHER (1")
189. EXPANDING DOWEL PIN (1" DIAMETER X 3.50")
200. DOWEL PIN PROTECTOR

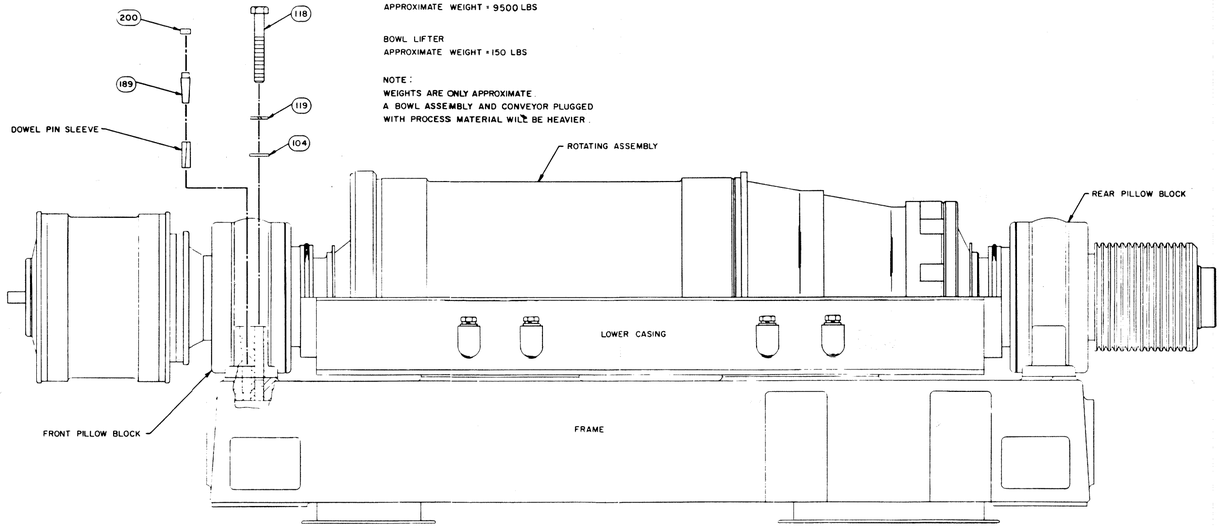
4. LIFTING STRAP
6. HEXAGON SOCKET HEADLESS SET SCREW (⅝"-10 x ⅞") .

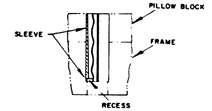
VIEW "A"
LIFTING

ROTATING ASSEMBLY
APPROXIMATE WEIGHT = 9500 LBS

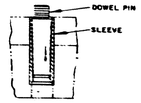
BOWL LIFTER
APPROXIMATE WEIGHT = 150 LBS

NOTE:
WEIGHTS ARE ONLY APPROXIMATE.
A BOWL ASSEMBLY AND CONVEYOR PLUGGED WITH PROCESS MATERIAL WILL BE HEAVIER.



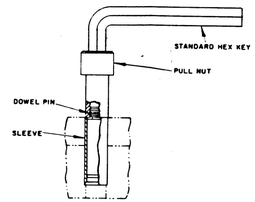


PRESS IN SLEEVE - MAKE SURE THE RECESS IN BORE IS ON THE BOTTOM AS SHOWN.

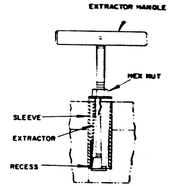


INSERT THREADED TAPERED DOWEL PIN AND TAP IN FIRMLY USING A COLD ROLLED STEEL OR BRASS PUNCH.

ASSEMBLY
VIEW "C"



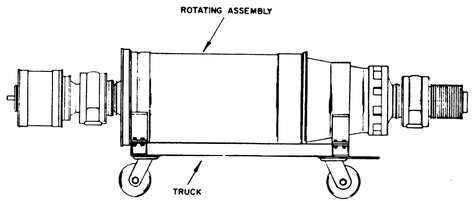
SCREW PULL NUT ON THREAD OF DOWEL PIN UNTIL PIN IS LOOSE AND REMOVE PIN



TURN NUT COUNTERCLOCKWISE ALLOWING EXTRACTOR TO BE FULLY INSERTED IN SLEEVE. TURN HEX NUT CLOCKWISE, HOLDING HANDLE, UNTIL LIP OF TOOL ENGAGES RECESS AT BOTTOM OF SLEEVE. PULL SLEEVE OUT.

DISASSEMBLY
VIEW "D"

DOWEL PIN ASSEMBLY AND DISASSEMBLY



VIEW "B"

ROTATING ASSEMBLY
FIGURE 11-1

SHARPLES PENNWALT
EQUIPMENT • CHEMICALS
HEALTH PRODUCTS

BULLETIN 5/12/2
CHAPTER 12
GEAR BOX ASSEMBLY

CONTENTS

Sharples Policy on Gearbox Repair i

A. General 12-1

B. Oil Level Checking, Filling and Draining Oil 12-1

1. Check Oil Level 12-1

2. Draining and Filling 12-1

C. Remove Gear Box From Centrifuge 12-1

D. Disassembly 12-2

1. General 12-2

2. Remove Front Cap Items 12-2

3. Disassemble Front Cover and Remove First Stage Gear Assembly 12-3

4. Disassemble Rear Cover and Remove Second Stage Gear Assembly 12-4

E. Cleaning 12-5

F. Assembly 12-5

1. Assemble Rear Cover 12-5

2. Assemble Second Stage Gear Assembly 12-5

3. Assemble First Stage Gear Assembly 12-6

4. Assemble First Stage Sun Gear 12-6

5. Complete the Gear Box Assembly 12-6

6. Checkout 12-7

G. Install Gear Box Onto Centrifuge 12-7

Gear Box Assembly . . . . . Figure 12-1

Gear Box Indicating and Handling . . . . . Figure 12-2

SHARPLES
PENNWALT
EQUIPMENT • CHEMICALS
HEALTH PRODUCTS

SHARPLES POLICY ON GEAR BOX REPAIR

The gear boxes used on Sharples Vertical & Horizontal Super-D-Canter® centrifuges are not of the usual commercial variety. They are designed and manufactured by Sharples especially for centrifuge operation, where the housing rotates at high centrifuge speed. In addition, the need for high output torque and low mass, results in the gear boxes having the following features:

1. Each is a two stage planetary design, with the housing rotated, while the first stage sun gear is stationary, or maintained at a controlled speed.

2. The stage assemblies and the housing assembly are individually dynamically balanced.

3. All planet and sun gears are hardened and ground to AGMA Class 12 accuracy.

4. Planet gears are selectively assembled as sets, and may not be replaced individually.

A planetary gear box requires each planet to share the torque load. To accomplish this, each component is manufactured to a high degree of accuracy. Close quality control of assembly and test, as well as manufacturing, is required.

DUE TO THE ABOVE

Sharples recommends that the only maintenance done to gear boxes is to change the oil, as specified in the instruction book.

For customers who have repair facilities with qualified and trained by Sharples mechanics, the instruction book describes the interior of the box. Removal of sludge, and replacement of seals, O-rings, hardware, and anti-friction bearings is acceptable, if supervised by a Sharples service engineer.

Other maintenance, if required, should be done at the Sharples repair facility. Improper repair may result in rapid destruction of the box with serious economic consequences.

Sharples will be happy to assist you in planning a spare gear box program for your installation. Contact the local Sharples Sales Representative or the Manager of Centrifuge Parts, in Warminster, Pa., for assistance.

A. GENERAL

This chapter describes procedures for checking and maintaining gear box oil level, removing the gear box from the centrifuge, gear box disassembly and assembly, and component cleaning recommendations.

B. OIL LEVEL CHECKING, FILLING AND DRAINING OIL

The gear box oil level should be checked every three months. The oil should be completely drained and replaced yearly for one shift per day operation and every 6 months for 24 hour operation. Refer to Bulletin 576 for the type gear box oil required.

1. Check Oil Level:

   Figure 12-1:

   a. Rotate gear box until plug (16-5) is in the 12 o'clock position.

   b. Remove the uppermost front cover plug (13).

   c. Oil should appear at the hole for plug (13). If not, remove plug (16-5) and add clean oil until oil appears at plug (13) hole.

CAUTION

Use care to prevent contaminating the gear box when plugs are removed.

2. Draining And Filling:

   a. Rotate gear box until plug (16-5) is at 6 o'clock postion. Remove plug (16-5).

   b. Remove uppermost plug (13) to facilitate draining.

CAUTION

Use care to prevent contaminating the gear box when plugs are removed.

   c. After complete draining, rotate gear box until plug (16-5) is at 12 o'clock position.

   d. Install plug (13). Remove other plug (13) (plug 45° from plug (16-5).

   e. Pour oil into plug (16-5) opening until oil appears at plug (13) hole.

   f. Install plugs (16-5, 13) securely to prevent leakage.

C. REMOVE GEAR BOX FROM CENTRIFUGE

Figure 9-1:

1. Remove screws (123), lockwashers (91), and gear box guard (4).
2. Disconnect torque control or backdrive. Refer to separate bulletin.

Figure 12-2:

3. Support the gear box with a sling and hoist.
4. If installed remove screws (217) and set cover ring (216) back.

NOTE

If the gear box has previously been shimmed, mark the thickness and location of the shim on the gear box and the gear box adapter.

5. Loosen screws (225).
6. Install ¾" - 10 x 3" square head jackscrews in adapter jackscrew holes. Jack gear box as far as it will go with screws (225) still in it.
7. Remove screws (225).
8. Move gear box away from the adapter with support and hoist.

D. DISASSEMBLY

ATTENTION

IT IS NOT RECOMMENDED THAT THE GEAR BOX BE DISASSEMBLED WITHOUT A PENNWALT SHARPLES CUSTOMER SERVICE REPRESENTATIVE PRESENT.

1. General

When gear box is disassembled, all work must be accomplished in a clean area with an overhead hoist available.

CAUTION

The gear box consists of three independently balanced assemblies which are match marked.

First Stage Gear Assembly
Second Stage Gear Assembly
Gear Box Shell Assembly: Ring Gear Housing (Shell)
Front Cover
Rear Cover

Therefore, prior to proceeding with disassembly and assembly of the gear box for repair or cleaning, the following restrictions must be understood and strictly adhered to:

a. Do not attempt to disassemble stage assemblies. They are assembled and balanced to a high degree of accuracy and should only be reworked at the Pennwalt Sharples factory. Bearings (8) may be replaced, however.

b. "Line up" match marks when assembling trhe gear box shell assembly.

2. Remove Front Cap Items:

Figure 12-1:

a. Support gear box in a vertical position with pinion (first stage sun gear (5)) up.

b. Remove:

(1) Screws (10)
(2) Front cap (1) - use jacking screws
(3) Wavy spring (29)
(4) Retainer (30)
(5) Spacer (28)
(6) Gasket (11)
(7) Seal (4)

3. Disassemble Front Cover and Remove First Stage Gear Assembly:

a. Remove:

(1) Screws (219) and cover ring (218) if supplied

(2) Screws (16-4)

(3) Front cover (16-1) - use jacking screws

(4) First stage gear assembly (15) - lift using eyebolts and a hoist.

WARNING

IF WHILE JACKING FRONT COVER (16-1) FROM SHELL (16-2), THE BEARING BINDS AND FIRST STAGE GEAR ASSEMBLY (15) LIFTS UP WITH THE FRONT COVER, DO NOT CONTINUE DISASSEMBLY. FOLLOW ALTERNATE PROCEDURES.

Alternate 1

Keep a constant tension on front cover (16-1) with the hoist. Try to pry it away from the first stage gear assembly or try tapping inner race of bearing (8) using a suitable piece of tubing and a mallet. If this does not work, proceed to alternate 2.

WARNING

KEEP HANDS AWAY FROM PINCH POINTS.

Alternate 2

(1) Remove jacking screws.

(2) Fasten front cover (16-1) to shell (16-2) with screws (16-4).

(3) Invert gear box and brace the front cover.

(4) Remove screws (16-4).

(5) Jack front cover until it breaks contact with the shell.

(6) Install eyebolts into the rear cover and hoist shell, rear cover, and second stage gear assembly from front cover and first stage gear assembly (15).

(7) Install eyebolts into the first stage and apply tension.

(8) Pry the first stage away from the front cover.

WARNING

KEEP HANDS AWAY FROM PINCH POINTS.

b. If required remove:

(1) Retaining ring (6)

(2) Sun gear (5) and attached parts

(3) Bearing (3) - use an arbor Press

(4) Springs (2)

(5) Bearing (8) located on front cage of first stage gear assembly (15)

4. Disassemble Rear Cover and Remove Second Stage Gear Assembly

   a. Turn gear box over so rear cover (16-3) faces up.

   b. Remove:

      (1) Screws (219) and cover ring (218) if supplied

      (2) Screws (16-4)

      (3) Rear cover (16-3) - use jacking screws

WARNING

IF WHILE JACKING THE REAR COVER (16-3) FROM THE SHELL, IT BINDS WITH THE SECOND STAGE GEAR ASSEMBLY (17), DO NOT CONTINUE DISASSEMBLY. FOLLOW ALTERNATE PROCEDURES.

Alternate 1:

Keep a constant tension on the rear cover and try to pry it away from the second stage gear assembly. If this does not work, proceed to alternate 2.

WARNING

KEEP HANDS AWAY FROM PINCH POINTS.

Alternate 2:

(1) Remove jacking screws.

(2) Fasten rear cover (16-3) to shell (16-2) with screws (16-4).

(3) Invert the gear box and brace the rear cover.

(4) Remove screws (16-4)

(5) Jack the rear cover until it breaks contact with the shell.

(6) Install eyebolts in the shell and hoist shell from the rear cover and second stage gear assembly.

(7) Install eyebolts in the second stage and apply tension.

(8) Pry the second stage away from the rear cover.

WARNING

KEEP HANDS AWAY FROM PINCH POINTS.

   c. Disassemble Rear Cover (16-3) Items:

      (1) O-ring (14)

      (2) Retaining ring (19)

      (3) Stabilizing ring (26)

      (4) Oil seal (18)

      (5) Retaining ring (23)

   d. Install eyebolts into the jacking screw holes located on top of the second stage gear assembly (17). Lift the assembly from shell (16-2).

e. If necessary, remove bearing (8) from rear cage of second stage assembly (17).

f. If necessary, remove retaining ring (20) and bearing (8) from front cage of second stage gear assembly (17).

E. CLEANING

Every two years the gear box must be cleaned. When doing this, the gear box must be disassembled, i.e., stages removed. Make certain accessible oil passages are thoroughly cleaned. Follow the same cleaning procedure when disassembling the gear box for repair.

CAUTION

Extreme care must be taken to avoid abrading ground and machined surfaces.

1. Wash components in clean kerosene. Kerosene is for tar removal.
2. Wash components in clean acetone. Acetone will remove the kerosene.
3. Steam or hot water clean components. The Borate additive in the Chevron oil is soluble in water. If gear box has not been in use and sludge buildup is nonexistent, this step is not necessary.
4. Wash components in acetone again. This will remove residual water left by steam cleaning.
5. Immediately after cleaning each part, spray with a low viscosity oil film (example: a mixture of one part Rust Veto to ten parts light oil) to prevent rust formation.

F. ASSEMBLY

Figure 12-1:

NOTE

For ease of assembly when replacing bearings, heat the bearings in 212°F (maximum) oil.

1. Assemble Rear Cover
   a. Install retaining ring (19).
   b. Lay rear cover (16-3) down on a flat surface with bowl shape facing up and supported with blocks. (Figure 12-2, View "D").
   c. Install:
      (1) New seals (18)
      (2) Stabilizing ring (26)
      (3) Retaining ring (23) - undercut portion should rest against the bearing.
      (4) New O-ring (14)
2. Assemble Second Stage Gear Assembly

   If removed, install:

   a. Bearing (8), located between rear cover (16-3) and second stage assembly (17), onto second stage rear cage.

b. Bearing (8), located between second stage assembly (17) and center of shell (16-2), onto second stage front cage.

c. Retaining ring (20)

3. Assemble First Stage Gear Assembly

   If removed, install bearing (8) onto front cage of first stage gear assembly (15).

4. Assemble First Stage Sun Gear

   a. Install onto the sun gear shaft:

      (1) Springs (2)

      (2) Bearing (3)

   b. Install assembled shaft (5) into the first stage gear assembly (15).

   c. Install retaining ring (6).

5. Complete The Gear Box Assembly

   a. Set rear cover (16-3) into the recommended support stand. (Figure 12-2, View "D").

   b. Install second stage gear assembly (17) into the rear cover.

   c. Lower shell (16-2) onto the second stage and rear cover. Fasten with screws (16-4) align the "V" marks.

   d. Press against the second stage gear assembly to make sure that retaining ring (23) and bearing (8) are in position.

   e. Lower the first stage gear assembly into the shell.

   f. Install:

      (1) O-ring (14) into front cover (16-1)

      (2) Front cover onto shell (16-2) - align "V" marks

      (3) Screws (16-4)

      (4) Spacer (28) - calculate thickness as shown in Figure 12-1

      (5) Spring retainer (30), wavy spring (29).

      (6) Oil seal (4) into front cap (1)

      (7) Gasket (11) into front cap

      (8) Front cap onto front cover

NOTE

Before installing front cap, tape the pinion shaft up to the point where the diameter changes to the seal diameter. Do this to cover up the sharp edges of the keyway thus eliminating the possibility of damaging the cap oil seal. Remove tape after installation.

      (9) Screws (10)

      (10) Cover ring (218) and screws (219)

6. Checkout

   a. Rotate sun gear (5) by hand to check that all gears and bearings move freely.

   b. Fill gear box with oil to specified level.

G. Install Gear Box Onto Centrifuge

Figure 12-2:

1. Indicate gear box adapter (224).

   a. Install the indicator as shown.

   b. Indicate the pilot diameter of the adapter. Maximum runout is 0.001 inch.

2. Support and lift the gear box until it is centered opposite the spline shaft.
3. Align the splines in the gear box with the spline shaft.
4. Push the gear box toward the adapter and spline shaft leaving about ¼ inch clearance between the gear box and adapter.
5. Align the tapped holes in the gear box with the bolt holes in the adapter.
6. Push the gear box in all the way and fasten with screws (225).
7. Indicate gear box:

   a. Install indicator onto frame extension.

   b. Indicate the machined surface.

   c. If it indicates greater than 0.003 inch, follow this high indicating point along the gear box circumference and add shims between the gear box and gear box adapter.

NOTE

Shims must cover three bolt hole lengths.

CAUTION

If the runout exceeds 0.005 inch, contact the Pennwalt Sharples customer service department.

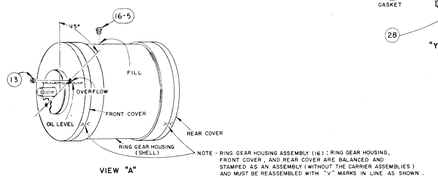
8. Check the oil level.
9. Reconnect torque control or backdrive. Refer to separate bulletin.
10. Figure 9-1. Install gear box guard (4), screws (123), and lockwashers (91).

REFERENCE
(F-943)

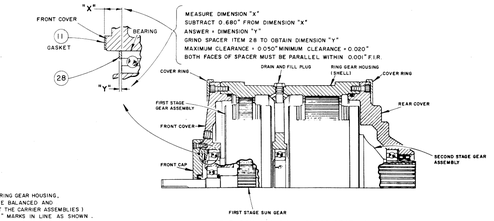
1. Front Cap
2. Disk Spring
3. Bearing
4. Oil Seal
5. First Stage Sun Gear
6. Retaining Ring
8. Bearing
10. Hexagon Socket Head Cap Screw (5/16" - 18 × 7/8")
11. Front Cap Gasket
13. Front Cover Plug (1/2" - 14 N.P.T. "Nylok")
14. O-ring
15. First Stage Gear Assembly
16. Gear Box Shell Assembly
16-1. Front Cover, Gear Box Shell
16-2. Gear Box Shell
16-3. Rear Cover, Gear Box Shell
16-4. Hexagon Socket Head Cap Screw (1/2" - 13 × 1-1/4")
16-5. Pipe Plug
16-6. O-ring
17. Second Stage Gear Assembly
18. Oil Seal
19. Retaining Ring
20. Retaining Ring
23. Seal Retaining Ring
26. Stabilizing Ring
28. Spacer
29. Wavy Spring
30. Spring Retainer

REFERENCE
(R-290, R-405)

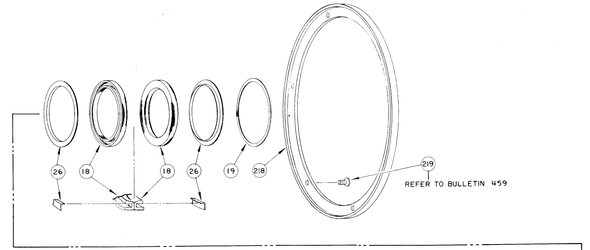
218. Gear Box Cover Ring
219. Hexagon Socket Flat Head Screw (3/8" - 16 × 3/4")

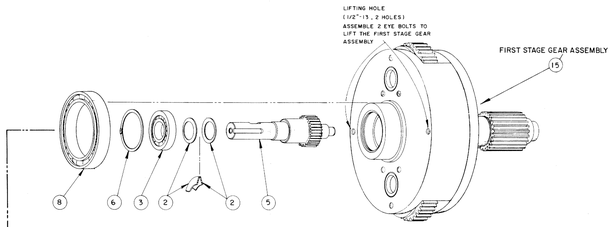


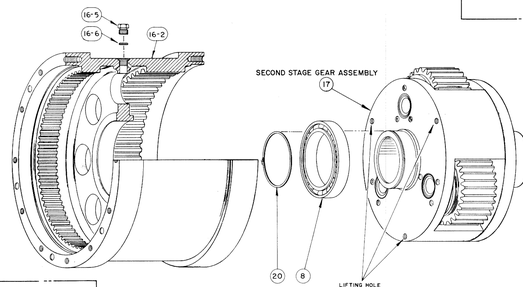
VIEW "A"

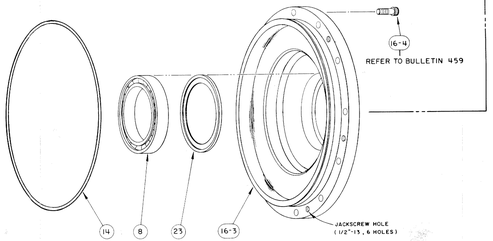


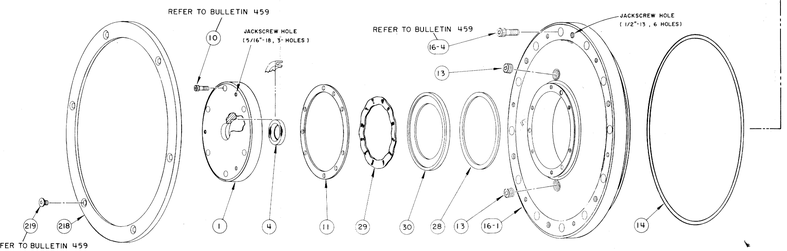
GEAR BOX ASSEMBLY CROSS SECTION





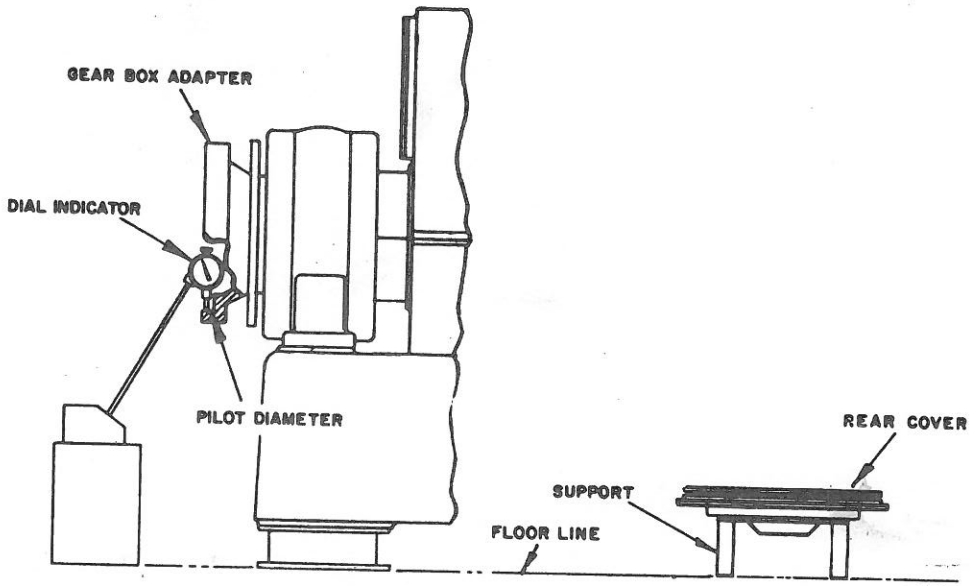






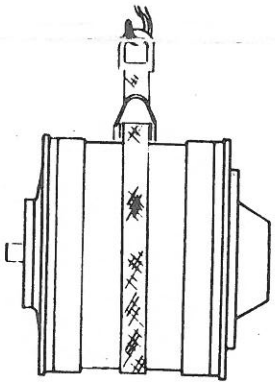
GEAR BOX ASSEMBLY
FIGURE 12-1

216. Cover Ring
217. Hexagon Socket Flat Head Screw
($^3/_8$'' - 16 x ¾'')
225. Hexagon Socket Head Cap Screw
(¾'' - 10 x 2¼'')

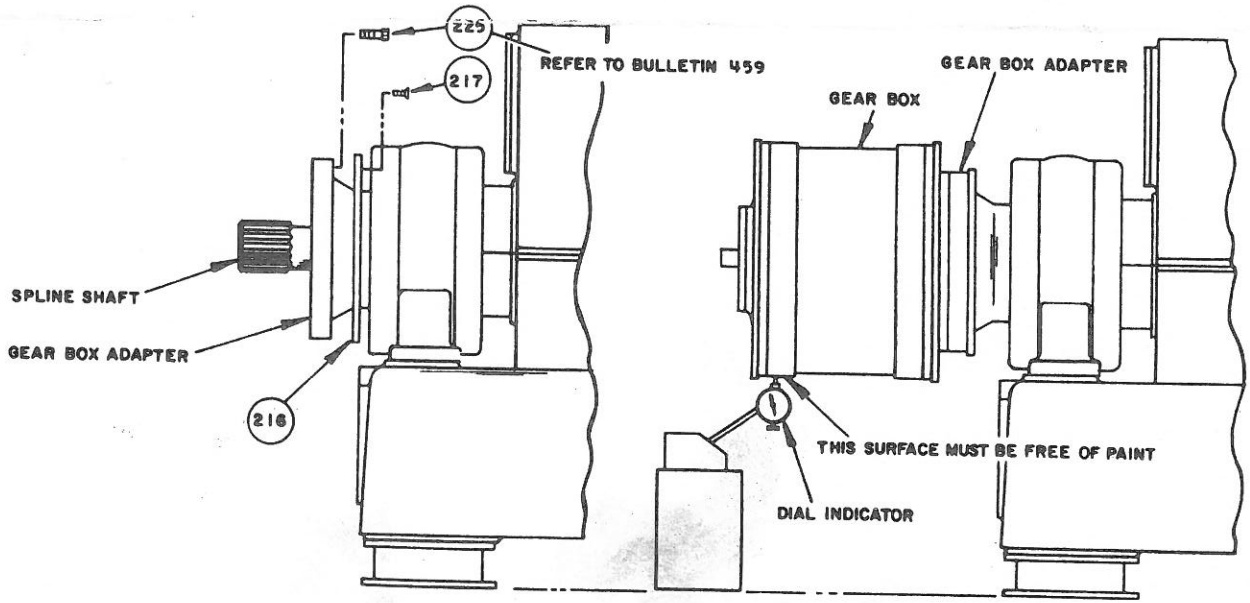


VIEW "A"
(INDICATE ADAPTER PILOT DIAMETER)

VIEW "D"



GEAR BOX ASSEMBLY
APPROXIMATE WEIGHT = 1000 LBS.



VIEW "B"
(INSTALL THE GEAR BOX)

VIEW "C"
(INDICATE THE GEAR BOX)

GEAR BOX INDICATING AND HANDLING
FIGURE 12-2

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CHAPTER 13
FEED TUBE ASSEMBLY

CONTENTS

A. Remove Feed Tube 13-1
B. Replace Feed Tube Seal 13-1
C. Remove Feed Tube Bracket 13-1
D. Install Feed Tube Bracket 13-1
E. Install Feed Tube 13-2
Feed Tube Assembly . . . . . Figure 13-1

A. REMOVE FEED TUBE

Figure 13-1:

1. Loosen set screws (371) on feed tube seal assembly.
2. Remove:
   a. Screws and washers (89-2, 89-3)
   b. Feed tube clamp
   c. Feed tube (82)
   d. Feed tube seal assembly

B. REPLACE FEED TUBE SEAL

1. Remove screws (370), clamp (367), and feed tube seal (368) from feed tube seal holder (369).
2. Reassemble in reverse order.

C. REMOVE FEED TUBE BRACKET

Remove:

1. Screws and washers (90, 91)
2. Feed tube bracket (89)

D. INSTALL FEED TUBE BRACKET

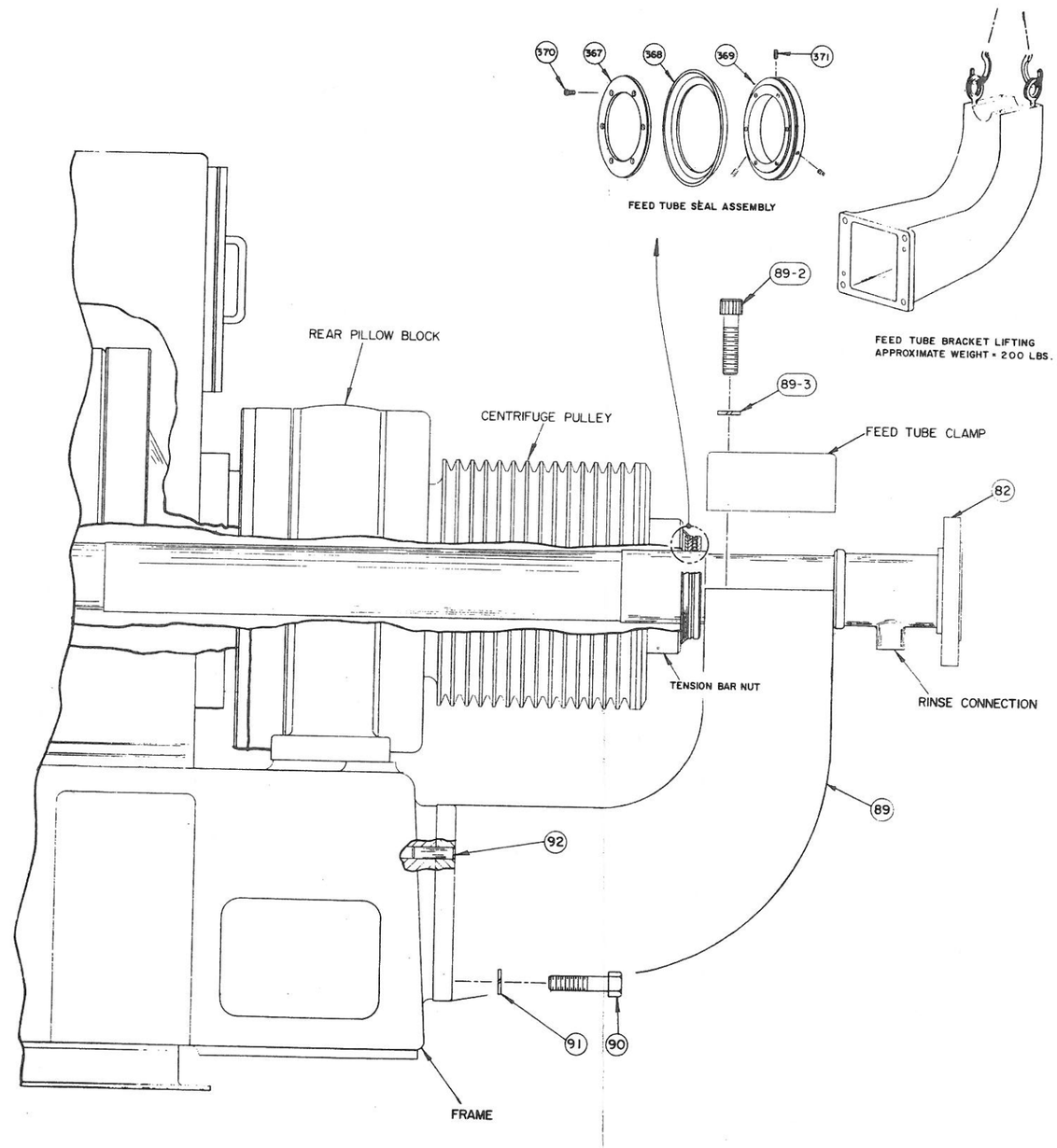
Install:

1. Feed tube bracket (89) - align with dowel pins (92)
2. Screws and washers (90, 91)

E. INSTALL FEED TUBE

1. Position feed tube seal assembly.
2. Install:
   a. Feed tube (82) - make sure feed tube collar is against feed tube bracket
   b. Feed tube clamp
   c. Screws and washers (89-2, 89-3)
3. Position feed tube seal assembly so feed tube seal (368) slightly contacts tension bar nut. Tighten set screws (371).

82. Feed Tube
89. Feed Tube Bracket
89-2. Hexagon Socket Head Cap Screw (¾'' - 10 x 3¼'')
89-3. Lockwasher (¾'')
90. Hexagon Head Cap Screw (¾'' - 10 x 2½'')
91. Lockwasher (¾'')
92. Dowel Pin (½'' Dia. x 2'')
367. Feed Tube Seal Clamp
368. Feed Tube Seal
369. Feed Tube Seal Holder
370. Hexagon Socket Flat Head Screw (#6 - 32 x 3/8'')
371. Hexagon Socket Headless Set Screw (¼'' - 20 x ¾'')



FEED TUBE ASSEMBLY
FIGURE 13-1

CHAPTER 14
FRONT PILLOW BLOCK AND GEAR BOX ADAPTER ASSEMBLY

CONTENTS

A. Remove Gear Box Adapter 14-1
B. Remove Front Pillow Block and Bearing 14-1
C. Check Front Hub Shoulder for Alignment 14-2
D. Install Bearing Inner Race 14-2
E. Check Bearing Inner Race for Alignment 14-3
F. Install Front Pillow Block 14-3
G. Check Pillow Block for Alignment 14-3
H. Install Outer Cover 14-4
I. Install Gear Box Adapter 14-4
J. New Gear Box Adapter Spacer 14-4
Front Pillow Block Assembly . . . . . Figure 14-1
Front Hub Shoulder Alignment . . . . . Figure 14-2
Pillow Block and Bearing Alignment . . . . . Figure 14-3

A. REMOVE GEAR BOX ADAPTER

1. Remove:
   a. Rotating assembly from frame—refer to Chapter 11
   b. Gear box—refer to Chapter 12

   Figure 14-1:

   c. Screws (226)
2. Screw an eyebolt into the proper hole in adapter (224).
3. Attach a hoist to the eyebolt and place a slight amount of tension on the adapter.
4. Attach the reducer as shown in view "A".
5. Pump hydraulic oil into the adapter to about 3500 pounds. Adapter should easily slide most of the way off.
6. Use jacking screws to remove it the rest of the way.
7. Remove key (46-31).

B. REMOVE FRONT PILLOW BLOCK AND BEARING

1. Remove bowl front hub assembly—refer to Chapter 16.

   Figure 14-1:

2. Remove:
   a. Screws (8) fastening inner and outer covers
   b. Outer cover (7)—use jacking screws

c. Stabilizing ring (10)
d. Spacer (145)
e. Pillow block (11)—use eyebolt and hoist
f. Bearing (298) outer race and rollers

NOTE

Bearing outer race and rollers might remain with the pillow block.

3. Remove screws (348) retaining holder (347) assembly to inner cover (12).
4. Install bearing puller tool as shown on Figure 14-1, View "B" and pump until the bearing (298) inner race is released from the hub.
5. Remove flinger (99) by slightly heating and/or tapping.
6. Slide off inner cover (12).
7. Remove seal ring (100) by slightly heating and/or tapping.
8. Remove the following parts from the holder (347) if worn or damaged:

   Screws (262)
   Clamp (346)
   Seal (385)
   Seal ring (345)

C. CHECK FRONT HUB SHOULDER FOR ALIGNMENT

Figure 14-2:

1. The face of the hub must be free of burrs, nicks, etc.
2. Position the indicating bar as shown against the face of the hub and hand hold in place.
3. Slide the long stem dial indicator through one of the holes until the indicator stem is in position in relation to the shoulder as shown.
4. Secure the indicator to the bar with the locking set screw.
5. Preload the dial to allow free movement of the needle in both directions.
6. Indicate the hub shoulder at four different places (12, 3, 6, 9 o'clock).
7. Maximum total difference should not exceed 0.0002 inch. If the readings exceed this tolerance, consult the Pennwalt Sharples customer service department.

D. INSTALL BEARING INNER RACE

Figure 14-1:

1. Install the following parts on holder (347) if removed:

   Seal ring (345)
   Seal (385)
   Clamp (346)
   Screws (262)

2. Slip the assembled holder (347) over the bowl hub.
3. Check for nicks or other damage and then heat in 212°F (maximum) clean oil: Seal ring (100), flinger (99), bearing (298) inner race.

4. Install:

   a. Seal ring (100)
   b. Inner cover (12) with O-ring (9)
   c. Flinger (99)
   d. Bearing (298) inner race

NOTE

Take care to insure all parts of the bearing inner race, outer race, and roller assembly are lowered straight down onto the hub.

5. Allow parts to cool.

E. CHECK BEARING INNER RACE FOR ALIGNMENT

Figure 14-3:

1. Set up dial and bar as was done for checking alignment of front hub shoulder.
2. Indicate the inner race at four different places.
3. Maximum total difference should not exceed 0.001 inch.

NOTE

Operating the centrifuge with a greater run-out will result in higher operating temperatures, shorter bearing life, and horizontal and axial vibrations that will eventually impose stresses on other critical surfaces.

If the reading is off, the inner race may have been installed skewed, or the inner race, seal ring, or hub shoulder may be worn, burred, etc.

F. INSTALL FRONT PILLOW BLOCK

Figure 14-1:

1. Install:

   a. Bearing (298) outer race and roller assembly
   b. Stabilizing ring (10)—make sure it is free of nicks and burrs
   c. O-rings (9)—replace if defective
   d. Pillow block (11)
   e. Screws (8) fastening pillow block (11) and inner cover (12). For now, ignore the gap

2. Install front hub assembly on bowl—refer to Chapter 16.

G. CHECK PILLOW BLOCK FOR ALIGNMENT

1. Install:

   a. Rotating assembly into frame—refer to Chapter 11
   b. Dowel pins and sleeves—refer to Chapter 11
   c. Figure 11-1. Screws and washers (104, 118, 119)

Figure 14-3:

2. Set up dial and bar as was done for checking alignment of front hub shoulder.
3. Indicate the pillow block at the 12 o'clock and 6 o'clock positions.

5/14/3

NOTE
Do not rotate bowl.

4. If required, shim under the pillow block, at front or back, until the maximum difference between the readings is 0.002 inch.
5. Reset the dial on zero and indicate at the 3 o'clock and 9 o'clock positions. If the difference between these two readings is greater than 0.002 inch, contact the Pennwalt Sharples customer service department.

H. INSTALL OUTER COVER

Figure 14-1:

1. Remove screws (8)—inner cover to pillow block
2. Install:
   a. Outer cover (7)—establish oil line port location first
   b. Screws (8)—outer cover to pillow block
   c. Screws (8)—inner cover to pillow block

NOTE
The outer cover of the pillow block is fastened down before the inner cover. This will automatically establish the required gap between the pillow block and the inner cover.

   d. Screws (348) securing holder (347) to inner cover

I. INSTALL GEAR BOX ADAPTER

Figure 14-1:

1. Install key (46-31).
2. Heat gear box adapter (224) in 350°F (maximum) clean oil.
3. Install adapter with screws (226).
4. Cool adapter to room temperature, and then recheck screws (226) for tightness.

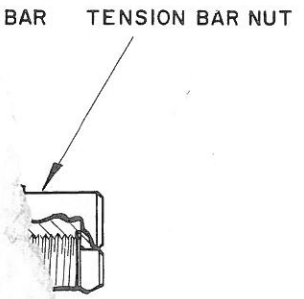
J. NEW GEAR BOX ADAPTER SPACER

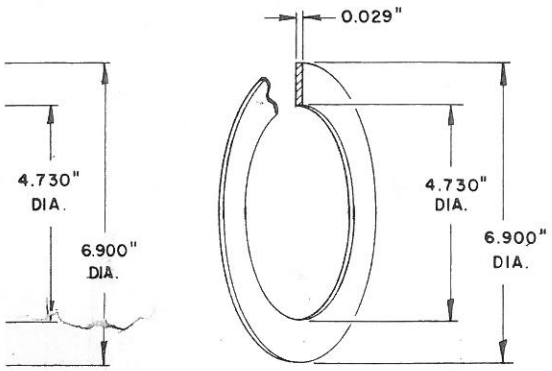
NOTE
Whenever a gear box adapter is replaced new, a new spacer (145) must be recalculated.

Figure 14-1, view "E":

1. Measure dimension "G" and record.
2. Measure dimension "H" and record.
3. Subtract "H" from "G" to obtain required spacer (145) thickness or dimension "J". Grind spacer accordingly.

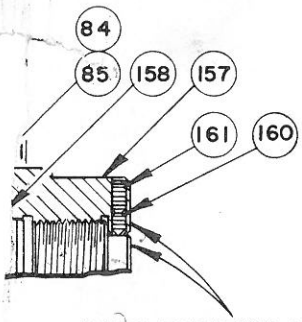
84. Tension Bar Spacer
85. Tension Bar Spacer
157. Tension Bar Nut
158. Tension Bar Nut Quad Ring
160. Hexagon Socket Headless Set Screw (3/8" - 16 x 3/4", Cone Point, "Nylock")
161. Hexagon Socket Headless Set Screw (3/8" - 16 x 1/2", Cup Point, "Nylock")



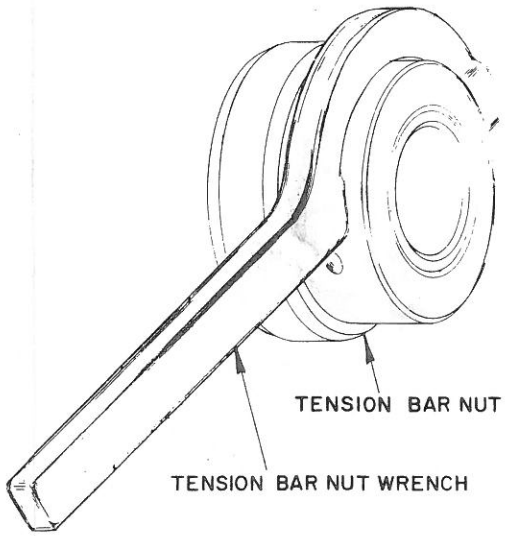


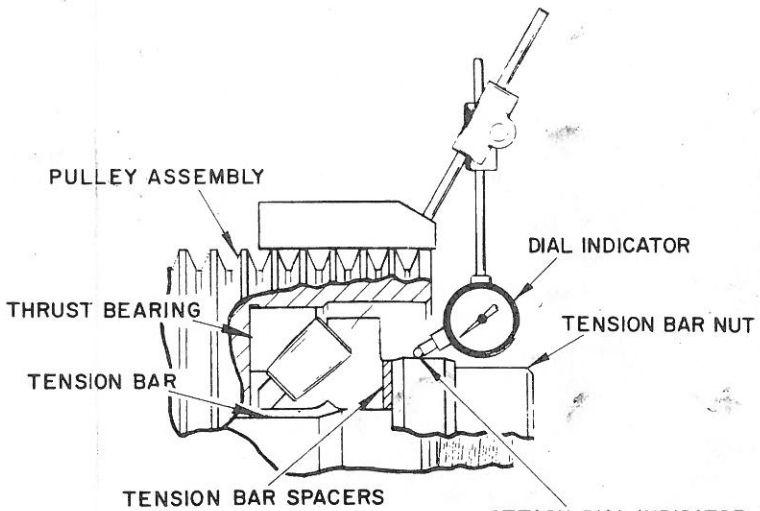
ITEM 85

IAR SPACERS MATERIAL = STEEL
UPPLIED BY CUSTOMER
SS SHOWN AS PROVIDED BY PENNWALT)



WHEN ROTATING ASSEMBLY IS PROPERLY ASSEMBLED THE END OF THE TENSION BAR SHOULD BE FLUSH WITH THE TENSION BAR NUT.





TENSION BAR RUNOUT CHECK

VIEW "C"

ATTACH DIAL INDICATOR AND CHECK RUNOUT ON THIS SURFACE OF THE TENSION BAR NUT.

TENSION BAR SPACER CALCULATIONS AND RUNOUT CHECK
FIGURE 18-3

PILLOW BLOCK OIL PIPING

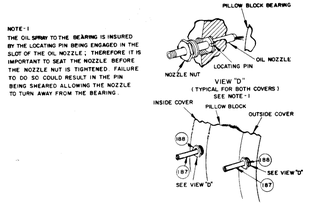
187. Oil Nozzle
188. Oil Nozzle Nut

PILLOW BLOCK ASSEMBLY

7. Pillow Block Outside Cover
8. Hexagon Socket Head Cap Screw (5/8'' - 11 x 2¼'')
9. Pillow Block O-Ring
10. Stabilizing Ring
11. Pillow Block
12. Pillow Block Inside Cover
13. Lubricator (1/8'' N.P.T.)

46-31. Key

63. Eyebolt (¾'' - 10)
99. Bowl Hub Flinger
100. Seal Ring
124. Pipe Plug (1/8'' N.P.T.)
145. Gear Box Adapter Spacer
216. Gear Box Adapter Cover Ring
217. Hexagon Socket Flat Head Screw (3/8'' - 16 x ¾'')
224. Gear Box Adapter
225. Hexagon Socket Head Cap Screw (¾'' x 10 x 2¼'')
226. Hexagon Socket Head Cap Screw (5/8'' - 11 x 1¾'')
262. Hexagon Head Cap Screw (¼'' - 20 x ¾'')
298. Pillow Block Bearing
345. Casing Seal Ring
346. Bowl Hub Seal Clamp
347. Bowl Hub Seal Holder
348. Hexagon Socket Head Cap Screw (½'' - 13 x 1¼'')
385. Bowl Hub Seal

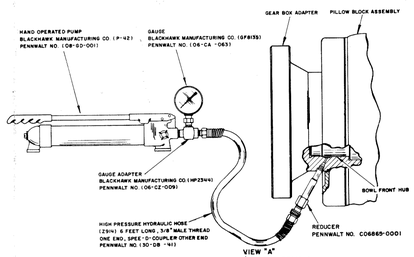


VIEW "C"
PILLOW BLOCK OIL PIPING

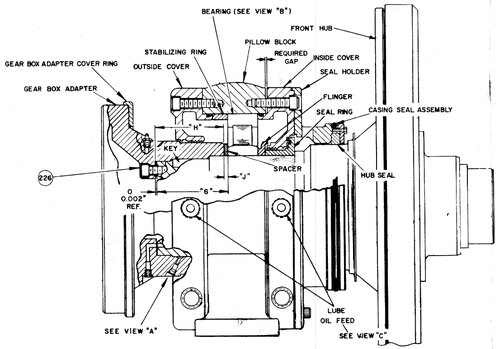


GEAR BOX ADAPTER LIFTING
APPROXIMATE WEIGHT=120 LBS.

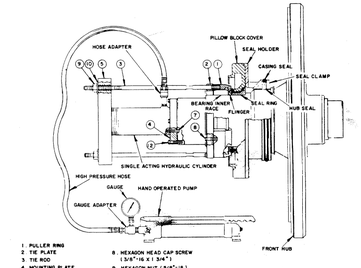
PILLOW BLOCK ASSEMBLY LIFTING
APPROXIMATE WEIGHT= 350 LBS.



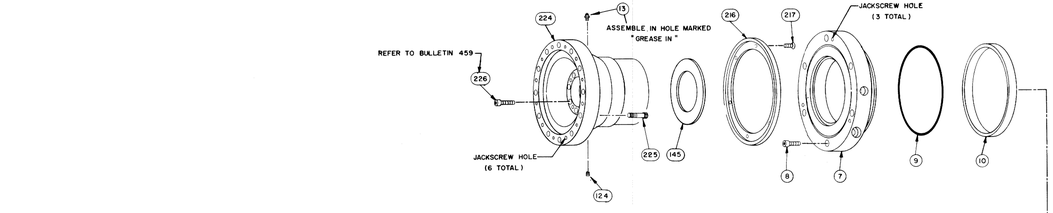
GEAR BOX ADAPTER REMOVAL

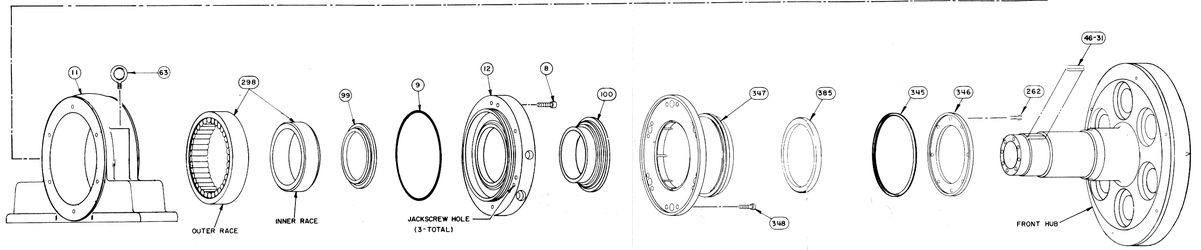


VIEW "E"
PILLOW BLOCK ASSEMBLY CROSS SECTION

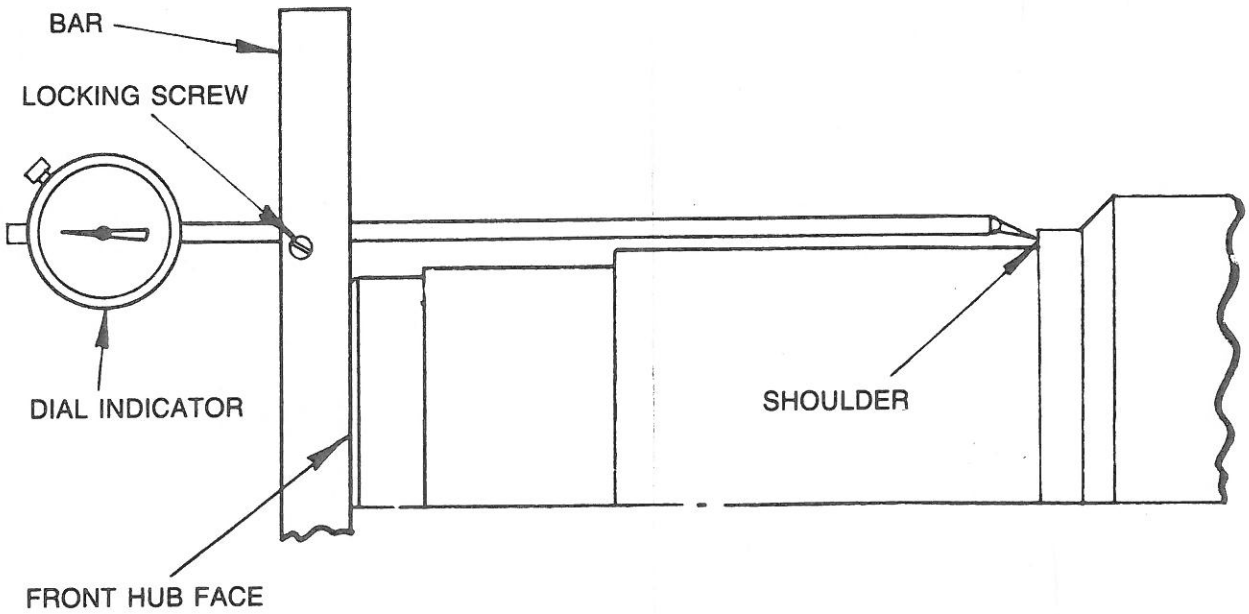


VIEW "B"
BEARING INNER RACE REMOVAL



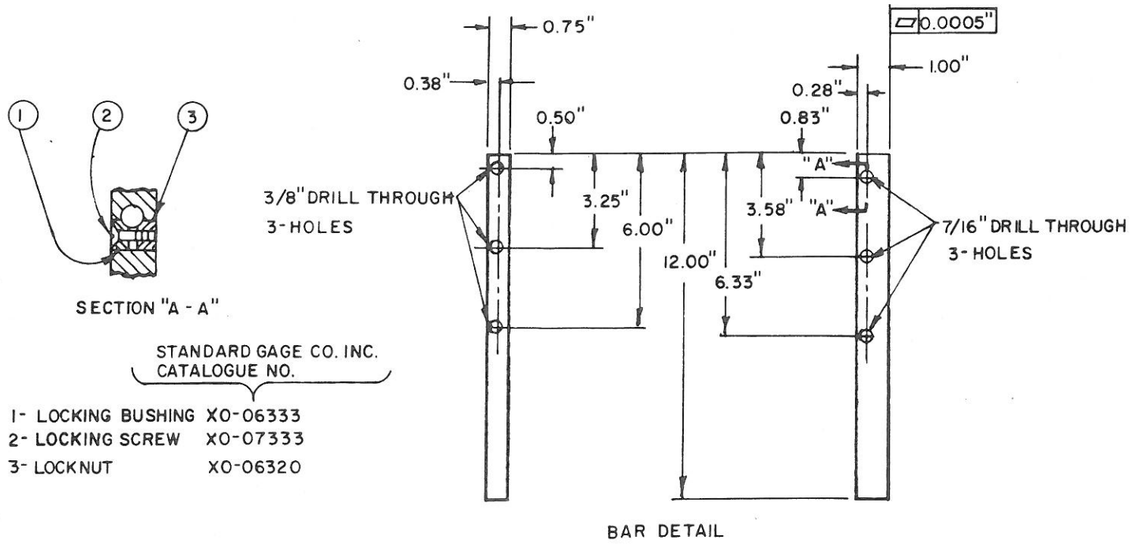


FRONT PILLOW BLOCK ASSEMBLY
FIGURE 14-1

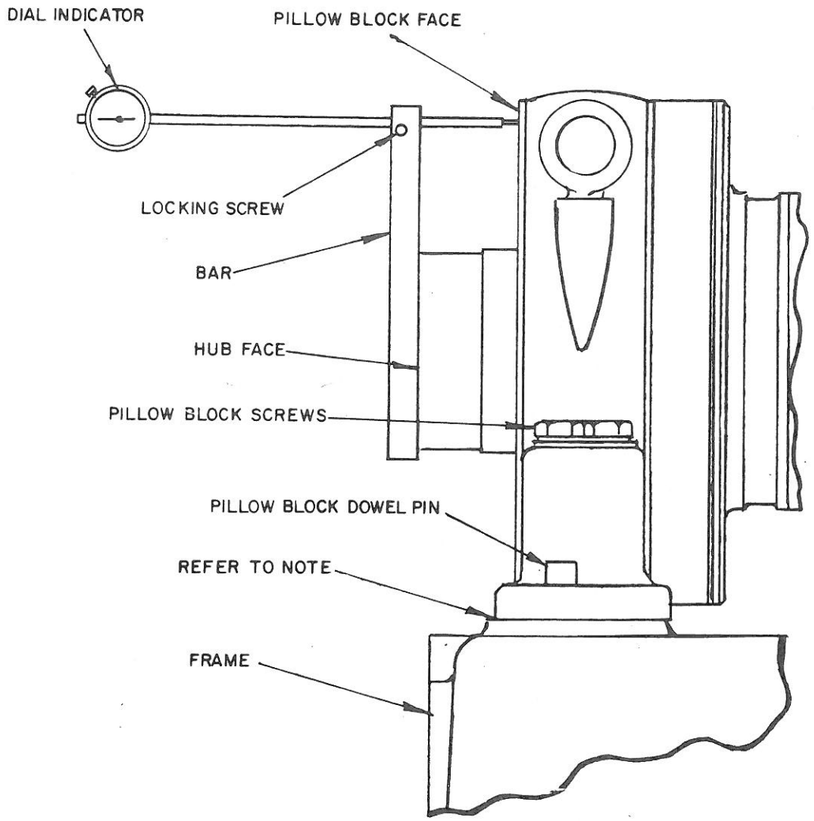


FRONT HUB SHOULDER ALIGNMENT
FIGURE 14-2

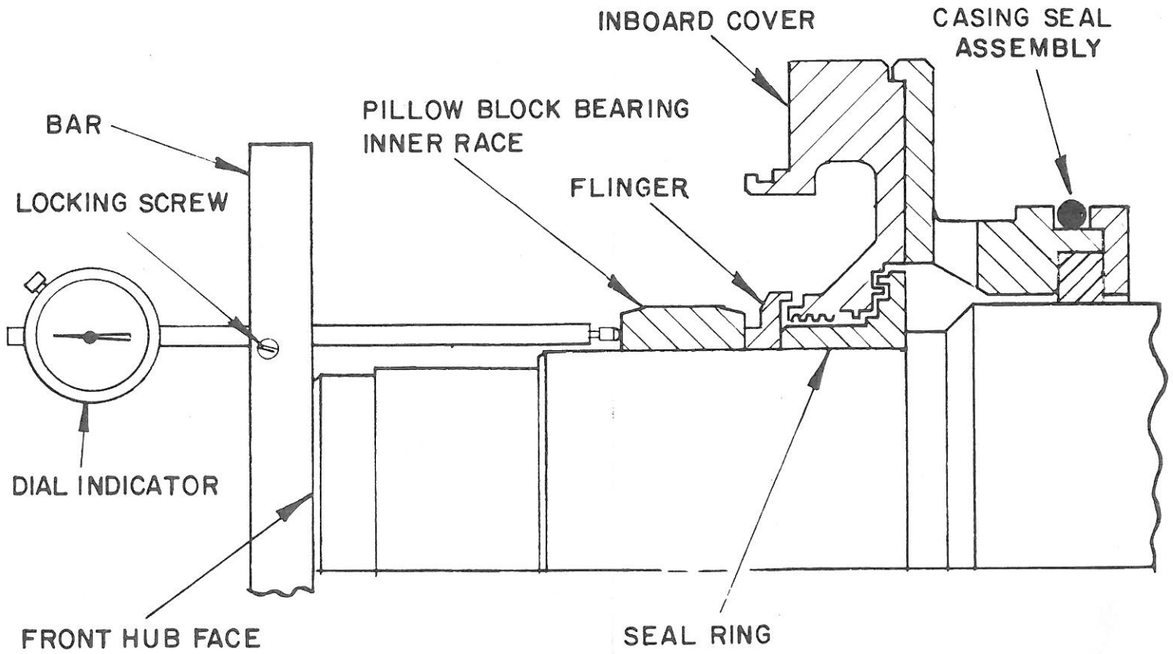
5/14/1
5/14/2
5/14/3



BAR DETAIL

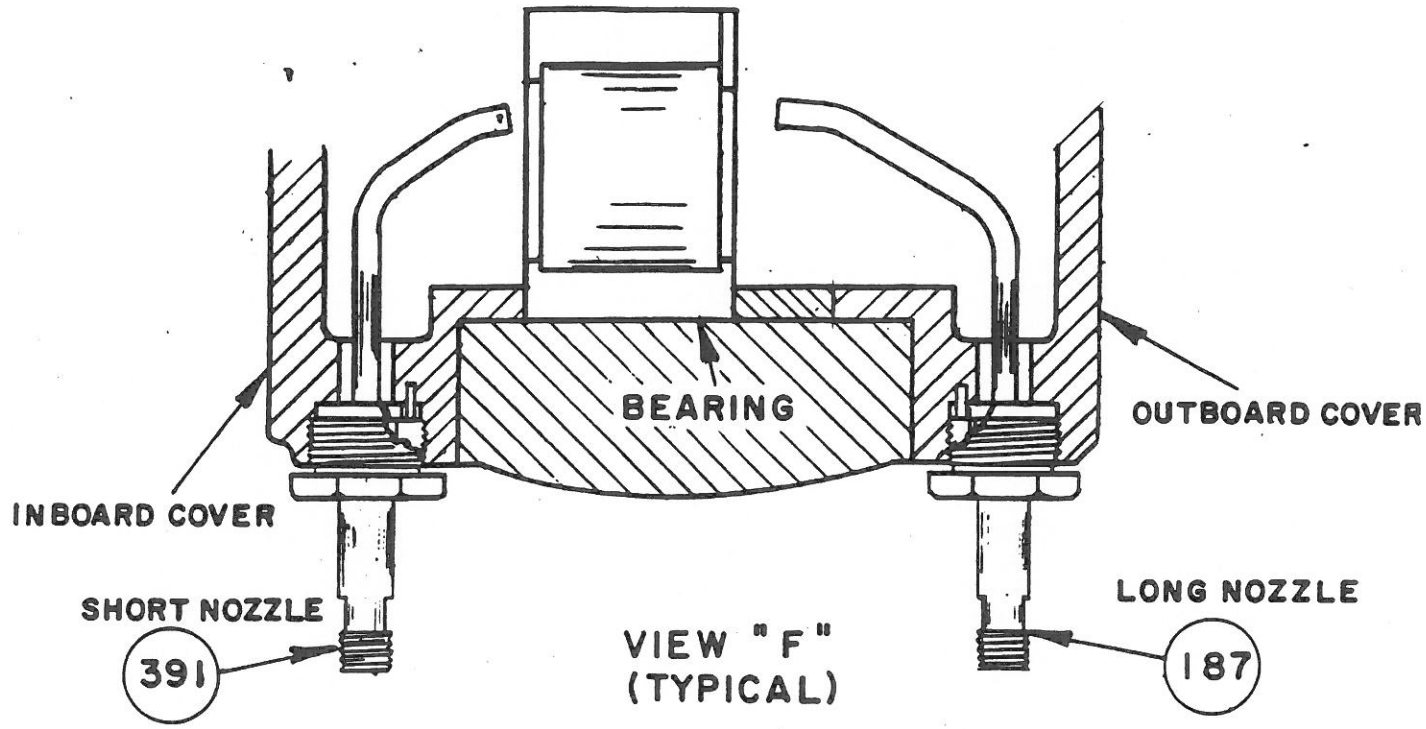


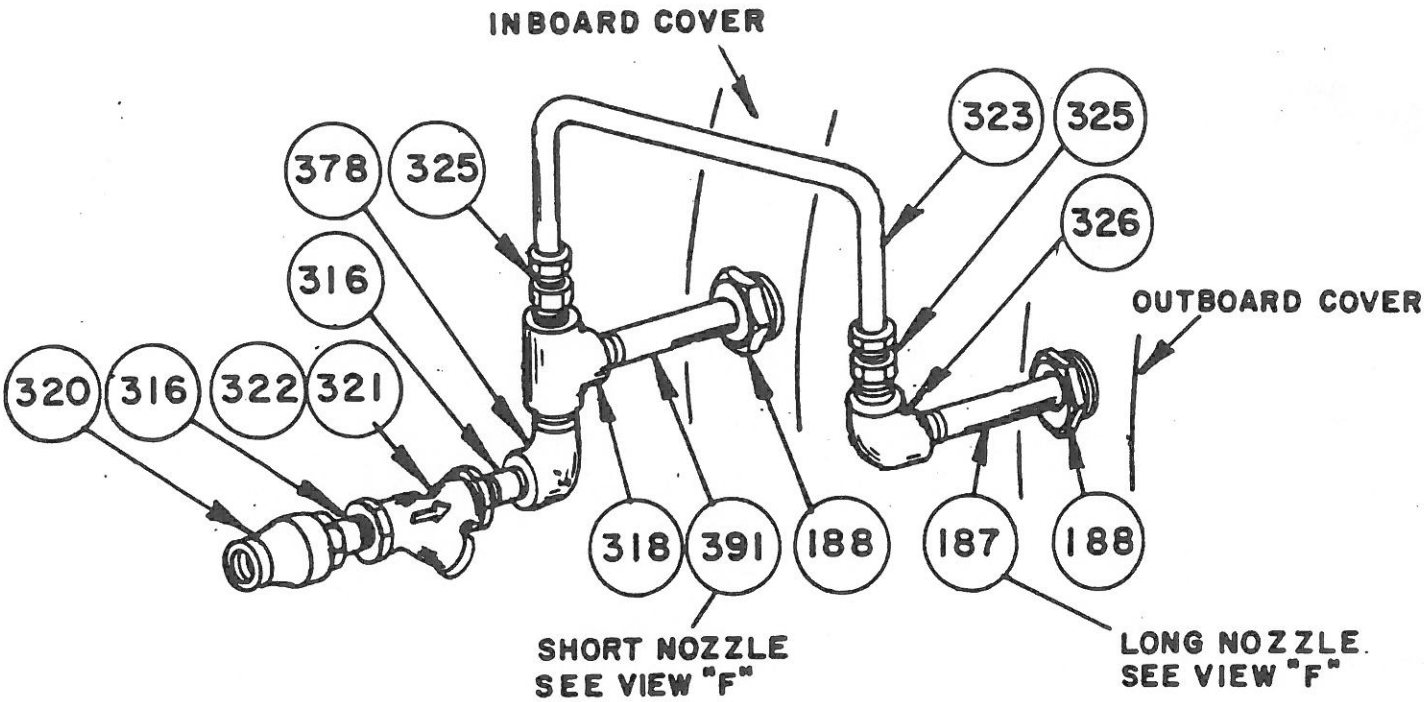
PILLOW BLOCK ALIGNMENT



BEARING INNER RACE ALIGNMENT

PILLOW BLOCK AND BEARING ALIGNMENT
FIGURE 14-3





SUPPLEMENT FOR FIGURES 14-1 and 15-1

CHAPTER 15
REAR PILLOW BLOCK AND PULLEY ASSEMBLY

CONTENTS

A. Remove Pulley Seals and Thrust Bearing 15-1
B. Remove Pulley From Hub 15-2
C. Remove Rear Pillow Block and Bearing 15-2
D. Check Rear Hub Shoulder for Alignment 15-3
E. Install Bearing Inner Race 15-3
F. Check Bearing Inner Race for Alignment 15-3
G. Install Rear Pillow Block 15-4
H. Check Pillow Block for Alignment 15-4
I. Install Outer Cover 15-4
J. Install Pulley 15-5
K. Install Thrust Bearing and Pulley Seals 15-5
L. New Rear Hub Nut Spacer 15-6
Rear Pillow Block and Pulley Assembly . . . . . Figure 15-1
Rear Hub Shoulder Alignment . . . . . Figure 15-2
Pillow Block and Bearing Alignment . . . . . Figure 15-3

A. REMOVE PULLEY SEALS AND THRUST BEARING

Remove:

1. Feed tube and bracket—refer to Chapter 13.
2. Set screws (161, 160) and tension bar nut (157)—see Figure 18-3; use the tension bar nut wrench.

NOTE
The pulley does not have to be removed to service the seals and thrust bearing.

Figure 15-1:

3. Screws (79)
4. Seal holder (78)
5. Retaining ring (83)
6. Seals and stabilizers (81, 159)
7. Spacers (84, 85)
8. Bearing (77) inner race—use the puller as shown in View "A"

NOTE

If the tension bar and conveyor have already been removed, it is not necessary to use the puller tool.

At this point, the bearing and seals may be replaced or set aside for access to the rear pillow block bearing.

B. REMOVE PULLEY FROM HUB

If only the pulley is to be serviced proceed as follows; if more extensive work is required remove rotating assembly from frame—refer to Chapter 11.

Figure 15-1:

Remove:

1. Screws (228)
2. Pulley (227)—use jacking screws
3. Key (46-32)

C. REMOVE REAR PILLOW BLOCK AND BEARING

1. Remove conveyor assembly—refer to Chapter 18.

Figure 15-1:

Remove:

2. Screws (8) fastening inner and outer covers
3. Outer cover (70)—use jacking screws
4. Hub nut spacer (342)
5. Stabilizing ring (10)
6. Screws (72-2)
7. Rear hub nut (72)—use rear hub nut wrench
8. Bearing flange
9. Pillow block (11)—use eyebolt and hoist
10. Bearing (68) outer race and rollers

NOTE

Bearing outer race and rollers might remain with the pillow block.

11. Remove screws (348) retaining holder (347) assembly to inner cover (67).
12. Install bearing puller tool as shown on figure 15-1, View "C" and pump until the bearing (68) inner race is released from the hub.
13. Remove flinger (99) by slightly heating and/or tapping.
14. Slide off inner cover (67).
15. Remove seal ring (100) by slightly heating and/or tapping.
16. Remove spacer (190).

17. Remove the following parts from the holder (347) if worn or damaged:

    Screws (262)
    Clamp (346)
    Seal (385)
    Seal ring (345)

D. CHECK REAR HUB SHOULDER FOR ALIGNMENT

Figure 15-2:

1. The face of the hub must be free of burrs, nicks etc.
2. Position the indicating bar against the face of the hub and hand hold in place.
3. Slide the long stem dial indicator through one of the holes until the indicator stem is in position in relation to the shoulder as shown.
4. Secure the indicator to the bar with the locking set screw.
5. Preload the dial to allow free movement of the needle in both directions.
6. Indicate the hub shoulder at four different places (12, 3, 6, 9 o'clock).
7. Maximum total difference should not exceed 0.0002 inch. If the readings exceed this tolerance, consult the Pennwalt Sharples customer service department.

E. INSTALL BEARING INNER RACE

Figure 15-1:

1. Install the following parts on holder (347) if removed:

    Clamp (346)
    Seal ring (345)
    Seal (385)
    Screws (262)

2. Slip the assembled holder (347) over the bowl hub.
3. Check for nicks or other damage, then install spacer (190).
4. Check for nicks or other damage, then heat in 212°F (maximum) clean oil:
   Seal ring (100), flinger (99), bearing (68) inner race
5. Install:
   a. Seal ring (100)
   b. Inner cover (67) with O-ring (9)
   c. Flinger (99)
   d. Bearing (68) inner race
6. Allow parts to cool.

F. CHECK BEARING INNER RACE FOR ALIGNMENT

Figure 15-3:

1. Set up dial and bar as was done for checking alignment of rear hub shoulder.
2. Indicate the inner race at four different places.
3. Maximum total difference should not exceed 0.001 inch.

NOTE

Operating the centrifuge with a greater runout will result in higher operating temperatures, shorter bearing life, and horizontal and axial vibrations that will eventually impose stresses on other critical surfaces.

If the reading is off, the inner race may have been installed skewed, or the inner race, seal ring, or hub shoulder may be worn, burred, etc.

G. INSTALL REAR PILLOW BLOCK

Figure 15-1:

Install:

1. Bearing (68) outer race and rollers
2. Bowl rear hub nut (72)—use the wrench provided
3. Screws (72-2)
4. Pillow block (11)
5. Stabilizing ring (10)—for now, ignore the gap

H. CHECK PILLOW BLOCK FOR ALIGNMENT

1. Install conveyor assembly—refer to Chapter 18.
2. Install rotating assembly into frame—refer to Chapter 11.

Figure 15-3:

3. Set up dial and bar as was done for checking alignment of rear hub shoulder.
4. Indicate the pillow block at the 12 o'clock and 6 o'clock positions.
5. If required, shim under the pillow block, at front or back, until the maximum difference between the readings is 0.002 inch.
6. Reset the dial to zero and indicate at the 3 o'clock and 9 o'clock positions. If the difference between these two readings is greater than 0.002 inch, contact the Pennwalt Sharples customer service department.

I. INSTALL OUTER COVER

Figure 15-1:

1. Remove screws (8)—inner cover to pillow block.
2. Install:
   a. Outer cover (70) with O-ring (9)—establish oil line port location first
   b. Screws (8)—outer cover to pillow block
   c. Screws (8)—inner cover to pillow block

NOTE

The outer cover of the pillow block is fastened down before that of the inner cover. This will automatically establish the required gap between the pillow block and the inner cover.

   d. Screws (348) securing holder (347) to inner cover

J. INSTALL PULLEY

Figure 15-1:

1. Check surface of pulley diameter for burrs, nicks, etc.

NOTE

A new rear hub spacer (342) must be recalculated whenever any of the following items are replaced new:

Pulley (227), seal ring (100), flinger (99), bearing (68), rear hub nut (72), pillow block (11), inner or outer covers (67, 70).

Do so now referring to Figure 15-1 and paragraph L. Otherwise proceed as follows:

2. Heat pulley (227) in 212°F (maximum) oil.
3. Coat the locating diameters of the extension of the bowl rear hub with Never Seez or equivalent.
4. Install:
   a. Key (46-32)
   b. Hub nut spacer (342)
   c. Pulley (227)
   d. Screws (228)
5. Allow pulley (227) to cool, then check screws (228) for tightness.

K. INSTALL THRUST BEARING AND PULLEY SEALS

Figure 15-1:

1. Install bearing (77) outer race.
2. Install bearing (77) inner race.

NOTE

Whenever a new pulley is installed, it is necessary to recalculate the thickness of the tension bar spacers (84, 85). Refer to Chapter 18. Otherwise, proceed as follows:

3. Install tension bar nut (157)—fasten tightly with the tension bar nut wrench to position the bearing. Refer to Chapter 18.
4. Remove tension bar nut.
5. Install:
   a. Spacers (84,85)
   b. Assembled seal holder (78):
      O-ring (80)
      Seals and stabilizers (81, 159)
      Retaining ring (83)
   c. Screws (79)
6. Install tension bar nut (157), set screws (160,161)—see Figure 18-3; use the tension bar nut wrench.

7. If removed, install rotating assembly into frame—refer to Chapter 11.
8. Install feed tube and bracket—refer to Chapter 13.

L. NEW REAR HUB NUT SPACER

NOTE

A new rear hub nut spacer (342) must be recalculated whenever any of the following parts are replaced new:

Pulley (227), seal ring (100), flinger (99), bearing (68), rear hub nut (72), pillow block (11), inner or outer covers (67, 70).

Figure 15-1:

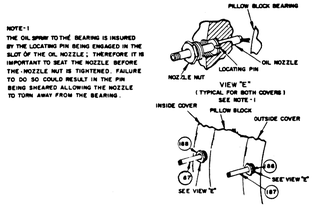
1. Measure dimension "L" of pulley and record.
2. Measure dimension "M" and record.
3. Dimension "K"or spacer (342) equals dimension "L" minus dimension "M".
4. Grind a spacer to this thickness. Seating surfaces to be parallel within 0.001 inch F.I.R.

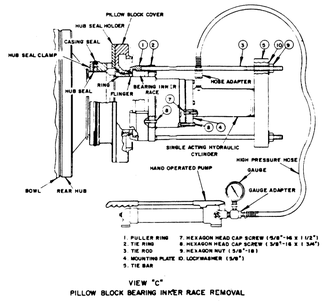
PILLOW BLOCK OIL PIPING

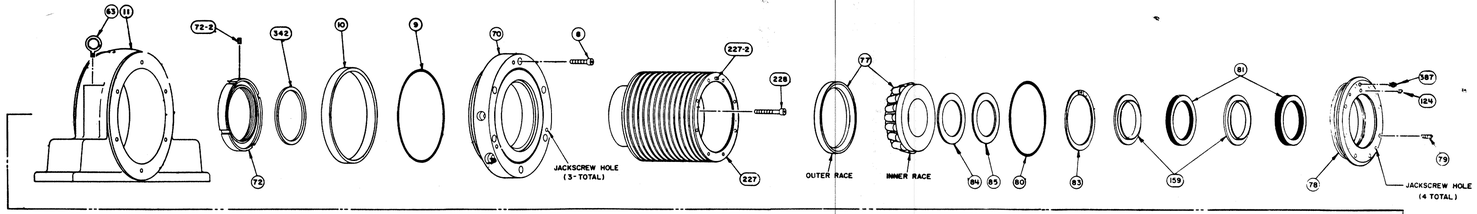
187. Oil Nozzle
188. Oil Nozzle Nut

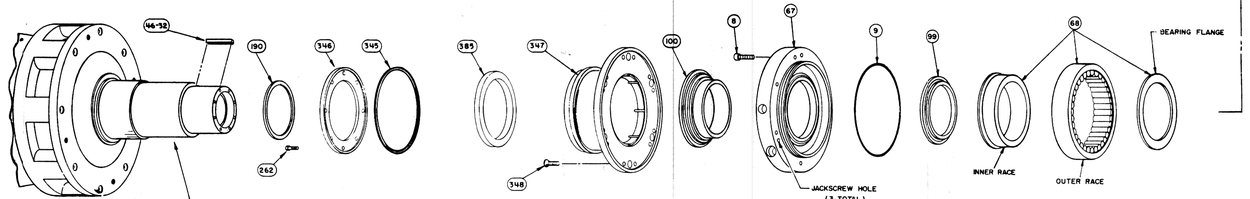
PILLOW BLOCK AND PULLEY ASSEMBLY

8. Hexagon Socket Head Cap Screw (⅝" - 11 x 2¼")
9. Pillow Block Cover O-Ring
10. Stabilizing Ring
11. Pillow Block
46-32. Key
63. Eyebolt (¾" - 10)
67. Pillow Block Cover (Inner)
68. Pillow Block Bearing
70. Pillow block Cover (Outer)
72. Bowl Hub Nut
72-2. Hexagon Socket Headless Set Screw (⅜" - 16 x ½")
77. Pulley Thrust Bearing
78. Pulley Seal Holder
79. Hexagon Socket Head Cap Screw (⅝" - 18 x ¾)
80. Pulley Seal Holder O-Ring
81. Pulley Seal
83. Pulley Seal Retaining Ring
84. Tension Bar Spacer
85. Tension Bar Spacer
99. Bowl Hub Flinger
100. Seal Ring
124. Pipe Plug (⅛" N.P.T.)
159. Pulley Seal Stabilizing Member
190. Pillow Block Bearing Spacer
227. Pulley
227-2. Dowel Pin (⅝ x ⅝)
228. Hexagon Socket Head Cap Screw (⅜ - 16 x 3¼)
262. Hexagor Socket Head Cap Screw (¼" - 20 x ¾")
342. Hub Nut Spacer
345. Casing Seal Ring
346. Bowl Hub Seal Clamp
347. Bowl Hub Seal Holder
348. Hexagon Socket Flat Head Screw (½' - 13 x 1¼")
385. Bowl Hub Seal
387. Lubricator (⅛" N.P.T.)



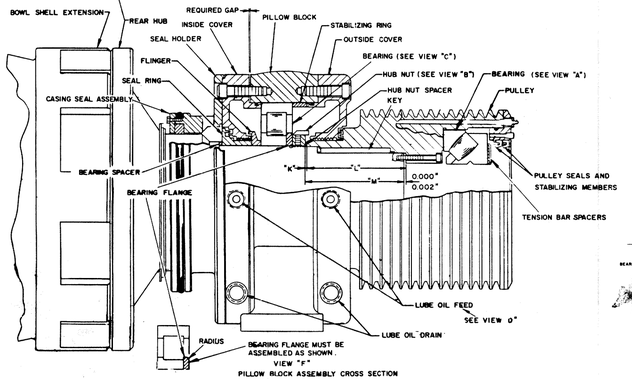


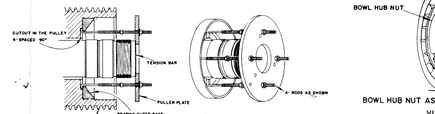




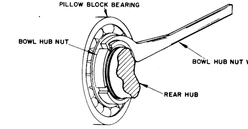

PULLEY ASSEMBLY LIFTING
APPROXIMATE WEIGHT= 200 LBS.


PILLOW BLOCK ASSEMBLY LIFTING
APPROXIMATE WEIGHT= 350 LBS.

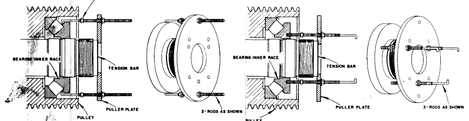




REMOVING THE BEARING OUTER RACE
TYPICAL FOR FAG AND SKF BEARINGS

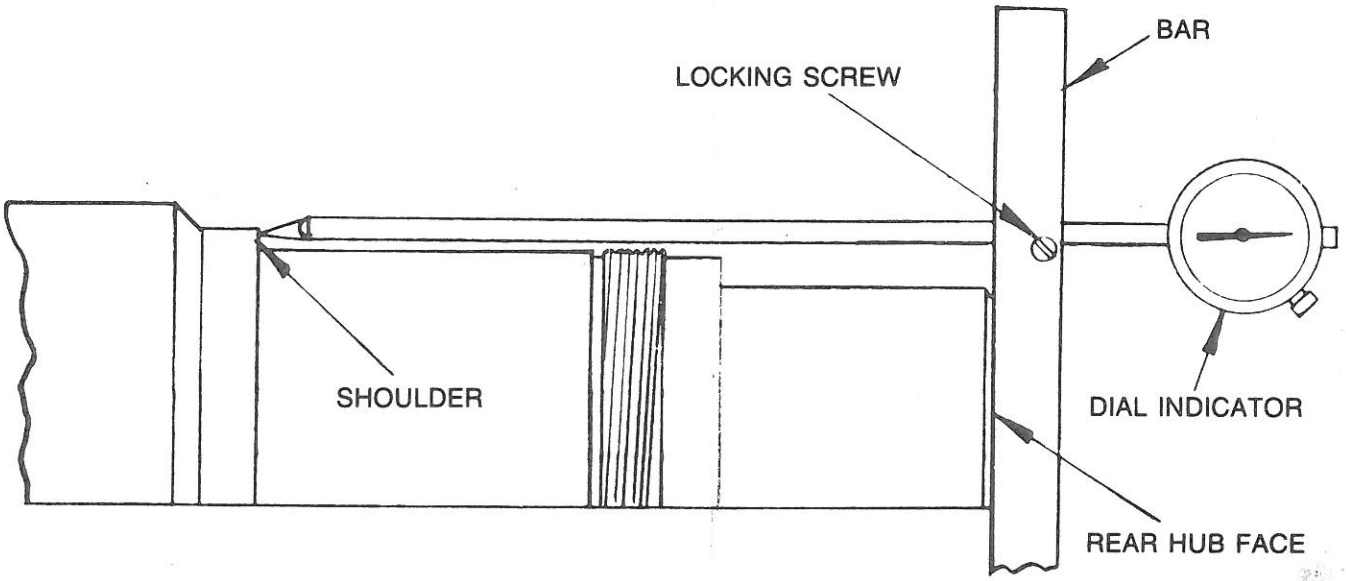


BOWL HUB NUT ASSEMBLY AND DISASSEMBLY
VIEW "B"



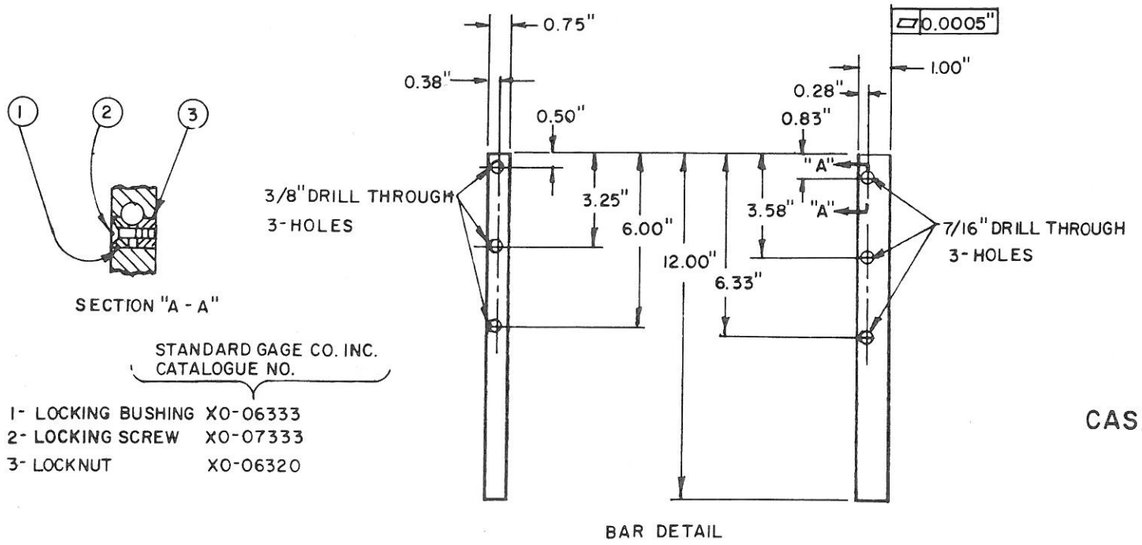
REMOVING THE PULLEY THRUST BEARING
VIEW "A"

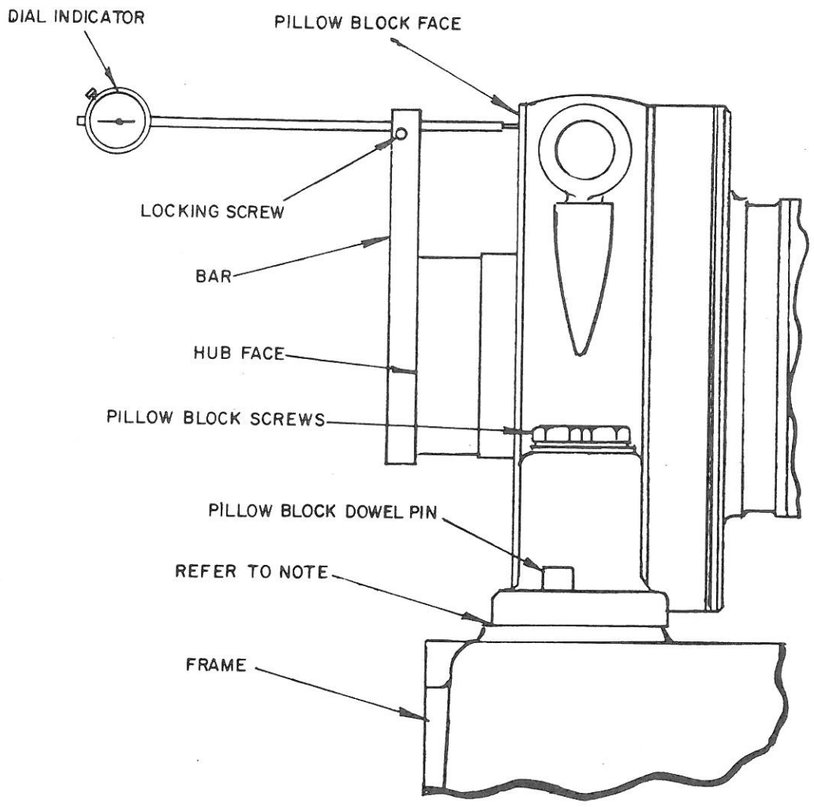
REAR PILLOW BLOCK AND PULLEY ASSEMBLY
FIGURE 15-1



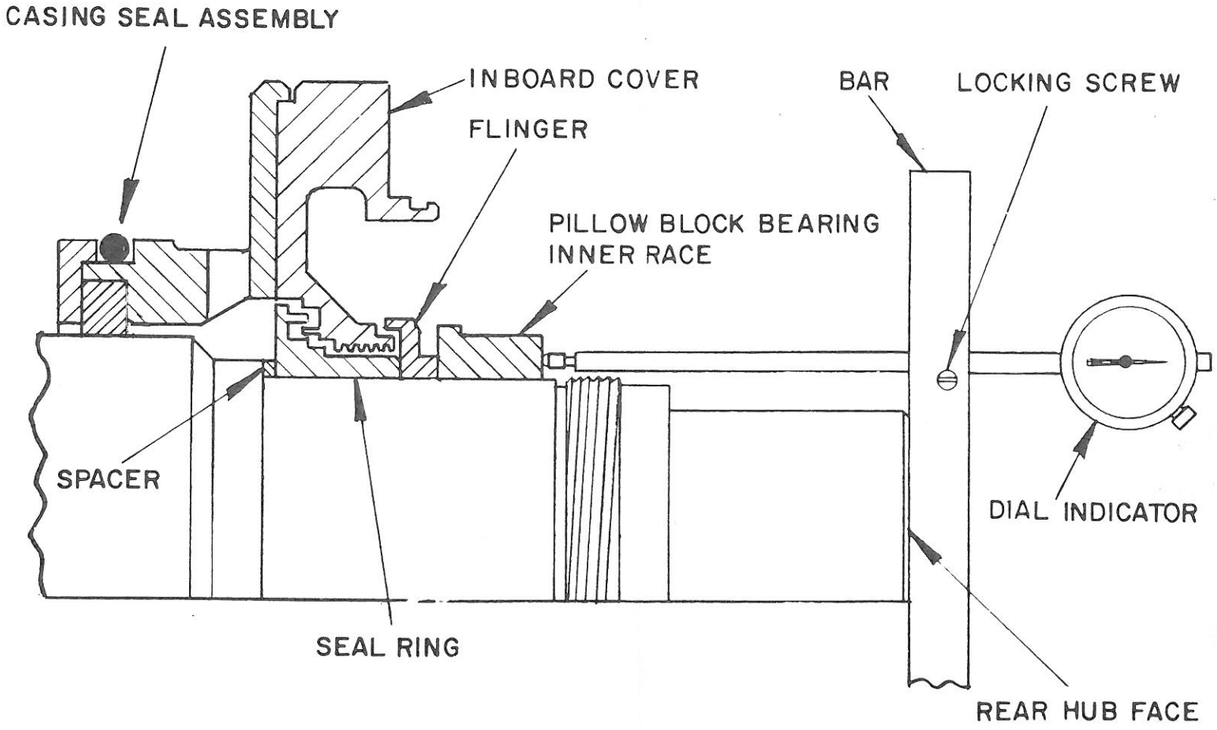
5/15/1
5/15/2
5/15/3

REAR HUB SHOULDER ALIGNMENT
FIGURE 15-2



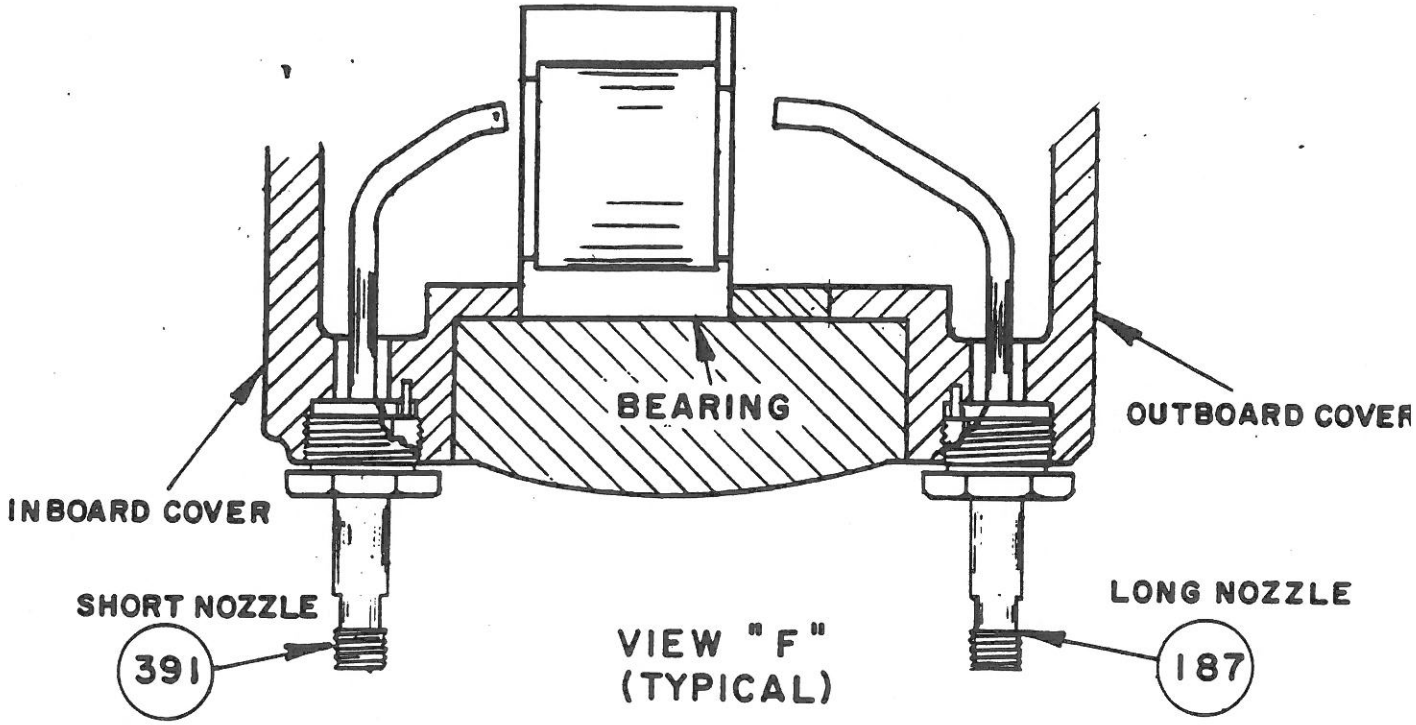


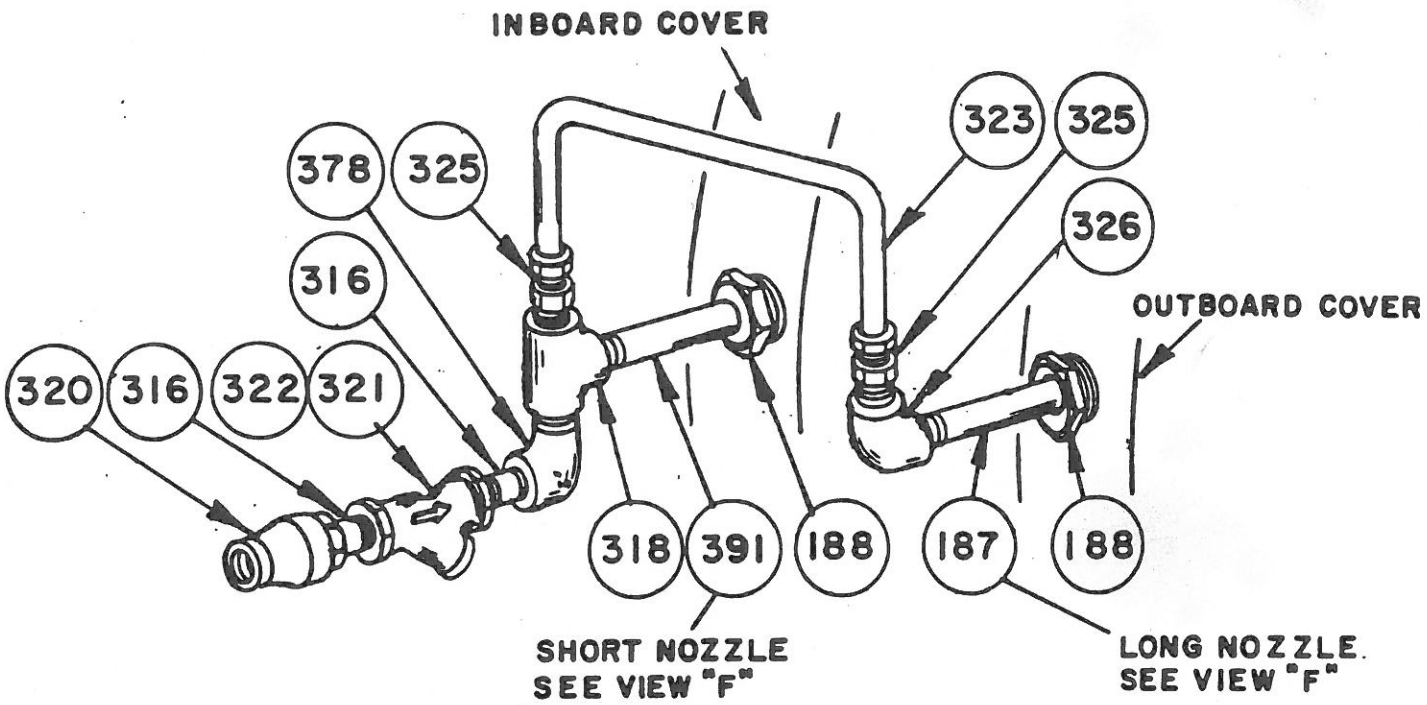
PILLOW BLOCK ALIGNMENT



BEARING INNER RACE ALIGNMENT

PILLOW BLOCK AND BEARING ALIGNMENT
FIGURE 15-3





SUPPLEMENT FOR FIGURES 14-1 and 15-1

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BULLETIN 5/16/3

CHAPTER 16
FRONT BOWL HUB, DAM, AND CONVEYOR FRONT BEARING INNER RACE AND SLEEVE

CONTENTS

A. Remove Bowl Front Hub Assembly 16-1
B. Remove Conveyor Front Bearing Inner Race and Sleeve 16-1
C. Install Conveyor Front Bearing Inner Race and Sleeve 16-2
D. Install Bowl Front Hub Assembly 16-2
E. Change Plate Dams 16-3
F. Disassemble Bowl Front Hub Assembly 16-3
G. Assemble Bowl Front Hub Assembly 16-3
Bowl Front Hub Assembly . . . . . Figure 16-1

A. REMOVE BOWL FRONT HUB ASSEMBLY

1. Remove:
   a. Rotating assembly from frame and set it in a horizontal position on a clean surface with "V" marks up—refer to Chapter 11
   b. Gear box—refer to Chapter 12
   c. Tension bar nut (157)—Figure 18-3; use the wrench provided

CAUTION

It is important tension bar nut be removed BEFORE bowl front hub to prevent possible damage to conveyor rear bearing or tension bar.

Figure 16-1:

2. Remove screws (46-48) and cover ring (46-47).
3. Support hub assembly as shown and apply a slight amount of tension on the sling.
4. Remove:
   a. Screws (46-6)
   b. Bowl front hub (46-1)—use jacking screws
5. Set the bowl front hub assembly down onto a wood support with the conveyor hub facing up.

B. REMOVE CONVEYOR FRONT BEARING INNER RACE AND SLEEVE

Figure 16-1:

Remove:

1. Screws (46-13)
2. Bearing retainer (46-12)

3. Bearing (129) inner race—use a standard bearing puller

NOTE
For conveyor front bearing outer race replacement, refer to Chapter 18. Complete bearing must be replaced.

4. Screws (46-9)
5. Sleeve (46-11)
6. O-ring (46-10)

NOTE
Remove conveyor hub only if damaged.

7. Screws (46-2)
8. Conveyor hub (46-14)

C. INSTALL CONVEYOR FRONT BEARING INNER RACE AND SLEEVE

1. If the conveyor hub (46-14) was removed, install:
   a. Conveyor hub (46-14)—use dowel pin (46-1-2) for alignment
   b. Screws (46-2)

CAUTION
Do not replace steel screws with ones of a different material.

2. Install:
   a. O-ring (46-10)
   b. Sleeve (46-11)
   c. Screws (46-9)
   d. Bearing (129) inner race
   e. Retainer (46-12)—use dowel pin for alignment
   f. Screws (46-13)

D. INSTALL BOWL FRONT HUB ASSEMBLY

1. Screw four 5 inch long threaded rods into the bowl shell for aligning and guiding front hub onto bowl shell.

Figure 16-1:

2. Support hub assembly as shown and guide the hub assembly toward the bowl.

NOTE
Align the "V" marks of the hub and shell.

3. To prevent stretching screws (46-6), fasten the bowl front hub to the bowl shell with STEEL screws. After the screws have seated, replace them with the stainless screws and torque as recommended in the Torque Seating Chart.

4. Install:

   a. Cover ring (46-47)
   b. Screws (46-48)
   c. Tension bar nut (157)—Figure 18-3; use the wrench provided
   d. Rotating assembly into frame—refer to Chapter 11
   e. Gear box—refer to Chapter 12

E. CHANGE PLATE DAMS

1. Remove upper casing—refer to Chapter 10.

Figure 2-2:

2. Remove:

   a. Screws (46-3)
   b. Retainer (46-38)
   c. Plate dam (46-5)
   d. Gasket (46-7)

3. Replace the dam and reassemble.
4. Install the upper casing—refer to Chapter 10.

F. DISASSEMBLE BOWL FRONT HUB ASSEMBLY

1. Remove the bowl front hub assembly—refer to Paragraph A.
2. Disassemble front pillow block and gear box adapter assembly—refer to Chapter 14.

G. ASSEMBLE BOWL FRONT HUB ASSEMBLY

1. Reassemble front pillow block and gear box adapter assembly—refer to Chapter 14.
2. Install bowl front hub assembly—refer to Paragraph D.

46-1. Bowl Front Hub

46-1-2. Dowel Pin

46-2. Hexagon Socket Head Cap Screw (½'' - 13 x 1½'')

46-8. Bowl Front Hub O-Ring (Large)

46-9. Hexagon Socket Head Cap Screw (⅜'' - 16 x 1'')

46-10. Bowl Front Hub O-Ring (Small)

46-11. Conveyor Front Bearing Hub Sleeve

46-12. Conveyor Front Bearing Retainer

46-13. Hexagon Socket Head Cap Screw (¼'' - 20 x ½'')

46-14. Conveyor Front Bearing Hub

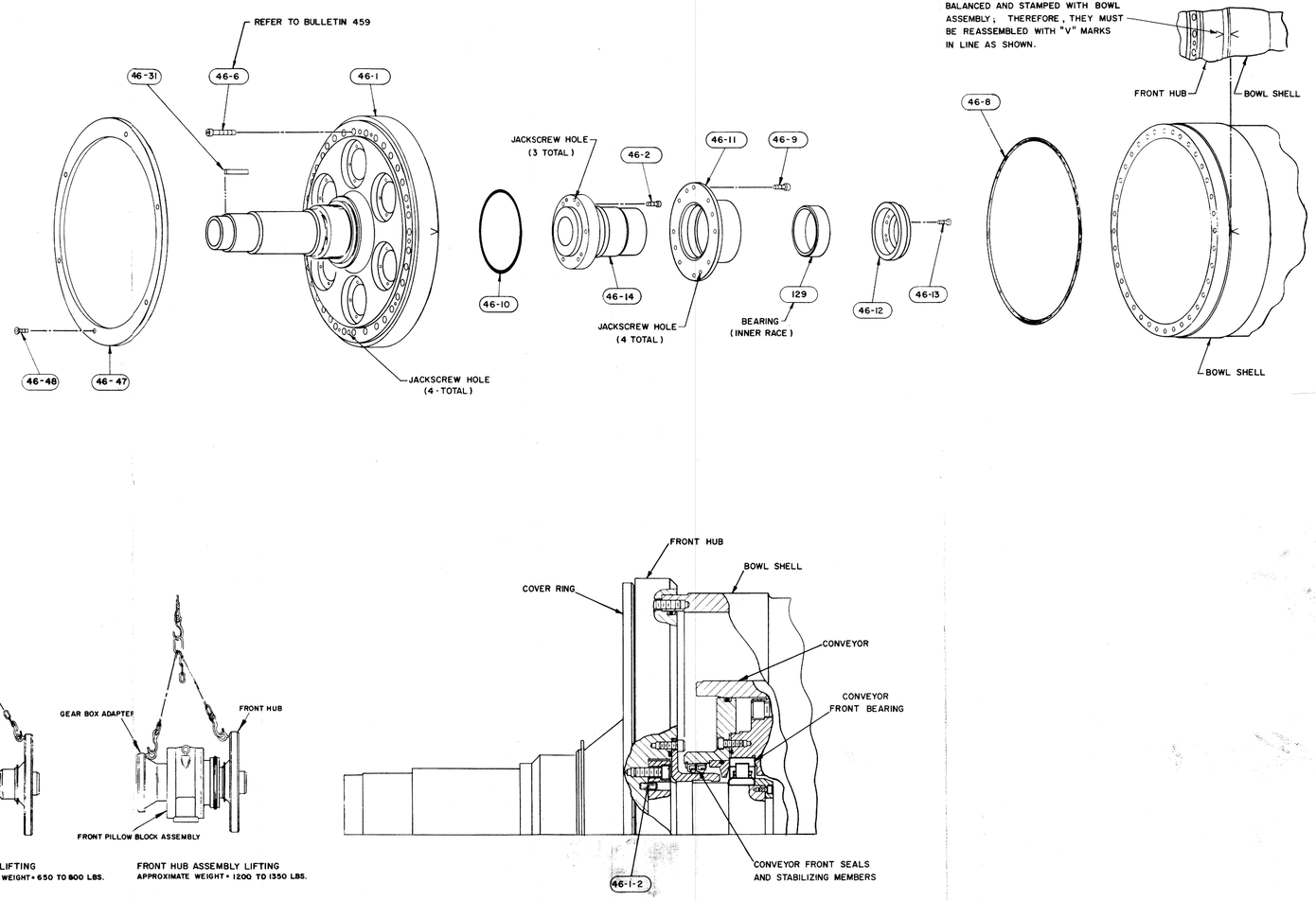
46-31. Bowl Front Hub Key

46-33. Hexagon Socket Head Cap Screw (¾'' - 10 x 2¼'')

46-47. Bowl Front Hub Cover Ring

46-48. Slotted Flat Head Cap Screw (⅜'' - 16 x ¾'')

129. Conveyor Front Bearing (Inner Race)



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BOWL FRONT HUB ASSEMBLY
FIGURE 16-1

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CHAPTER 17
REAR BOWL HUB AND REAR CONVEYOR BEARING AND SEAL

CONTENTS

A. Remove Bowl Rear Hub Assembly 17-1
B. Remove Conveyor Rear Bearing and Seal 17-1
C. Install Conveyor Rear Bearing and Seal 17-2
D. Install Bowl Rear Hub Assembly 17-2
E. Disassemble Bowl Rear Hub Assembly 17-3
F. Reassemble Bowl Rear Hub Assembly 17-3
Bowl Rear Hub Assembly . . . . . Figure 17-1

A. REMOVE BOWL REAR HUB ASSEMBLY

Remove:

1. Rotating assembly and set it in a horizontal position on a clean surface with "V" marks up—refer to Chapter 11
2. Conveyor—refer to Chapter 18

Figure 17-1:

3. Screws (46-33)
4. Rear hub assembly—use jacking screws

B. REMOVE CONVEYOR REAR BEARING AND SEAL

Figure 17-1:

Remove:

1. Screws (46-9)
2. Seal holder (46-20)—use jacking screws
3. Bearing (46-22)—use an arbor press as shown
4. Springs (46-24)
5. Retaining ring (46-44)
6. Stabilizing member (46-26)
7. Seal (46-25)

NOTE

The seal is retained by adhesive. To break the bead of adhesive between the seal and seal holder, place a ¼" square steel key or similiar object on the face of the seal in the area of the bead and strike the key with a hammer. Once the bead has been broken, the seal may be removed.

C. INSTALL CONVEYOR REAR BEARING AND SEAL

Figure 17-1:

1. Using fine emery cloth, clean any adhesive on the seal holder (46-20).
2. Thoroughly clean seal holder and seal (46-25) with a suitable safety solvent. Allow to dry.
3. Press seal into seal holder. Make sure seal is fully inserted and square with seal holder. Do not install stabilizing member (46-26) at this time.
4. Apply a small bead of Eastman 910 adhesive (Eastman Chemical Products, Kingsport, Tenn. or Loctite 06, Loctite Corp., Newington, Conn.) at the seal/seal holder interface. Apply the adhesive directly from the container.

WARNING
AVOID ALL CONTACT OF ADHESIVE WITH SKIN

5. Allow five minutes for wetting action, then wipe off excess adhesive with a clean cloth.
6. Install stabilizing ring (46-26) and retaining ring (46-44).
7. Allow 20 minutes for adhesive to cure before continuing assembly.
8. Install on seal holder:
   a. Springs (46-24)
   b. Bearing (46-22)—use an arbor press as shown

NOTE
The bearing when properly installed in the conveyor rear bearing seal holder will extend beyond the face of the seal holder. This is the function of the $^1/_8$'' spacer when installing the bearing. The spacer will guarantee that the bearing will position itself properly against the rear hub when the seal holder is bolted up to the rear hub.

If the conveyor rear bearing is installed improperly so it does not contact the rear hub as illustrated, premature failure of the bearing and/or belleville springs can result.

   c. O-ring (46-21)
9. Install assembled seal holder onto rear hub with screws (46-9)—align with the dowel pin.

D. INSTALL BOWL REAR HUB ASSEMBLY

1. Screw four 5 inch long threaded rods into the bowl shell extension to align and guide the hub onto the bowl shell extension.

Figure 17-1:

2. Support hub assembly as shown and guide it toward the bowl.

NOTE
Align the ''V'' marks of the hub and shell extension.

3. To prevent stretching screws (46-33), fasten the bowl rear hub to the bowl shell with STEEL screws. After the screws have seated, replace them with the stainless screws and torque as recommended in the Torque Seating Chart.
4. Install:
   a. Conveyor assembly—refer to Chapter 18
   b. Bowl front hub assembly—refer to Chapter 16
   c. Gear box—refer to Chapter 12
5. Install rotating assembly into frame—refer to Chapter 11

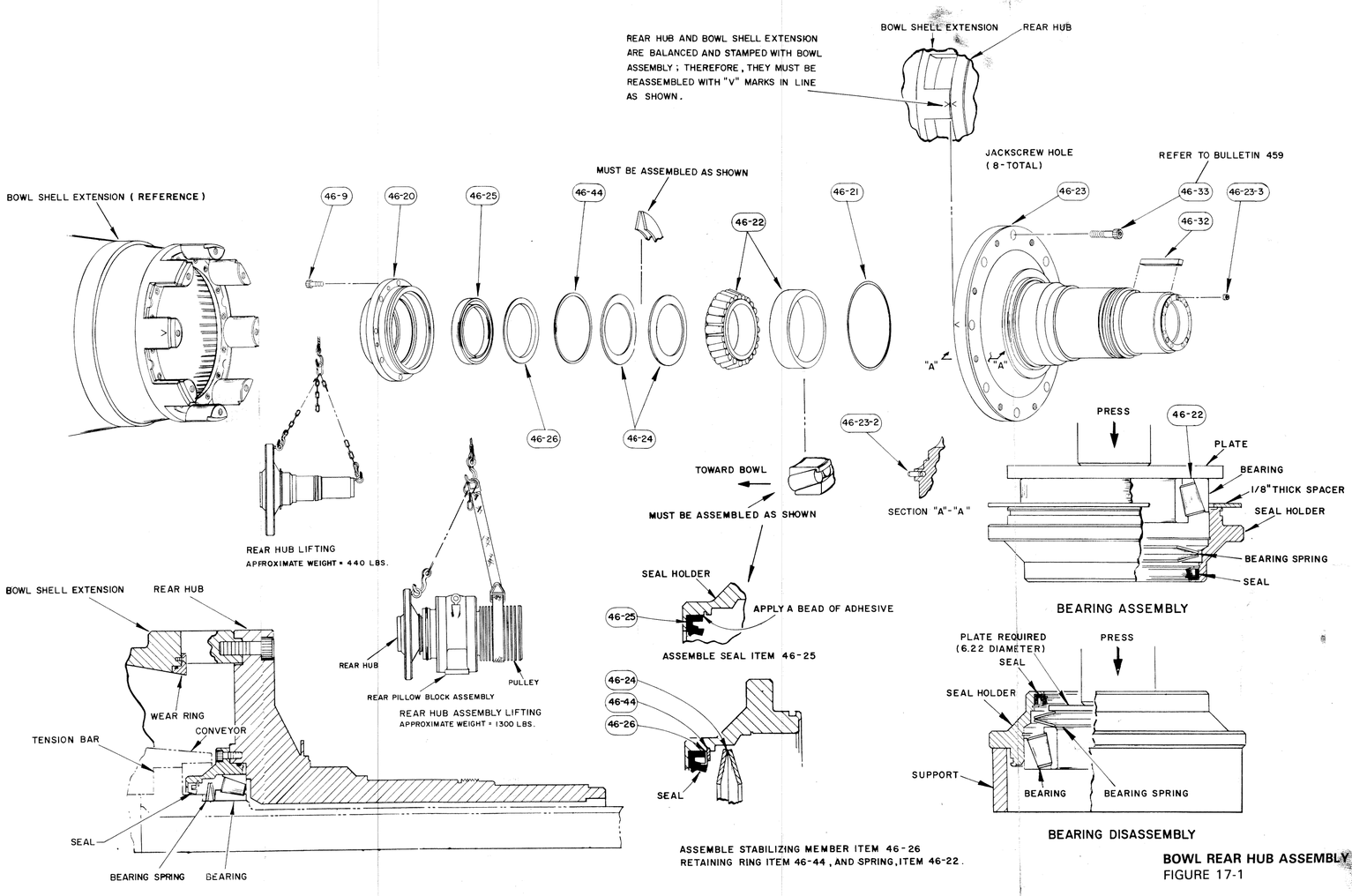
E. DISASSEMBLE BOWL REAR HUB ASSEMBLY

1. Remove bowl rear hub assembly—refer to paragraph A of this chapter.
2. Disassemble rear pillow block and pulley assembly—refer to Chapter 15.

F. REASSEMBLE BOWL REAR HUB ASSEMBLY

1. Reassemble rear pillow block and pulley assembly—refer to Chapter 15.
2. Install bowl rear hub assembly—refer to Paragraph D of this chapter.

46-9. Hexagon Socket Head Cap Screw (3/8'' - 16 x 1'')
46-20. Conveyor Rear Bearing Seal Holder
46-21. Conveyor Rear Bearing Seal Holder O-Ring
46-22. Conveyor Rear Bearing
46-23. Bowl Rear Hub
46-23-2. Dowel Pin (½'' Dia. x 1¼'')
46-23-3. Hexagon Socket Headless Set Screw (½'' - 13 x ½'')
46-24. Conveyor Rear Bearing Spring
46-25. Conveyor Rear Bearing Seal
46-26. Rear Seal Stabilizing Member
46-32. Bowl Rear Hub Key
46-33. Hexagon Socket Head Cap Screw (¾'' - 10 x 2¼'')
46-44. Conveyor Rear Bearing Seal Retaining Ring



BOWL REAR HUB ASSEMBLY
FIGURE 17-1

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BULLETIN 5/18/5

CHAPTER 18
CONVEYOR, SPLINE BUSHING, AND TENSION BAR ASSEMBLIES

CONTENTS

A. Remove Conveyor Front Seals and Bearing Outer Race 18-1
B. Remove Spline Shaft 18-2
C. Remove Conveyor Front Bearing Inner Race and Sleeve 18-2
D. Remove Conveyor Assembly 18-2
E. Remove Conveyor Rear Bearing and Seal 18-3
F. Remove Spline Bushing 18-3
G. Remove Tension Bar 18-3
H. Remove Accelerator, Feed Nozzles, and Feed Zone Liner 18-3
I. Remove Feed Cone Inserts 18-4
J. Install Feed Cone Inserts 18-4
K. Install Feed Zone Liner, Feed Nozzles and Accelerator 18-4
L. Install Spline Bushing and Bearing Outer Race 18-4
M. Install Conveyor Rear Bearing and Seal 18-5
N. Install Conveyor Front Bearing Inner Race and Sleeve 18-5
O. Install Tension Bar 18-5
P. Install Conveyor Assembly 18-5
Q. Install Spline Shaft 18-5
R. Install Conveyor Front Seals 18-6
S. Tension Bar Spacer Calculations and Tension Bar Runout Check 18-6
Conveyor Assembly . . . . . Figure 18-1
Conveyor Lifting . . . . . Figure 18-2
Tension Bar Spacer Calculations and Runout Check . . . . . Figure 18-3

A. REMOVE CONVEYOR FRONT SEALS AND BEARING OUTER RACE

NOTE
It is not necessary to remove the conveyor from the bowl to service the conveyor front seals and bearing.

Remove:

1. Tension bar nut (157) — use the wrench provided. See Figure 18-3.

2. Bowl front hub assembly — refer to Chapter 16.

Figure 18-1:

3. Screws (24)

4. Seal holder (108) from spline bushing (26) — use seal holder removal tool.

5. O-rings (25, 27)

6. Seal retainer (379)

7. O-ring (380)

8. Stabilizing members (152) and seals (109)

NOTE

The seals (109) are retained by adhesive. To break the bead of adhesive between the seals and seal holder (108), place a 1/4" square steel key or similar object on the face of the seal in the area of the bead and strike the key with a hammer. Use care not to damage the seal holder. Once the bead has been broken, the seal may be removed.

9. Bearing (129) outer race and roller — use a standard bearing puller.

B. REMOVE SPLINE SHAFT

Figure 18-1:

Remove:

1. Screws (375)

2. Split ring (374)

3. Spline shaft (122)

C. REMOVE CONVEYOR FRONT BEARING INNER RACE AND SLEEVE

Refer to Chapter 16.

D. REMOVE CONVEYOR ASSEMBLY

1. Remove:

Figure 18-1:

a. Tension bar nut (157) — use the wrench provided. See Figure 18-3
b. Bowl front hub assembly — refer to Chapter 16
c. Pulley, seal assembly, and thrust bearing — refer to Chapter 15
d. Screws (24)
e. Seal holder (108)

Figure 18-2:

2. Mount the conveyor lifter to the spline bushing.

3. As the conveyor (41) is moving out of the bowl, make sure the weight is balanced.

CAUTION

Use extreme care to prevent damage to optional conveyor wear tiles during removal of conveyor. Lay conveyor on a wooden platform or optional conveyor truck.

4. Remove lifter.

5. Install tension bar protecting cap.

E. REMOVE CONVEYOR REAR BEARING AND SEAL

Refer to Chapter 17.

F. REMOVE SPLINE BUSHING

NOTE

The spline bushing is an assembly of two components with interference fit, and SHOULD NOT be disassembled. The parts are machined and balanced as a unit.

Figure 18-1:

Remove:

1. Screws (6)
2. Assembled spline bushing (26):
   a. Screws (31)
   b. Spline bushing cap (30)
   c. Gasket (29)
   d. Spring screw (143)
   e. Washer (142)
   f. Spring (141)

G. REMOVE TENSION BAR

Figure 18-1:

Remove:

1. Screws (41-13)
2. Tension bar (41-12) — use jacking screws

H. REMOVE ACCELERATOR, FEED NOZZLES, AND FEED ZONE LINER

Figure 18-1:

Remove:

1. Screws (41-3)
2. Accelerator (41-2) — insert a long 2 inch x 4 inch wooden board in tension bar end of conveyor and drive out with an 8-12 pound sledge hammer.
3. Feed Nozzles (41-9) — remove through interior of conveyor. See Figure 18-1, section D.
4. Feed zone liner (41-5) — remove same as accelerator.

I. REMOVE FEED CONE INSERTS

Figure 18-1:

Remove:

1. Screws (41-22)
2. Retainer (41-21)
3. Feed cone insert (41-20)

J. INSTALL FEED CONE INSERTS

Figure 18-1:

Install:

1. Feed cone insert (41-20)
2. Retainer (41-21)
3. Screws (41-22)

K. INSTALL FEED ZONE LINER, FEED NOZZLES, AND ACCELERATOR

Figure 18-1:

Install:

1. New O-ring (41-4) on feed zone liner (41-5)
2. Feed zone liner (41-5) — line up the openings for the nozzles
3. Feed nozzles (41-9))
4. New O-ring (41-4) on accelerator (41-2)
5. Accelerator (41-2) — use a long threaded rod in accelerator to guide into place
6. Screws (41-3)

L. INSTALL SPLINE BUSHING AND BEARING OUTER RACE

1. Assemble spline bushing cap items:
   a. Cap (30)
   b. Spring (141)
   c. Washer (142)
   d. Screw (143)
2. Assemble spline bushing items:
   a. Assembled cap
   b. Gasket (29)
   c. Spline bushing (26)

d. Screws (31)

e. Bearing (129) — press in

f. O-ring (27)

3. Install assembled spline bushing with screws (6).

M. INSTALL CONVEYOR REAR BEARING AND SEAL

1. Install conveyor rear bearing and seal — refer to Chapter 17.

2. Install bowl rear hub and pillow block assembly on bowl shell extension — refer to Chapter 17.

NOTE
Do not install pulley, seals or thrust bearing at this time.

N. INSTALL CONVEYOR FRONT BEARING INNER RACE AND SLEEVE

Refer to Chapter 16.

O. INSTALL TENSION BAR

Figure 18-1:

Install:

NOTE
Mating faces of the tension bar and conveyor bore must be clean and free of nicks and burrs.

1. Tension bar (41-12) — apply anti-galling compound to the surfaces which mate with the conveyor.

2. Screws (41-13))

P. INSTALL CONVEYOR ASSEMBLY

Figure 18-2:

1. Install lifter onto spline bushing.

Figure 18-1:

2. Remove tension bar protecting cap.

3. Install conveyor assembly (41) into bowl.

4. Remove conveyor lifter.

Q. INSTALL SPLINE SHAFT

Figure 18-1:

Install:

1. Spline shaft (122) — use anti-galling compound on splines

2. Split ring (374)

3. Screws (375)

R. INSTALL CONVEYOR FRONT SEALS

Figure 18-1:

1. Using fine emery cloth, clean any adhesive on the seal holder (108).

2. Thoroughly clean seal holder and seals (109) with a suitable safety solvent. Allow to dry.

3. Fully insert first seal and stabilizing member (109,152) into seal holder. Make sure seal is fully inserted and square with seal holder. See View "F".

4. Apply a small bead of Eastman -910 adhesive (Eastman Chemical Products, Kingsport, Tenn.) or Loctite 06 (Loctite Corp., Newington, Conn.) at the seal/seal holder interface. Apply the adhesive directly from the container.

WARNING
AVOID ALL CONTACT OF ADHESIVE WITH SKIN.

5. Allow five minutes for wetting action, then wipe off excess adhesive with a clean cloth.

6. Install second seal and stabilizing member. Refer to steps 3, 4 and 5.

7. Allow 20 minutes to set before continuing assembly.

8. Install O-ring (380).

9. Install seal retainer (379).

10. Install:
    a. O-rings (25, 27)
    b. Assembled seal holder (108)
    c. Screws (24)

S. TENSION BAR SPACER CALCULATIONS AND TENSION BAR RUNOUT CHECK

NOTE
After all conveyor maintenance has been performed, it is necessary to check for proper spacer (84, 85) thickness and tension bar runout. Correct runout is an indication the rotating assembly has been properly reassembled.

1. Install the bowl front hub assembly — refer to Chapter 16. Do not install the gear box etc.

2. Install pulley and pulley thrust bearing — refer to Chapter 15. Do not install the pulley seal assembly.

Figure 18-3:

3. Install tension bar nut (157) with wrench to position bearing and to take up all clearance.

4. Tension bar nut must bottom on shoulder of tension bar and inner race of pulley thrust bearing.

5. Tension Bar Spacer Calculations:

Figure 18-3:

a. Measure dimension "R" through opening in bowl shell extension and record (View "A").

b. Spacer thickness (84, 85) or dimension "N" is equal to dimension "R" minus 0.320 inch.

c. Remove tension bar nut and add spacers singly or in combination to obtain proper thickness. Grinding of either spacer (84, 85) may be required. Seating surfaces to be parallel within 0.001 inch F.I.R. Reinstall tension bar nut and measure "R" again (View "B"). "R" should now measure from 0.300 to 0.340 inch.

NOTE

Maximum permissible deviation of "N" is ±0.020 inch.

6. Tension Bar Runout Check:

NOTE

This runout check may be performed after the bowl and assemblies have been reinstalled into the frame, especially if the maintenance procedures were not extensive enough to require removing the bowl from the frame.

Figure 18-3:

a. Attach the base end of a dial indicator to the pulley, and the indicating end to the surface of the tension bar nut.

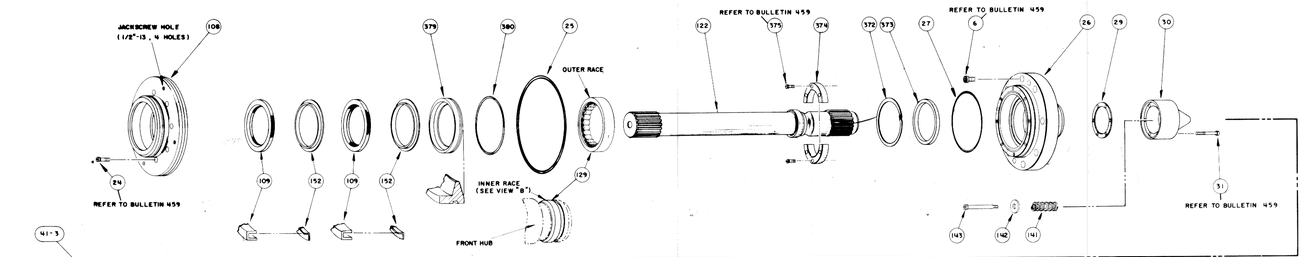
b. Hold the bowl stationary and rotate the conveyor by turning the spline shaft. Use a strap wrench. Do not use a pipe wrench.

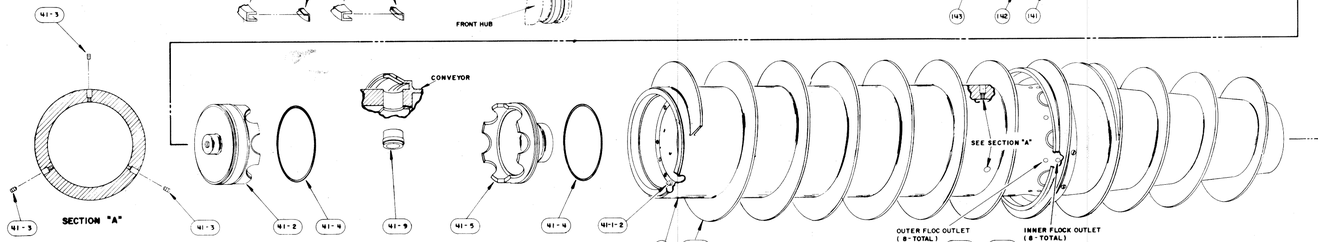
c. Runout should not exceed 0.004 inch. If it does, contact Pennwalt Sharples customer service department.

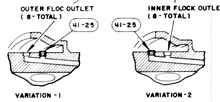
7. Install pulley seal assembly as directed in Chapter 15.

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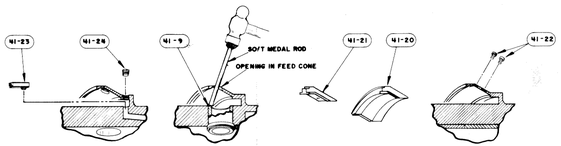
6. Hexagon Socket Head Cap Screw (3/4" - 10 x 2-1/4")
24. Hexagon Socket Head Cap Screw (3/8" - 16 x 1")
25. Conveyor Front Bearing Seal Holder Large O-Ring
26. Spline Bushing
27. Conveyor Front Bearing Seal Holder Small O-Ring
29. Spline Bushing Cap Gasket
30. Spline Bushing Cap
31. Hexagon Socket Head Cap Screw (3/8" - 16 x 3")
41. Conveyor Assembly
41-1. Conveyor
41-1-2. Dowel Pin (3/4" Dia. x 1-1/2")
41-2. Accelerator
41-3. Hexagon Socket Headless Set Screw (1/2" - 13 x 1")
41-4. Accelerator and Feed Zone Liner O-Ring
41-5. Feed Zone Liner
41-9. Feed Nozzle (Set of Eight)
41-12. Tension Bar
41-13. Hexagon Socket Head Cap Screw (3/4" - 10 x 2-1/4")
41-20. Feed Cone Insert
41-21. Feed Cone Insert Retainer
41-22. Hexagon Socket Head Cap Screw (1/4" - 20 x 1/2")
41-23. Floc Transfer Nozzle
41-24. Floc Transfer Nozzle Set Screw
41-25. Pipe Plug (3/8" N.P.T.)
108. Front Conveyor Bearing Seal Holder
109. Conveyor Front Bearing Seal
122. Spline Shaft
129. Conveyor Front Bearing
141. Spline Bushing Spring
142. Spline Bushing Spring Washer
143. Spline Bushing Spring Screw
152. Front Seal Stabilizing Member
203. Spacer Ring.
372. Retaining Ring
373. Bushing
374. Split Ring
375. Hexagon Socket Head Cap Screw (3/8" - 16 x 1-1/4")
379. Conveyor Front Bearing Seal Retainer
380. Conveyor Front Bearing Seal Retainer O-Ring







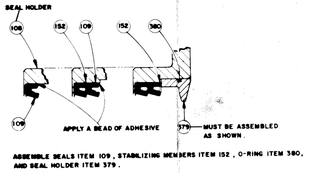
SECTION "H"



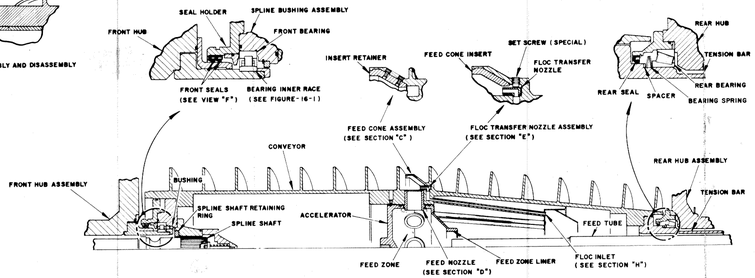
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FLOC TRANSFER NOZZLE ASSEMBLY AND DISASSEMBLY

SECTION "D"
FEED NOZZLE DISASSEMBLY

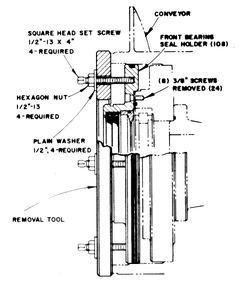
SECTION "C"
FEED CONE INSERT ASSEMBLY AND DISASSEMBLY



VIEW "F"

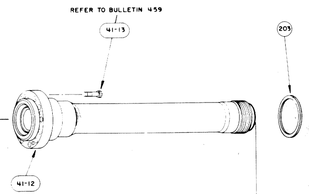


CONVEYOR ASSEMBLY CROSS SECTION
VIEW "B"

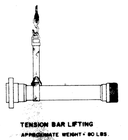


SECTION "G"
FRONT BEARING SEAL HOLDER REMOVAL

SECTION "G"

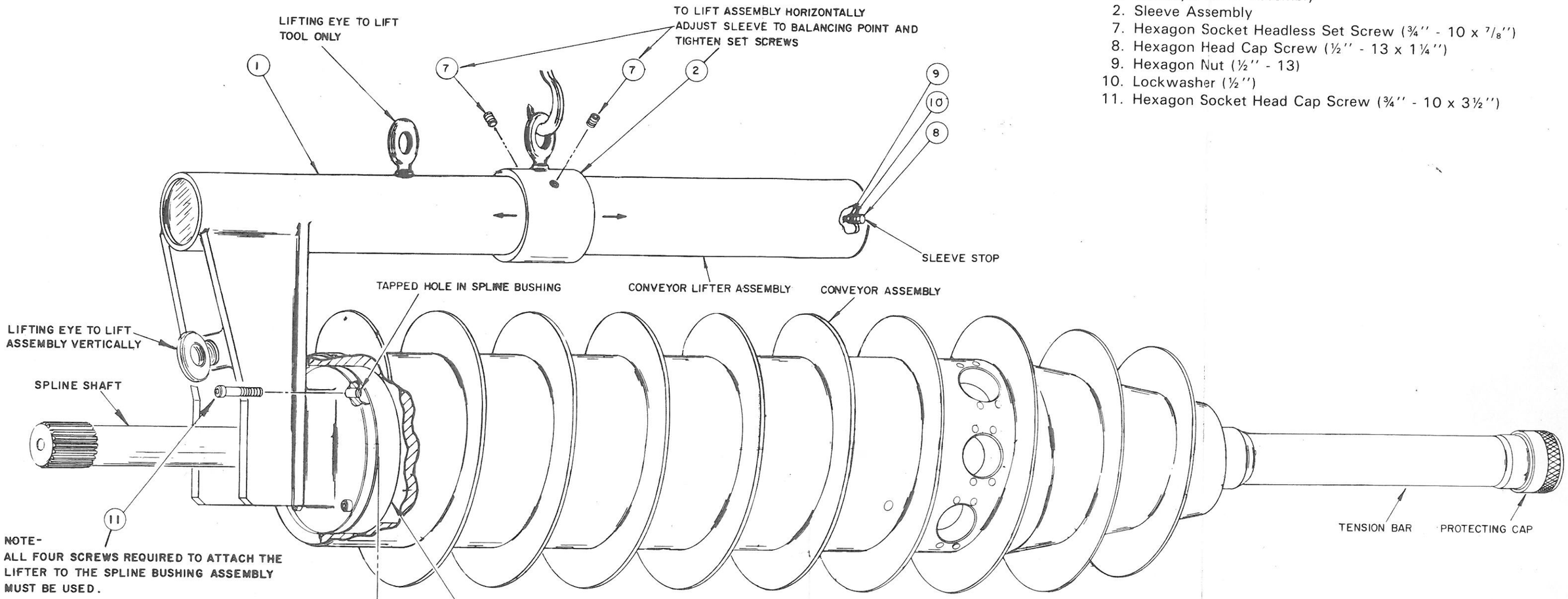




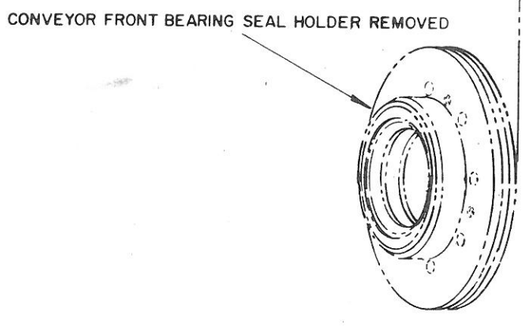


CONVEYOR ASSEMBLY
FIGURE 18-1

1. Conveyor Lifter Assembly
2. Sleeve Assembly
7. Hexagon Socket Headless Set Screw (¾'' - 10 x $^{7}/_{8}$'')
8. Hexagon Head Cap Screw (½'' - 13 x 1¼'')
9. Hexagon Nut (½'' - 13)
10. Lockwasher (½'')
11. Hexagon Socket Head Cap Screw (¾'' - 10 x 3½'')



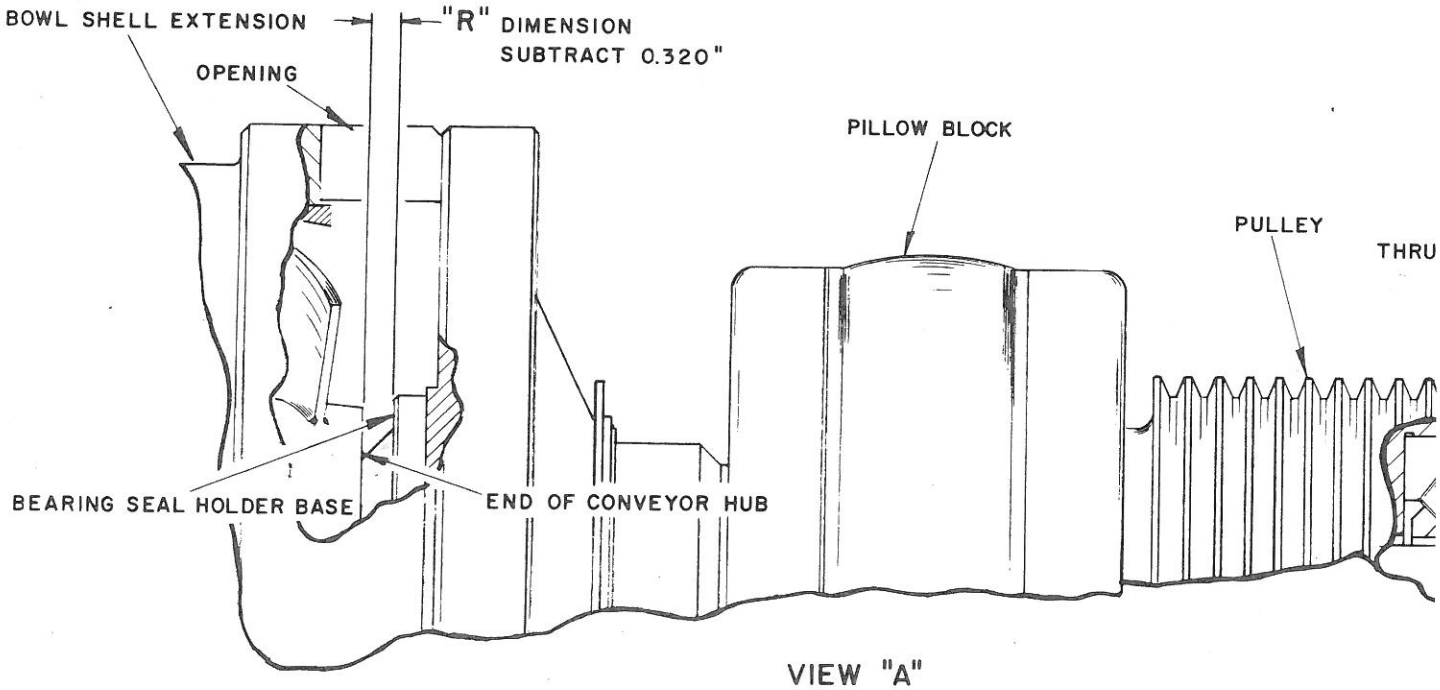
NOTE-
ALL FOUR SCREWS REQUIRED TO ATTACH THE LIFTER TO THE SPLINE BUSHING ASSEMBLY MUST BE USED.



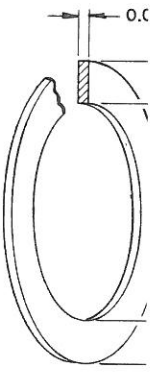
CONVEYOR ASSEMBLY
APPROXIMATE WEIGHT = 2700 LBS.

CONVEYOR LIFTER ASSEMBLY
APPROXIMATE WEIGHT = 450 LBS.

CONVEYOR LIFTING
FIGURE 18-2

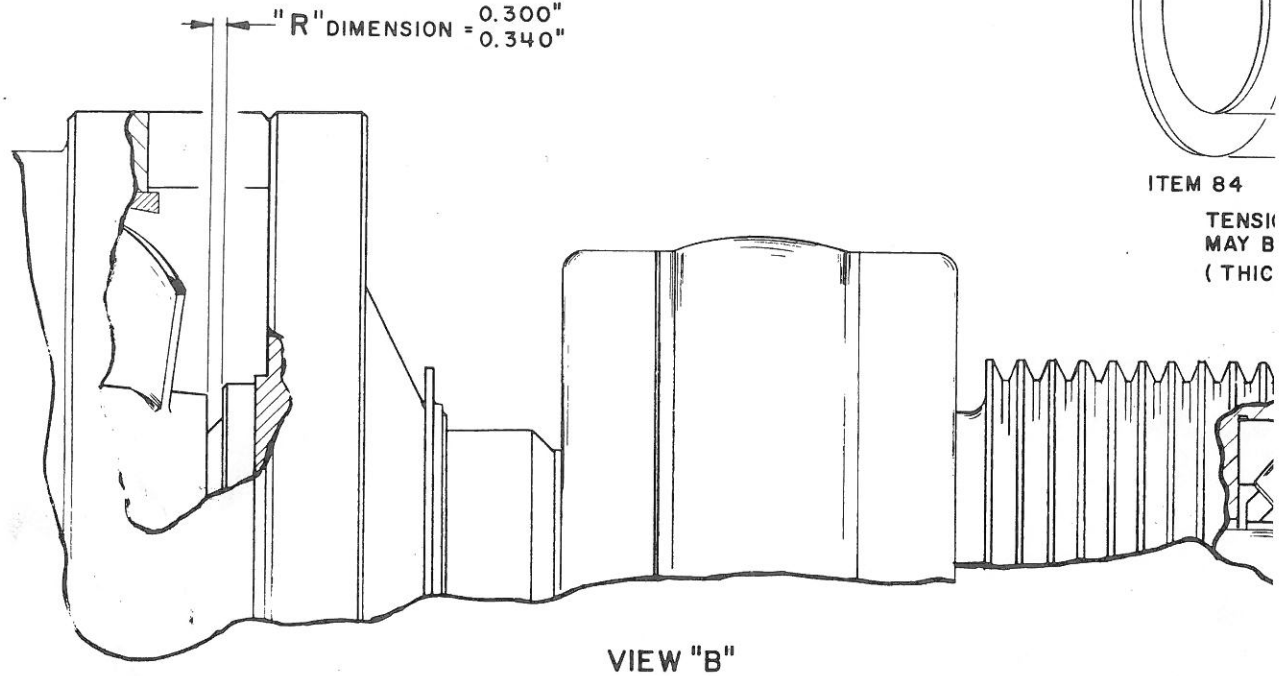


VIEW "A"



ITEM 84

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VIEW "B"

BULLETIN 5/19/5

CHAPTER 19
BOWL SHELL ASSEMBLY

CONTENTS

A. Bowl Cleaning 19-1
B. Disassemble Bowl 19-2
C. Replace Wear Sleeves 19-2
D. Replace Bowl Shell Liner 19-3
E. Reassemble Bowl 19-3
Bowl Shell Assembly . . . . . Figure 19-1

A. BOWL CLEANING

There are several methods recommended for cleaning a bowl. The following are in order of preference:

1. At shutdown, while the centrifuge is coasting to a stop, flush the bowl with hot water.

CAUTION
If the bowl shell extension is equipped with wear tiles, do not use water hotter than 140°F (60°C) and do not use caustic. This could remove the tiles.

2. Rotate the bowl forward and backward.

   a. Lift the upper casing—refer to Chapter 10.
   b. Two people are required to rotate the bowl, one person on each side of the bowl. If centrifuge is equipped with a backdrive, hold pinion shaft while rotating bowl.

WARNING
DO NOT ROTATE THE BOWL BY PULLING ON THE BELTS. FINGERS CAN BE INJURED BY PULLEY.

3. Disassemble the bowl and clean the parts as required.

CAUTION
Do not steam clean the interior of the bowl shell extension if it is equipped with wear tiles. Also do not use water hotter than 140°F (60°C) or use caustic. This could remove the tiles.

B. DISASSEMBLE BOWL

Remove:

1. Rotating assembly from frame—refer to Chapter 11. Set it in a horizontal position on a clean surface with "V" marks up
2. Gear box—refer to Chapter 12
3. Front hub assembly—refer to Chapter 16
4. Conveyor—refer to Chapter 18
5. Rear hub assembly—refer to Chapter 17

NOTE

Prior to removing rear hub assembly, tape around each wear sleeve (46-15-2-2) to prevent loss or breakage if the epoxy bond has failed—see Figure 19-1. If necessary, replace or reinstall wear sleeves as directed in subsequent paragraph C.

C. REPLACE WEAR SLEEVES

Figure 19-1:

1. Before reassembling bowl, inspect wear sleeves (46-15-2-2). They may have come loose or be worn and need replacing.
2. Replacement Procedure:
   a. Remove screws (46-36), wear ring (46-34), and O-ring (46-35).
   b. Remove tape from each sleeve and tap edge lightly with a brass hammer to ensure bond is secure. If not:

      (1) Completely remove loose wear sleeve (46-15-2-2).
      (2) Clean all surfaces to remove any process material or old epoxy.

      NOTE

      Do not use tools or abrasives that would damage any of the finished surfaces.

      (3) Stir each epoxy component for uniform consistency then proportion one part by weight of Emerson Cuming Eccobond 45 to one part by weight Catalyst 15 and mix thoroughly.
      (4) Apply epoxy to both surfaces.
      (5) Assemble sleeve, applying sufficient pressure to squeeze out excess epoxy. Wipe off excess and use a fixture to clamp wear sleeve securely until the epoxy has set (about 24 hours).
      (6) Remove fixture and check if bond is secure.

   c. Install O-ring (46-35), wear ring (46-34), and screws (46-36).

D. REPLACE BOWL SHELL LINER

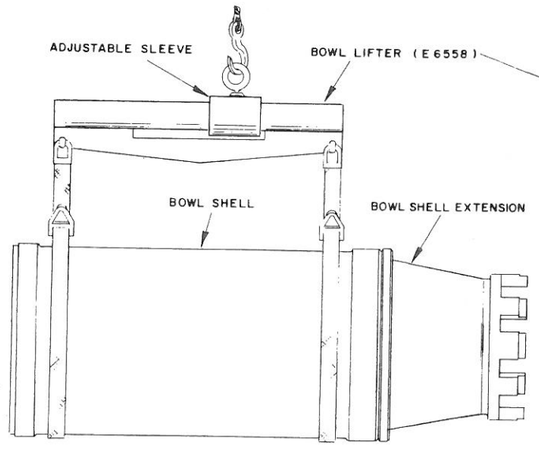
Figure 19-1:

If it is necessary to replace bowl shell liner (46-15-4), contact Pennwalt Sharples customer service department.

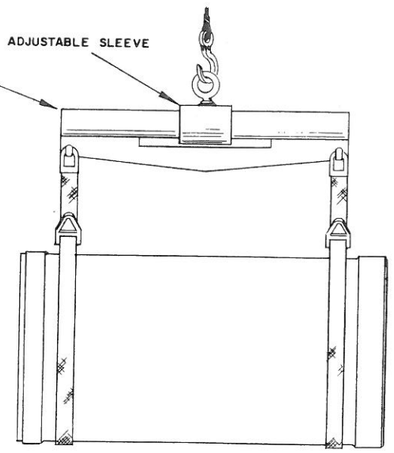
E. REASSEMBLE BOWL

Install:

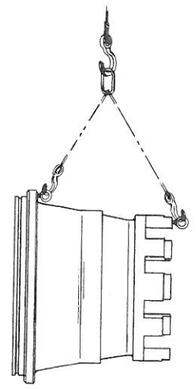
1. Rear hub assembly—refer to Chapter 17
2. Conveyor—refer to Chapter 18
3. Front hub assembly—refer to Chapter 16
4. Gear box—refer to Chapter 12
5. Rotating assembly into the frame—refer to Chapter 11



BOWL SHELL ASSEMBLY
APPROXIMATE WEIGHT = 3300 LBS.



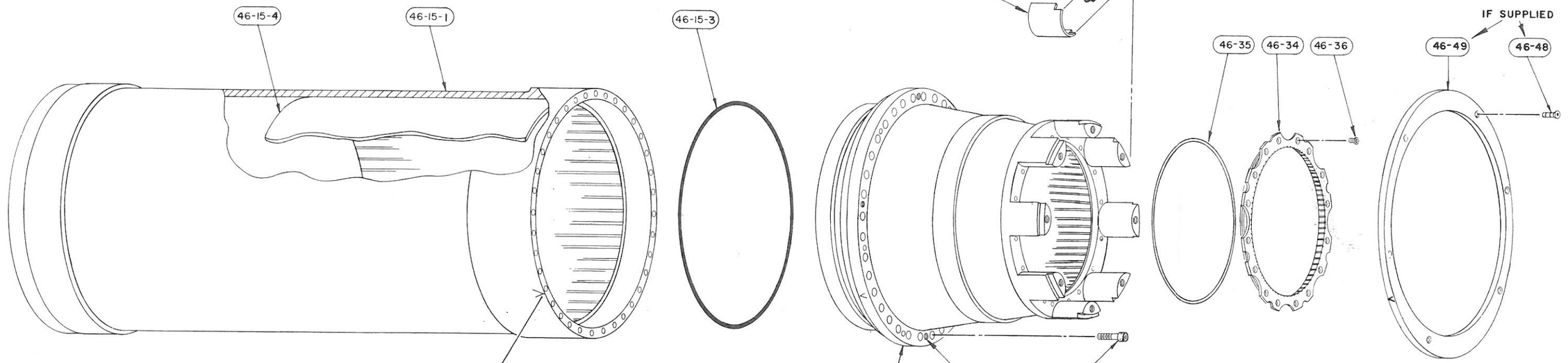
BOWL SHELL



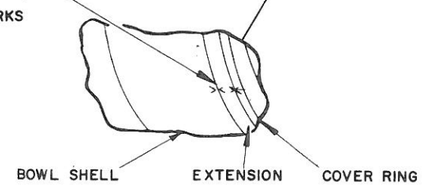
BOWL SHELL EXTENSION

46-15. Bowl Shell Assembly
46-15-1. Bowl Shell
46-15-2. Bowl Shell Extension
46-15-2-2. Wear Sleeve
46-15-3. Bowl Shell Extension O-Ring
46-15-4. Bowl Shell Liner (Rear)
46-15-5. Hexagon Socket Head Cap Screw (¾'' - 10 x 2¼'')
46-34. Wear Ring
46-35. Wear Ring O-Ring
46-36. Hexagon Socket Flat Head Screw (¼'' - 20 x 5/8'')
46-48. Flat Slotted Head Screw (3/8'' - 16 x ¾'') (If Supplied)
46-49. Cover Ring (If Supplied)

LIFTING



THE BOWL SHELL, BOWL SHELL EXTENSION, AND COVER RING (IF SUPPLIED), ARE BALANCED AND STAMPED AS AN ASSEMBLY; THEREFORE, THEY MUST BE REASSEMBLED WITH "V" MARKS IN LINE AS SHOWN.



46-15

BOWL SHELL ASSEMBLY
FIGURE 19-1

SHARPLES PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

BULLETIN 471B

CONVEYOR WEAR

A. INSPECTION

1. If the feed material to the centrifuge contains abrasives, wear on the conveyor flights will result, but can be reduced with welded hard surfacing on the flights.

2. Unless it is known from previous experience that the solids are not abrasive, set up a regular inspection schedule:

   a. If the conveyor flights have not been hard surfaced, after one month of operation, disassemble the bowl and examine all the flights in the solids discharge end of the conveyor from the small end to the feed zone. If no wear is seen, schedule for reexamination after three more months. If signs of wear are evident, arrange with Sharples for hard surfacing.

   b. If the conveyor flights have been hard surfaced, inspect after one month of operation, reinspect after three months, and estimate the rate of wear from these examinations.

B. DETERMINE WEAR

The rate of wear is best determined by using a *Conveyor Wear Gauge (typical shown on Figure 1) which shows the actual amount of hard surfacing still left as compared with the original thickness applied at the factory.

C. HARD SURFACING

1. Liquid Discharge End

   Thickness of Welded Hard Surfacing of flights as shipped from the factory: 1/8"

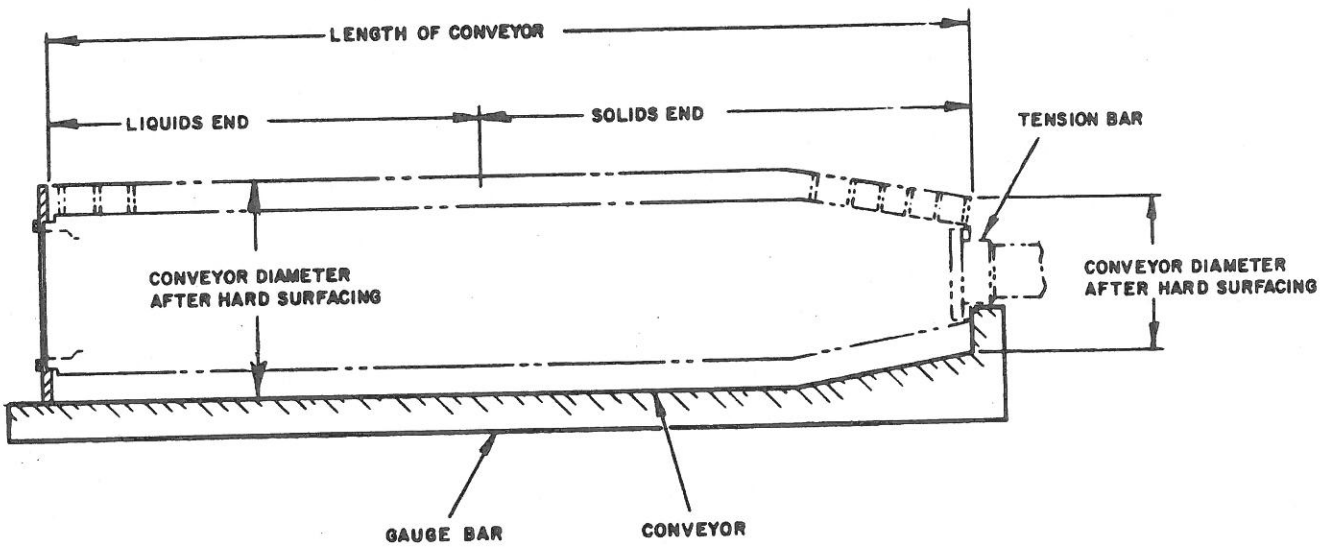
2. Solids Discharge End

   With Replaceable Tile Hard Surfacing, the back section of each tile has a series of ridges which may also be used as a guide in determining the extent of wear. When wear has proceeded beyond the third ridge from the tip, the tile should be replaced.

D. FOLLOWUP

Make subsequent examinations at periods based on the determined wear rate, arranging with Sharples for resurfacing before the wear has reached the unsurfaced, parent metal of the flights. Should abrasion continue until the edges of the flights are considerably worn, repair of the conveyor may be very expensive.

* A drawing to enable you to construct a Conveyor Wear Gauge is available on request from the Customer Parts Service Department. Be sure to mention the serial number of your centrifuge when ordering.



TYPICAL CONVEYOR WEAR GAUGE FIGURE - 1

BULLETIN 511

Revision 1

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

REMOVAL AND REPLACEMENT OF

CENTRIFUGE CONVEYOR

SINTERED TUNGSTEN CARBIDE TILES

PENNWALT CORPORATION . . . . . 955 MEARNS ROAD WARMINSTER, PA. 18974

SHARPLES-STOKES DIVISION

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A. INTRODUCTION

1. Figures 1, 2. The sintered tungsten carbide hard surfacing tile system is designed for use on Sharples Super D'Canter centrifuges only. Field replacement is applicable to previously tiled conveyors but not to conveyors hard surfaced by weld deposits. Such conveyors must be converted at the factory.

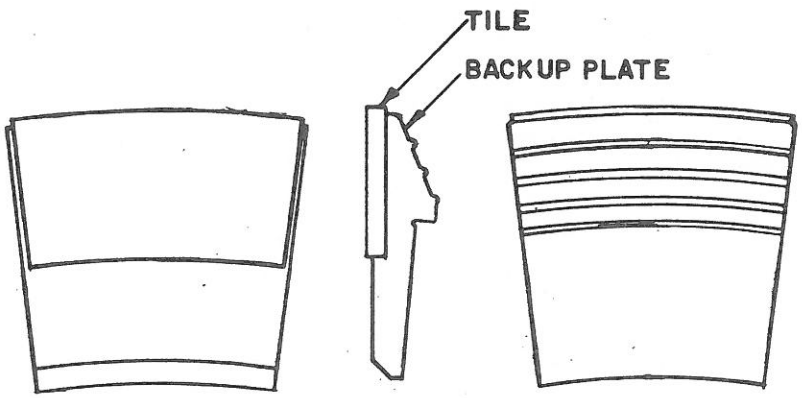


FIGURE 1. CONVEYOR TILE ASSEMBLY

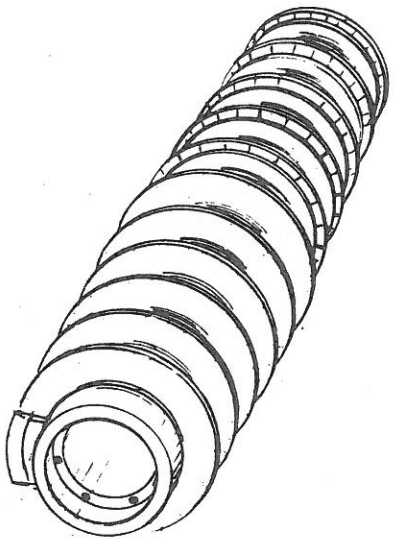
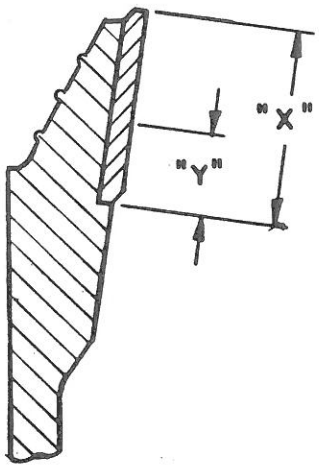


FIGURE 2. TILED CONVEYOR

2. The easily applied tile sections will give extremely long life as compared to standard weld deposited systems. When and if wear has proceeded beyond the limit given in Figure 3., the tile should be removed and replaced with the appropriate size tile for the conveyor involved.

CAUTION

If wear proceeds beyond this point, it may remove metal from the circumference of the conveyor flight to which the tile is attached. It is important to maintain this dimension so that when the new tile is affixed to the flight, the overall diameter of the conveyor remains the same as originally manufactured. If metal has been removed from the original flight, it must be built up to original dimensions by welding and machining before the tile section is welded into position.



"X" DIMENSION = 24.4 MM (NEW TILE)

"Y" DIMENSION = 10 MM (TILE WORN TO LIMIT)

FIGURE 3. MEASUREMENT OF TILE FOR WEAR

3. The Sharples Division of Pennwalt offers a factory repair service on all products manufactured by this division including tile replacement. Contact the Sharples sales or service departments for assistance or recommendations on field replacement of tile assemblies.

B. REMOVAL OF TILES

1. Figure 4. Removal of tiles is accomplished by grinding away welds #1 and #2 which hold the tile assembly to the conveyor flight.

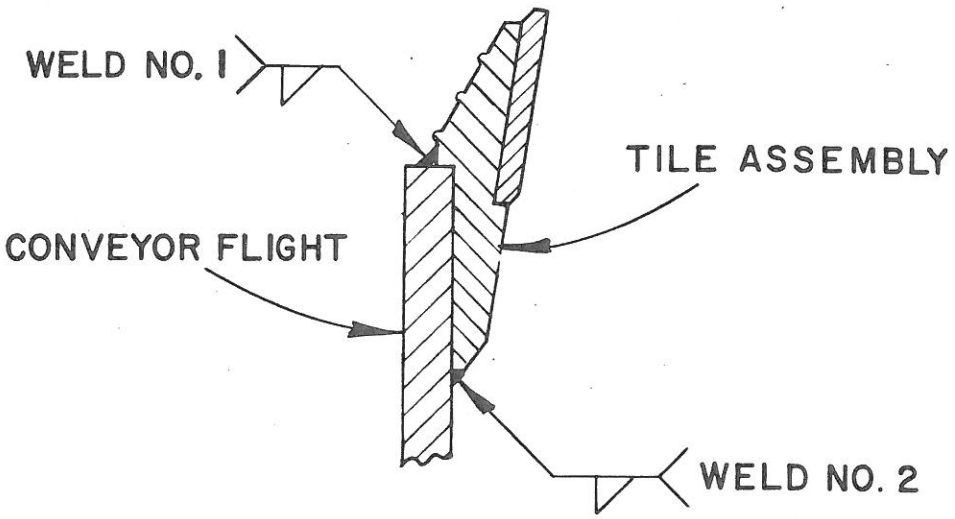


FIGURE 4. CROSS SECTION OF TILE ASSEMBLY

2. Figures 4, 5. Remove weld #1 by grinding with a thin grinding disc.

CAUTION

Do not grind into the top edge of the conveyor flight, Figure 5.

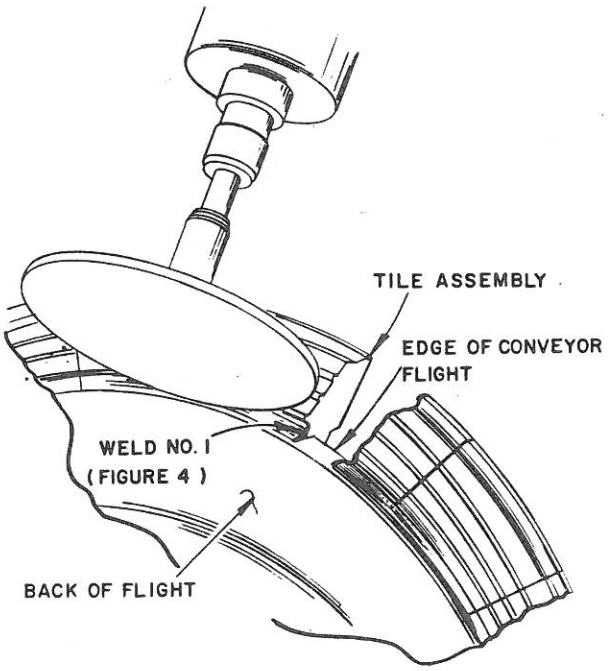


FIGURE 5. GRINDING WELD FROM BACK OF TILE ASSEMBLY

3. Recommended Tools:

   - Norton A60-OBNA
     Reinforced DX Wheel
     20375 RPM max. or equivalent
   - Chicago Pneumatic #9113
     Air Grinder or Equivalent

4. Figures 4, 6. Grind a sharp notch into weld #2 at the base of the tile assembly.

5. Remove the tile by hammering on the wear ridge area and breaking the remnants of weld #2.

6. Remove any excess weld metal from the flight with a standard grinding wheel.

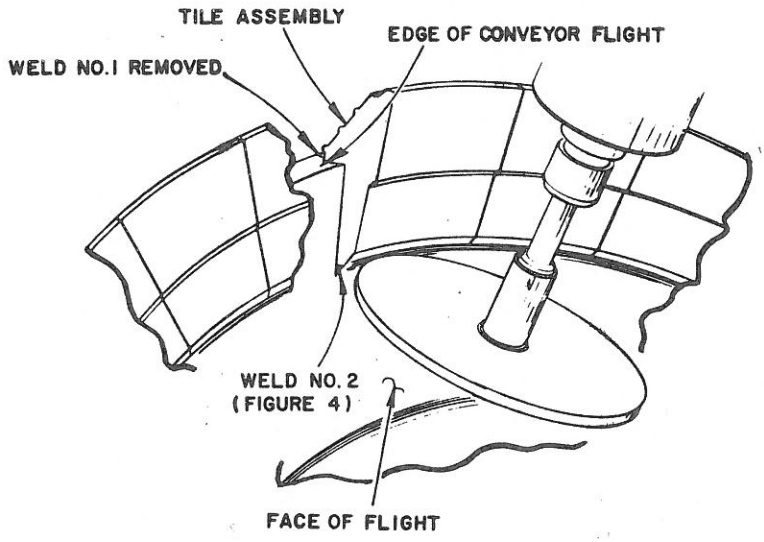


FIGURE 6. NOTCHING WELD ON FACE OF TILE ASSEMBLY

C. INSTALLATION OF NEW TILES

NOTE

Welders should be qualified to weld stainless steel to Section 8 of the ASME Pressure Vessel Code or to equivalent company certification standards. Pennwalt cannot assume responsibility for the improper installation or welding of replacement tiles.

1. Figure 7. Insert new tile assembly in place and hold firm with a C-clamp. The rear lip of the tile must seat directly against circumference of conveyor flight.

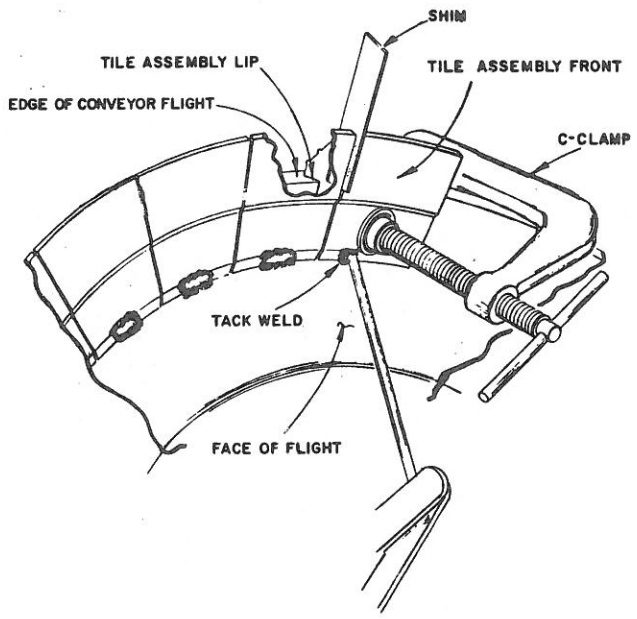


FIGURE 7. TACK WELDING FRONT EDGE

2. Tack weld the front edge of the conveyor tile to the face of the flight. Refer to table 1 for weld metal.

3. Use a 0.015'' shim to separate adjacent tiles to prevent contact of the adjacent wear inserts during welding.

4. Figure 8. Tack weld the rear edge of the tile assembly in place, making sure the C-clamp is holding the assembly tightly against the conveyor flight.

5. Proceed with the tack welding of additional tile assemblies as noted previously until all assemblies are installed.

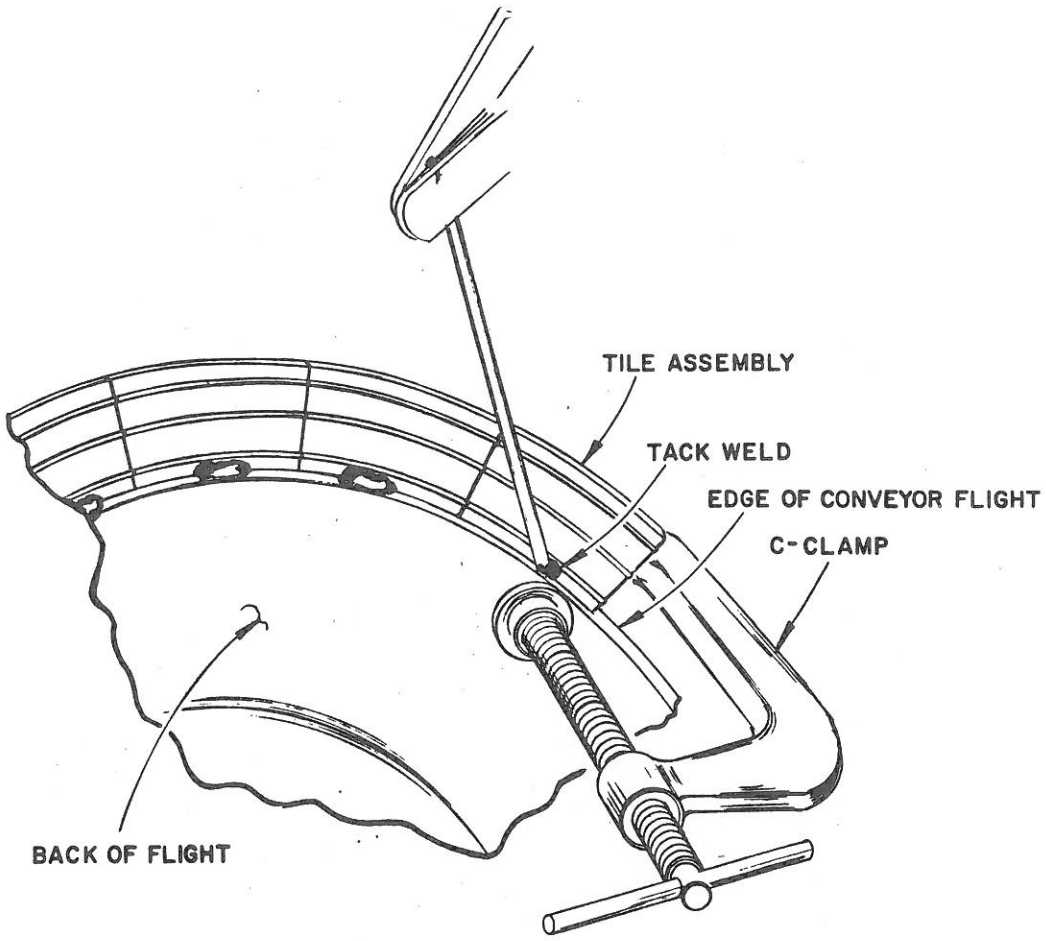


FIGURE 8. TACK WELDING REAR EDGE

6. Figure 9. Remove the C-clamp and apply a 1/8'' weld bead on the rear lip on the insert and the edge of the flight. The length of this weld should be 3/4'', but should not extend to the space between each section. Refer to table 1 for weld metal.

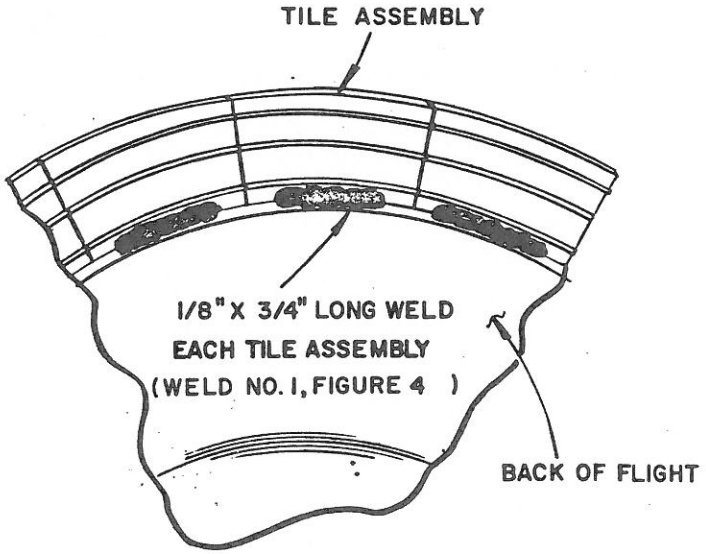


FIGURE 9. REAR WELD

7. Figure 10. Place conveyor in the vertical position and weld a full bead across the front face of the tile (3/16'' fillet).

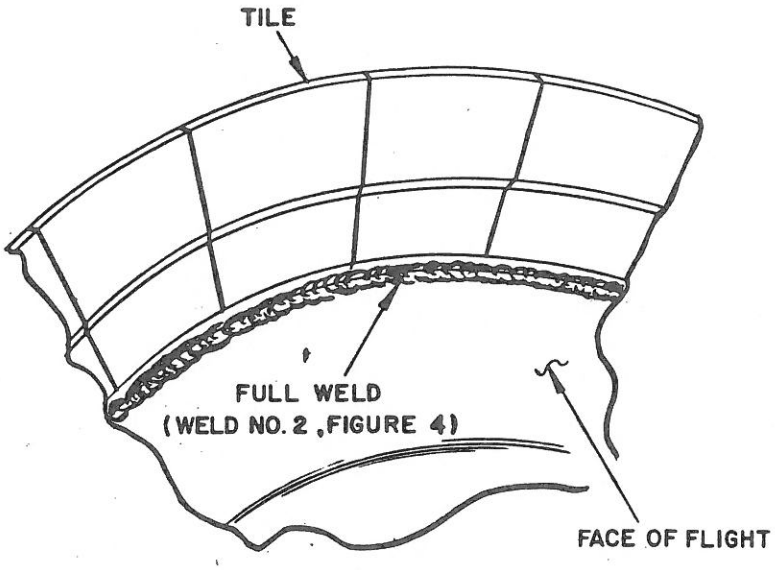


FIGURE 10. FRONT WELD

8. Figure 11. In severe cases of wear, welded hardsurfacing may have to be applied to the conveyor flight immediately adjacent to the last carbide tile. In this case the heat of hardsurfacing could crack the carbide tile or weaken the braze joint. To form a smooth transition from the weld deposited hardsurfacing to the tile assembly, remove the last two tile assemblies. Apply weld deposited hardsurfacing to the worn flight. Grind the hardsurfacing to conform with the proper diameter using the removed tile assembly as a gage. Reinstall the tile assemblies, or if damaged, replace with new tile assemblies. The gas weld hardsurfacing technique is described in Pennwalt process specification #71 which may be obtained from the service department. Rebalancing may be required.

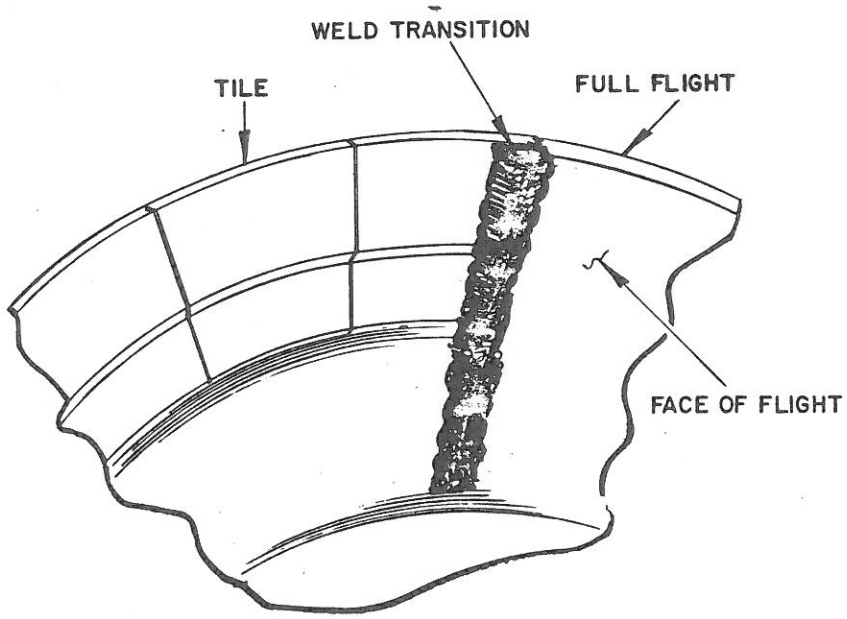


FIGURE 11. JUNCTION OF TILES AND WELDED SURFACE

TABLE 1. REQUIRED WELD METALS

Conveyor Flight Material	Tile Assembly Back Up Plate Material	Required Weld Metal
304/304L 316/316L	316,316L, 17-4PH	E316L
316/316L	Hastelloy C	AWS ENi Cr Fe-2 (INCO A) ARCOS Chromend- 4N1A
Hastelloy C-276	Hastelloy C	Hastelloy C-276
Steel	316/316L, 17-4PH	E309

NOTE

For all other material combinations, contact the Pennwalt Corporation Metallurgy Department.

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

BULLETIN 440, Rev. 2

PREVENTIVE MAINTENANCE RECOMMENDATIONS FOR MOTORS AND MOTOR CONTROLS

PENNWALT CORPORATION . . . 955 MEARNS ROAD, WARMINSTER, PA. 18974

SHARPLES-STOKES DIVISION

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I. INTRODUCTION

The Sharples Division of Pennwalt Corporation manufactures Centrifuges. These centrifuges are very often accompanied by other equipment not manufactured by Sharples: motors, pumps, electrical controls, etc.

The following "General Preventive Maintenance Recommendations for Motors and Controls, Bulletin 440" has been included along with your centrifuge instructions to alert you about possible motor and control problems.

Bulletin 440 is NOT a motor or controls instruction manual. It is only a *generalized guideline* of preventive maintenance and troubleshooting.

If more specific information is needed –

If repairs are necessary –

The user must refer to the instructions supplied by the manufacturers of the motor and controls, or contact the manufacturers directly.

THE EQUIPMENT MANUFACTURER INSTRUCTIONS SUPERSEDE SIMILAR INFORMATION CONTAINED WITHIN BULLETIN 440.

II. SAFETY PRECAUTIONS

Before handling any electrical equipment, carefully read the safety precautions recommended by the manufacturers of the centrifuge (Bulletin 424), motor, and motor control.

WARNING

Never Apply A Motor To an Operation For Which It Was Not Originally Specified Without First Consulting The Motor And Equipment Manufacturers To Determine Requirements For The New Usage.

III. PRE-INSTALLATION CONSIDERATIONS

1. Before installation, examine motor and controls for damage during shipment.
2. Rotate motor shaft by hand – it should turn freely.
3. Check motor nameplate voltage against power supply and wiring instructions.
4. If the equipment is not to be installed immediately, or if the equipment will be used for only a short period of time (seasonal operation), or if the equipment will be exposed to outside weather for any length of time, certain protective steps must be taken:
   a. Refer to motor and control manufacturer storage recommendations.
   b. Refer to the Sharples "Centrifuge Rust Prevention and Storage" Bulletin 442.

IV. INSTALLATION RECOMMENDATIONS

A. HANDLING

Follow motor and control manufacturer recommendations for handling: Lifting, anchoring, etc.

CAUTION

The capacity of the lifting eyebolt on the motor is usually rated only for the weight of the motor.

B. LOCATION

1. Motors last longer and perform better in a clean, dry, and well ventillated area. Dirt builds up thicker in a wet atmosphere and copper and iron corrode—all leading to higher electrical resistance and overheating.

2. Space heaters are necessary if the area is damp or cold, especially when the motor is shut off at night.

C. FOUNDATION

The foundation should offer good support, be level, and not subject to vibration. Refer to both centrifuge and motor manufacturer instructions for specific foundation requirements.

D. MOTOR BASE

The base on which the motor rests should be rigid and flat (not warped), and of adequate capacity for the motor weight.

E. CONNECTIONS AND POWER SUPPLY

1. Check the motor nameplate for operating temperature, rated load, power supply required, voltage, and frequency.

NOTE

Do not exceed voltage beyond ±10% from normal.

Do not exceed frequency beyond ±5% from normal.

Prolonged overload raises the operating temperature, resulting in shorter motor life.

2. All terminal connections should be checked against the motor connection diagram to be certain the polarity or direction of rotation will be correct.

3. Check that bolted connections are tight, adequately insulated, and that proper clearances exist between conductors and ground. Since both the motor and centrifuge rotate at high speeds, vibration and lateral movement is to be expected.

4. All wires, outlets, connectors, etc., must be in good physical condition.

V. STARTUP PROCEDURE

1. Before energizing the control, check:

   a. All connections to the control terminal

   b. Mechanical operation of all relays

   c. Starter

   d. Shutoff devices

   e. Fasteners and motor base

2. Immediately on turning on the motor, note:

   a. Excessive noise, humming, or vibration

   b. Stalling, dragging

   c. Odors

NOTE

Do Not operate equipment unless ALL conditions are satisfactory.

3. Refer to the wiring drawing supplied with each piece of equipment for specific startup and shutdown procedures.

VI. PULLEY AND BELT CARE

A. PULLEYS

1. Worn grooves, burrs, rough spots, dirt, oil, rust, pitting, etc., can damage belts.

2. Proper alignment of the equipment pulley and the drive motor pulley is essential to longer belt life. Refer to the equipment and motor manufacturer instructions for alignment procedures.

3. Keys must be fully seated.

4. Bushings must be securely fastened.

B. CARE OF BELTS

1. Wipe belts with a dry cloth to remove buildup of foreign matter. If the belts have been splattered with grease or oil, clean them. Avoid using flammable solvents.

2. If one or more belts break, *all* the belts should be replaced with new ones.

NOTE

Do not mix new belts with old belts.

Each belt in a set has a "match number" code set by the manufacturer. Do not use belts that are not compatibly match numbered.

C. TENSIONING "V" BELTS

1. Proper tension allows running without slippage. Belts that are too loose or too tight can cause belt and pulley groove wear, and overheating of drive components.

2. There will normally be a drop in tension during the first 24 to 48 hours of operation. During this "run-in" period, the belts seat themselves in the pulley grooves and the initial stretch takes place. After a day or two the drive should be stopped and another check made for the correct amount of tension.

3. Refer to the centrifuge instruction manual for required belt deflection force.

D. TENSIONING TIMING BELTS

1. Timing belts are installed to fit pulleys snugly, neither too tight nor too loose. There is no need for high initial tension which can cause premature failure.

2. When torque is unusually high, a loose belt may "jump teeth" on startup. Increase tension gradually until satisfactory operation is obtained and the teeth are fully engaged.

E. BELT TROUBLESHOOTING

	PROBLEM	POSSIBLE CAUSE
1.	Speed loss	Improper belt tension
2.	Abnormal wear	Pulleys misaligned Improper belt tension
3.	Belt softening	Oil or chemical contamination
4.	Belt hardening and cracking	Excessive heat or cold, or chemical contamination

	PROBLEM	POSSIBLE CAUSE
5.	Belt Slap	Improper tension Pulleys misaligned
6.	Static sparks from belts	If the frame is not grounded, dry weather can create static electric charges in the atmosphere.

VII. MOTOR TYPES AVAILABLE

1. *Drip-proof motors* are designed for operation in well ventilated areas where the atmosphere is reasonably free of dirt and moisture.

2. *Totally enclosed motors* are designed for operation where motors may be exposed to dirt, moisture, and most outdoor conditions.

3. *Explosion-proof motors,* bearing the Underwriters' Laboratories label designating the motor U/L Class and Group as defined in the National Electrical Code, are designed for operation in areas classified by local authorities as hazardous in accordance with standards set forth in that Code.

VIII. THERMAL PROTECTION AVAILABLE

A. THERMAL CUTOUTS

1. Thermally protected motors have built-in protection (example: thermostats, temperature detectors, stator savers) to protect against overheating.

2. The leads from the cutout should be wired to the control to automatically shut down the motor and centrifuge.

3. After the motor has cooled to ambient and the cause for the shutdown has been corrected, the motor may be restarted.

   a. Manual overload protectors are reset after the motor cools by pressing the external reset button.

   b. Automatic overload protectors reset automatically as the motor cools.

WARNING

Where the unexpected starting would be hazardous to personnel, do not use the automatic reset protection.

B. THERMISTORS

Thermal protection can be provided in the form of thermistors installed in the windings:

Thermistors are semi-conductors having a very rapid resistance increase when the temperature of the thermistor reaches a critical value. The thermistor turns off the gate circuit of the silicon controlled rectifier (SCR) which de-energizes (opens up) the motor starter control circuit. The system is then failsafe.

C. OVERLOAD HEATERS

Consult motor manufacturer for correct size to suit your needs.

CAUTION

Do not restart a motor that has shut down until the problem has been corrected.

IX. INSPECTION SCHEDULE

It is recommended that a regular itemized schedule of inspection be set up and a record kept of the maintenance performed, including comments of equipment condition at each inspection period.

A. LUBRICATION

1. Greased Bearings

   a. Clean exterior of motor.

   b. Remove hardened grease from inlet and outlet passages.

   NOTE

   Hardened grease is more easily removed when the motor is warm.

   c. Use a low pressure grease gun, and type and quantity of grease recommended by the motor manufacturer.

   d. Fill inlet passage (one or two, depending on motor and bearing) until grease shows a surplus at the outlet passage(s).

   e. Replace all plugs. Some manufacturers recommend running the motor for several hours before replacing the plugs.

f. Troubleshooting:

PROBLEM	POSSIBLE CAUSE	REMEDY
Oil leakage from overflow plugs	Stem of overflow plug is tight Cracked or broken overflow plug Plug cover not tight	

g. Motors that do not have grease fittings can be lubricated by:

1) Removing the end shields from the motor.

2) Cleaning the grease cavity.

3) Refilling the cavity three-quarters full with recommended grease.

h. Greasing schedules depend on the type and severity of service, and temperature of the surrounding air. Dusty, wet, very hot, etc., environments require more frequent greasing. All manufacturers recommend following a regular lubrication schedule based on personal experience.

2. Typical Greasing Schedule

MOTOR SPEED	BEARING TEMPERATURE	FREQUENCY
Up to 1800 rpm	Up to 210°F	6 to 8 months
Up to 3600 rpm	Up to 250°F	4 to 6 months

NOTE

A new motor should be inspected after only two months.

CAUTION

Do not overgrease bearing.

3. Greased-Packed Bearings

Some motors have grease-packed bearings. After about two years (depending on conditions), remove the bearings, clean them, check for wear and damage and repack with proper type grease. Always follow manufacturer instructions.

B. REPLACING BEARINGS

1. Only qualified personnel should replace bearings after consulting the recommendations in the motor manufacturer instructions.

2. Bearing replacement must be performed in a clean, dust free room.

3. Use an appropriate puller when removing a bearing to avoid damaging it if it is to be reinstalled.

4. After service, test run the motor to check the temperature and noise and vibration levels.

5. Spare bearings should be kept in their original factory wrappings until ready for use.

6. Use only bearings recommended by the motor manufacturer.

C. BEARING TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	REMEDY
Bearings Run Hot: In General	Belts too tight	– Consult Centrifuge Drive Alignment Instructions
	Misalignment Bent Shaft Bearings stiff Bearings Damaged Pulley located or sized wrong Dirt surrounding bearing High ambient temperature Acid atmosphere Humid atmosphere	CONSULT MOTOR MANUFACTURER INSTRUCTIONS
Grease-lubricated	Too much or too little grease Wrong grease Grease contaminated or deteriorated Bearing overloaded Bearing damaged Grease leaking onto insulation	
Oil-lubricated	Oil too heavy or too light Too little oil Bearing dirty Bearing worn or damaged Motor not level Wrong oil Dirty oil Coupling to Centrifuge misaligned	– Consult Centrifuge Drive Instructions
Self-lubricated (Sleeve)	Bent or damaged oil rings Too much end thrust Bearing dirty Bearing surface not true Clogged oil grooves Bent shaft Belts too tight Misalignment with Centrifuge	– Consult Centrifuge Drive Instructions

D. INSULATION

1. Before a motor is put into service (a new motor or one that has been inactive for a time), the insulation resistance of the windings must be checked.

CAUTION

If a motor is used with low insulation resistance, the windings may be permanently damaged.

2. Refer to the motor instruction manual for items to be measured, taking care not to apply high voltage to auxiliary equipment.

3. If less than one megohm is measured, or if resistance reading has dropped more than 50% from the measurement taken at time of shipment (consult motor manufacturer), disconnect motor leads from supply cables at the motor junction box. Take readings of the motor and cable separately. If lower readings still show up after remeasuring, follow recommended drying procedures.

4. A regular schedule of insulation inspection and record keeping will help extend motor life. Refer to motor manufacturer for recommended procedure. (Use a megger or equivalent instrument).

E. SHAFT END PLAY

CAUTION

Refer to motor manufacturer instructions for proper method of checking shaft end play—Do Not apply excessive force to the shaft extension.

PROBLEM	POSSIBLE CAUSE	REMEDY
Lack of end play	Corrosion and rust in the bearing area Bent Shaft Bearings installed cocked	Consult Motor Manufacturer Instructions

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X. AC MOTORS

A. TESTCHECK AFTER INSTALLATION

1. Power is off.

2. Check all electrical connections.

3. Check that centrifuge is mechanically ready for operation.

4. Inspect the motor as recommended by the motor manufacturer.

5. Check power supply against nameplate of control.

6. Turn power on.

7. Check for proper centrifuge rotation, and if required, interchange any two phase leads if rotation is incorrect.

8. Check control transformer voltages and safety interlocks against the certified wiring diagram supplied.

9. Operate manually if possible, or on automatic without product for two hours.

10. Using an ammeter and a 20,000 ohm/volt ohmmeter, perform the following tests as recommended by the equipment manufacturer:

    a. Compare motor full load amps (on nameplate) against requirements for the overload heater and requirements of the National and Local Electrical Codes.

    b. Measure and record the primary volts between each phase (the voltage should be balanced, and should not be too high or too low). If corrections are necessary, notify your power company.

PROBLEM	SOLUTION
Amp unbalance but line voltage is balanced.	Recheck motor connection, If condition persists, consult motor manufacturer.
Amp readings higher than motor rating.	Overloaded motor. High line voltage.

B. AC MOTOR TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	REMEDY
Motor connected but does not start	One phase open. Motor may be overloaded. Rotor defective. Poor stator coil connection. Fuses blown. Jammed. Improper line voltage Bearings stiff. Grease stiff. Overload relay tripped. Open circuit in stator or rotor.	– Consult Centrifuge Operating Instructions CONSULT MOTOR MANUFACTURER INSTRUCTIONS
Motor runs, then stops	Power failure. Motor overheated. Misphased Wye – Delta motor line connections.	– Thermal protectors or thermisters have opened the circuits

AC MOTOR TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
Motor does not come up to speed	Voltage too low at motor terminals. If wound rotor, improper control operation of secondary resistance. Starting load too high. Low pull-in torque of synchronous motor. Brushes are not riding on rings. Broken rotor bars. Open primary circuit.	– Consult Centrifuge Electrical Department
Motor takes too long to accelerate	Excess loading. Poor circuit. Defective squirrel-cage rotor. Applied voltage too low.	– Consult Centrifuge Operating Instructions
Motor overheats while running under load	Overload. Wrong blowers, or air shields may be clogged with dirt and prevent proper ventilation of motor. Motor may have one phase open. Grounded coil. Unbalanced terminal voltage. Shorted stator coil. Faulty connection. High voltage. Low voltage. Rotor rubs stator bore. Overgreased bearings. Bearings stiff. Belts too tight.	– Consult Centrifuge Operating Instructions – Consult Centrifuge Drive Alignment Instructions
Motor vibrates after corrections have been made.	Motor misaligned. Weak foundations. Coupling out of balance (If supplied.) Centrifuge unbalanced.	– Consult Centrifuge Operating Instructions

CONSULT MOTOR MANUFACTURER INSTRUCTIONS

AC MOTOR TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
Motor vibrates after corrections have been made. (Continued)	Defective bearing. Bearings not in line. Balancing weights shifted. Wound rotor coils replaced. Polyphase motor running single phase or misphased Wye – Delta connections. Excessive end play.	CONSULT MOTOR MANUFACTURER INSTRUCTIONS
Scraping noise	Fan rubbing air shield. Fan striking insulation. Motor loose on bedplate.	
Magnetic noise	Air gap not uniform. Loose bearings. Rotor unbalance.	
Motor stalls	Overloaded motor Low motor voltage. Open circuit. Incorrect control resistance of wound rotor	– Consult Centrifuge Operating Instructions
Wrong rotation	Wrong sequence of phases.	Reverse leads of two of the three lines.
Unbalanced line current on polyphase motors during normal operation.	Unequal terminal volts. Single phase operation. Poor rotor contacts in control wound resistance (tight or loose). Brushes not in proper position in wound rotor.	

XI DC MOTORS

A. BRUSHES, HOLDERS, SPRINGS

1. Brushes

   a. Brushes should be checked for excessive wear (three-fourths of wear length), uneven wear, chipping, cleanliness, and accumulated brush dust.

   b. Brushes should be the correct size, and proper grade and composition.

2. Brushholders

   a. Brushholders should work smoothly and be free of dust and dirt.

   b. If brushes are tight or stuck in the holders, holders may be warped.

   c. Brushholders should be set (using a piece of hard fiber of the proper thickness) at the correct angle and distance from the commutator.

   d. Brushholders must be evenly spaced around the commutator, approximately 1/32 inch, and in alignment with the brush arm and commutator bars. Brushes should be staggered in pairs. Refer to motor manufacturer instructions for this dimension.

3. Brush Springs

   Check brush springs for uniform and proper tension as recommended by motor manufacturer.

B. COMMUTATOR

1. Keep the commutator clean (dirt, atmospheric contaminants) and maintain the smooth polished surface (rough, burned, pitted, or dirty commutator). If the commutator surface is allowed to break down, the exposed area will allow current to pass through.

2. Check for discoloration:

   If more than occasional wiping (canvas wiper) is required to maintain the commutator, refer to the motor manufacturer instructions for suggested inspection and service.

   Normal operating color is an evenly colored light to dark brown (no traces of black or copper colored specks).

   Canvas Wiper: Wrap and fasten eight thicknesses of six ounce canvas duck over the end of a board 3/8" x 3" hardwood. Unwrap the layers as they soil. Wiping should remove carbon, gum, etc. Checking should be performed monthly at first until a regular schedule can be initiated based on experience.

3. Check for concentricity:

   Place a stick (sharpened like a pencil) on the revolving commutator at a slight angle. It should feel as if it is moving over a smooth glass surface. If not, consult the motor manufacturer for regrinding.

C. TESTCHECK AFTER INSTALLATION

1. Power is off.

2. Check all electrical connections.

3. Check that centrifuge is mechanically ready for operation.

4. Inspect the motor as recommended by the motor manufacturer.

5. Check power supply against nameplate of control.

6. Turn power on.

7. Check that supply connections are made in the correct phase sequence.

8. Check for proper centrifuge rotation and correct by interchanging any two phase leads.

9. Check control transformer voltages and safety interlocks against the certified wiring diagram supplied.

10. Check exciter output voltage against the certified wiring diagram and instruction manual.

11. Operate manually if possible, or on automatic without product for two hours.

D. DC MOTOR TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	REMEDY
Will not start	Power may be off. Circuit not complete. Brushes not down on commutator. Brushes stuck in holders. Armature locked by frozen bearings in motor or main drive. Bearings stiff. Overload relay tripped. Overload. Control not operating. Jammed. Blown fuses. Poor or improper connections. Bad SCR Grease is stiff. Low armature voltage. Weak field. Winding grounded Open or short circuit. Improper line voltage.	—Consult Centrifuge Operating Instructions CONSULT MOTOR MANUFACTURER INSTRUCTIONS
Motor unstable (starts, then stops and reverses direction of rotation)	Reverse polarity of generator that supplies power. Shunt and series fields are bucking each other.	

DC MOTOR TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
Motor does not come up to rated speed	Overload. Starting resistance not all out. Voltage low. Short circuit in armature windings or between bars. Starting heavy load with very strong field. Motor off neutral. Motor cold. Tachometer Generator not producing rated voltage. Improper adjustment.	—Consult Centrifuge Operating Instructions
Motor runs too fast	Voltage above rated. Load too light Shunt field coil shorted. Shunt field coil reversed. Shunt field coil shorted or reversed. Series field coil shorted or reversed. Brushes behind neutral. Neutral setting shifted off neutral. Part of shunt field rheostat or unnecessary resistance in field circuit. Motor ventilation restricted causing hot shunt field. Low field voltage.	—Consult Centrifuge Operating Instructions
Motor gaining speed steadily and increasing load does not slow it down.	Unstable speed load regulation. Reversed field coil shunt or series. Too strong a commutating pole or commutating pole air gap too small. Tach connection improper.	
Motor runs too slow continuously	Voltage below rated. Overload. Neutral setting shifted. Armature has shorted coils or commutator bars. Interpole polarity reversed. Brushes ahead of neutral. Brushes stuck in holders. Wrong brush tension. Control not operating Open circuit Motor/Control resistance too light.	

CONSULT MOTOR MANUFACTURER INSTRUCTIONS

DC MOTOR TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
Motor overheats or runs hot (General)	Voltage above rated. Inadequately ventilated. Draws excessive current due to shorted coil. Grounds in armature. Armature rubs pole faces due to off-center rotor causing friction and excessive current. Overgreased bearings. Bearings stiff. Belts too tight. Blocked air passages. Overloaded. Overcycled.	CONSULT MOTOR MANUFACTURER INSTRUCTIONS
Motor overheats or runs hot (Hot Fields)	Inadequate ventilation. Voltage too high. Shorted turns or grounded turns. Resistance of each coil not the same. Coil not large enough to radiate its loss wattage.	
Motor vibrates and indicates un-balance.	Armature out of balance. Misalignment. Loose or eccentric pulley. Belt whip. Mismating of gear and pinion. (If provided.) Unbalance in coupling. (If provided.) Bent shaft. Foundation inadequate. Motor loosely mounted. Motor feet uneven.	
Motor sparks at brushes or does not commutate	Neutral setting not true neutral. Commutator rough, eccentric or dirty. Mica high—not undercut. Commutating pole strength too great—wrong gap. Shorted commutating pole turns. Reversed or shorted armature coils on commutator bars. Open or short circuit coils. Grounded windings. Partial short in shunt field. Poor soldered connection to commu-tator bars from armature coils. High bar or loose bar in commutator at high speeds. Brush grade wrong	

DC MOTOR TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
Motor sparks at brushes or does not commutate (Continued)	Brushes worn. Brushes improperly seated. Brushes off neutral. Copper picking. Motor overloaded. Unequal air gap. Brush pressure too light. Brushes stuck in holders. Brush shunts loose. Brushes chatter due to dirty film on commutator. Vibration. Brushholders improperly spaced. Reversed or shorted compensating field winding. Brushes not parallel with commutator bar.	CONSULT MOTOR MANUFACTURER INSTRUCTIONS
Brush wear excessive.	Brushes too soft. Commutator rough. Abrasive dust in ventilating air. Off neutral setting. Bad commutation. High, low or loose bar. Brush tension excessive. Electrical wear due to loss of film on commutator face. Threading and grooving. Oil or grease from atmosphere or bearings. Weak acid and moisture laden atmosphere. Wrong brushes, or composition. Severe sparking.	
Burned brushes	Poor commutation. Brushes off neutral. Too fast current changes. Wrong brushes used as replacement. Vibration upsetting commutation. Coupling loose on tach generator.	
Brush breakage and noise (chatter)	Rough commutator. High vibration. Wrong brushes used as replacement. Atmospheric contamination.	

DC MOTOR TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
Brush breakage and noise (chatter) (Continued)	Dirty commutator creating friction. High mica. Brushes tight in holders. Wrong brush size. Incorrect brush pressure.	
Motor noisy	Brush chatter. Motor loosely mounted. Foundation hollow and acts as sounding board. Strained frame. Armature punching loose. Armature rubs pole faces. Magnetic hum. Belts loose. Excessive current load. Mechanical vibration. Noisy bearings. Noisy fan. Single phased. Air gap not uniform. Loose fittings or couplings. Misaligned with centrifuge. Electrical unbalance—improper voltage and current.	
Short insulation life.	Contamination. Overheating. Vibration.	
Low insulation resistance or arcing.	Moisture. Dirt.	
Commutator bar marking	Wrong brush type. Opening present in armature circuit.	
Commutator bar etching	Atmospheric acid action on commutator—usually when not running.	
Flashing	Sudden change in current voltage or field strength.	
Motor runs in opposite direction.	Improperly connected armature.	

CONSULT MOTOR MANUFACTURER INSTRUCTIONS

DC MOTOR TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
Streaking or threading of commutator surface	Surface breakdown— Heavy atmospheric film of sulphur dioxide, chlorine, etc. Copper particles embedded in brush face. Wrong terminal connection. Wrong spring pressure. Wrong brush size. Wrong brushholder spacing. Wrong brush material. Mixed brushes.	CONSULT MOTOR MANUFACTURER INSTRUCTIONS

XII. MOTOR STARTERS

A. RECOMMENDED INSPECTION

1. Manual Starters

   Check the contact tips and connections for cleanliness and replace oil.

2. Magnetic Starters

   Check for: Worn contacts, free movement of all parts, pushbuttons are operable, shunts in good repair, contacts and connections operate together, contact tips and bearings are clean of oil, sealing surfaces are clean.

B. MOTOR STARTER TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	REMEDY
Contactor or relay does not open	Pushbutton not connected correctly. Shim in magnetic circuit worn, allowing residual magnetism to hold armature closed. Pushbutton, interlock, or relay contact not opening coil circuit. Feedback circuits. Permanent magnetism buildup. Contacts weld shut. Damaged, worn, or poorly adjusted mechanical parts. Incorrect wiring.	CONSULT MOTOR MANUFACTURER INSTRUCTIONS

MOTOR STARTER TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
Excessive corrosion of contacts – Contacts weld shut – Contacts overheat	Insufficient contact spring pressure. causing contacts to overheat or draw an arc on closing. Rough contact surface causing current to be carried by too small an area. Abnormal operating conditions. Chattering of contacts as a result of vibrations outside of controller cabinet. Sluggish operation.	CONSULT STARTER MANUFACTURER INSTRUCTIONS
Arc lingers across contacts	If blowout is series it may be shorted. If blowout is shunt it may be open circuited. Ineffective blowout coil. If no blowout is used, note travel of contacts. If used, arc box might be left off or not in correct position. Overload. Arcing or voltage breakdown over or through arc box wall.	
Noisy AC magnet	Improper seating of the armature. Broken shading coil. Low voltage. Dirty coil.	
Abnormally short coil life.	High voltage. Gap in magnetic circuit. Too high an ambient temperature.	
Panel and apparatus burned by heat from starting resistor	Motor being started too frequently.	
Contactor or relay does not close.	Blown fuses. No supply voltage. Low voltage. Incorrect wiring. Open-circuited coil. Pushbutton, interlock, or relay contacts not making contact. Loose connections or broken wire. Pushbutton not connected correctly. Overload relay contact open. Damaged, worn, or poorly adjusted mechanical parts.	

XIII. MOTOR CONTROLS

A. INSTALLATION

1. Location of the motor control depends on many factors: motor size, voltage drop, convenience, space for maintenance, etc.

2. Controls should be in a dry, clean area.

3. Care should be taken to minimize differences in temperature between the motor and its control.

4. Refer to the certified wiring diagram for connections.

5. Keep basic spare parts on hand.

B. INSPECTION

1. Contacts:

   a. Periodically check contacts for mechanical wear, electrical burning, and cleanliness.

   b. When replacing a contact, replace both the moving and stationary contacts.

   c. Do not use contacts that have deep pits or a very rough surface.

   d. Refer to manufacturer instructions for proper contact and contact spring pressures.

NOTE

The cleaning or smoothing down of a contact surface should not be extensive enough to change its shape.

2. Fuses:

   a. Before replacing a blown fuse, find the cause.

   b. Before replacing a fuse (use appropriate puller), open switches.

WARNING

Remove the hot side fuse first. Install the cold side fuse first.

3. Pilot Lights:

   Pilot lights are important indicators. They must be kept operable.

4. Switches:

WARNING

1. *Determine the operating condition of the circuit before opening or closing any switch.*

2. *Open switches completely. Close switches completely.*

   Partial positions are hazardous to personnel and damaging to equipment.

5. Capacitors:

WARNING

Discharge capacitors (use a shorting bar or an insulated short-circuit jumper) before handling.

6. Filters:

Keep clean and replace when necessary.

7. Consult manufacturer instructions for proper inspection procedure on the following:

Tubes, capacitors, resistors, switches, potentiometers, terminal blocks, insulators, relays, transformers, rheostats, meters.

C. CLEANING

1. Enclosures:

   a. Vacuum cleaners, or clean, dry, low pressure compressed air is usually effective for removing most dirt.

CAUTION

Do not use metal tipped tools.

   b. Steam or wet cleaning should be used only on water-tight enclosures after the interiors have been removed. Hose down enclosure and scrub with a stiff brush. Water pressure should be limited to 25 pounds per square inch. Water temperature should not exceed 194°F.

   Drying in the sun or in a warm, dry room will take about two to four days. If plaster drying equipment, electric heaters, or baking ovens are used, heat should be limited to 212°F, preferably starting at about 150° or lower and gradually building up to 212°F.

2. Interior electrical components may be cleaned with Freon or equivalent solvent.

D. MOTOR CONTROLS–TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE	REMEDY
Excessive motor amps	High line voltage. Overloaded motor. Partially burned out motor.	
Motor runs, but control does not	Welded starter contacts.	
Motor and control do not run	Disconnect devices malfunctioning. Improper transformer voltage. Open secondary connection or transfer contactor.	
CONTACTS Contact Chatter	Broken shading coil. Poor contact in control circuit. Low voltage.	
Welding or Freezing	Abnormal inrush of current. Rapid jogging. Insufficient tip pressure. Low voltage preventing magnet from sealing. Foreign matter preventing contacts from closing. Short circuit.	
Short Tip Life or Overheating of Tips	Filing or dressing. Interrupting excessive high currents. Excessive jogging. Weak tip pressure. Dirt or foreign matter on contact surface. Short circuits. Loose connection. Sustained overload.	
COILS Open Circuit	Mechanical damage.	
Burst Coil	Over voltage or high ambient temperature. Incorrect coil. Shorted turns caused by mechanical damage or corrosion. Under voltage, failure of magnet to seal in. Dirt or rust on pole faces increasing air gap.	

CONSULT CONTROL MANUFACTURER INSTRUCTIONS

MOTOR CONTROLS–TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
OVERLOAD RELAYS Tripping	Sustained overload. Loose connection on load wires. Incorrect heater.	CONSULT CONTROL MANUFACTURER INSTRUCTIONS
MAGNETIC & MECHANICAL PARTS Noisy Magnet	Improper air gap. Broken shading coil. Magnet faces not mating. Dirt or rust on magnet faces. Low voltage.	
Failure to Pick up and Seal	Low voltage. Coil open or shorted. Wrong coil Mechanical obstruction.	
Failure to Drop Out	Gummy substance on pole faces. Voltage not removed. Worn or rusted parts causing binding. Residual magnetism due to lack of air gap in magnet path.	
PNEUMATIC TIMERS Eratic Timing	Foreign matter in valve.	
Contacts Do Not Operate	Maladjustment of actuating screw. Worn or broken parts in snap switch.	
LIMIT SWITCHES Broken Parts	Overtravel of actuator.	
MANUAL STARTERS Failure to Reset	Latching mechanism worn or broken.	
COMPENSATORS (MANUAL) Welding of Contacts on Starting Side	Inching, jogging and operating handle Slowly.	
Welding of Contacts Running Side	Moving handle slowly to run position. Lack of sufficient spring pressure.	

MOTOR CONTROLS–TROUBLESHOOTING (Continued)

PROBLEM	POSSIBLE CAUSE	REMEDY
COMPENSATORS (MANUAL) Damaged or Burned Transformer	Repeated inching and jogging. Holding handle in start position for long periods.	CONSULT CONTROL MANUFACTURER INSTRUCTIONS
Motor starts unexpectedly.	Check for ground.	
Safety Overloads to not work.	Check for ground.	

E. CURRENT CURVE CHART

TIME	VOLTS	AMPS	TIME	VOLTS	AMPS
0 Seconds			210		
15			225		
30			4 Minutes		
45			255 Seconds		
1 Minute			270		
75 Seconds			285		
90			5 Minutes		
105			315 Seconds		
2 Minutes			330		
135 Seconds			345		
150			6 Minutes		
165			375 Seconds		
3 Minutes			390		
195 Seconds			405		

CURRENT CURVE CHART (Continued)

TIME	VOLTS	AMPS	TIME	VOLTS	AMPS
7 Minutes			525		
435 Seconds			9 Minutes		
450			555 Seconds		
465			570		
8 Minutes			585		
495 Seconds			10 Minutes		
510					

MODEL _____ SERIAL NUMBER _____

HORSEPOWER _____ AMPS _____ FRAME _____

INSPECTOR _____ DATE _____

XIV. VARIABLE SPEED MOTOR

1. Refer to nameplate for rated speed and horsepower. Do not exceed these.
2. Change speeds only when the unit is running.
3. If supplied with a gear reducer, do not operate before checking oil level.
4. Operate the motor through its entire speed range once weekly.
5. Motors with reducers should not be changed to a different assembly without factory approval.
6. Keep air vents clean.
7. If the motor is to be shut down for an extended period of time, before final stopping, shift into low speed.
8. Refer to manufacturer instructions for lubrication schedule and belt replacement method.
9. Refer to manufacturer instructions for operation and calibration of the speed sensing device supplied.

XV. CLEANING AND DRYING OF MOTORS

A. CLEANING

1. Dirt and dust accumulated on the motor are as harmful as corrosion. Brushes, lint-free cloths, suction, or dry compressed air (maximum 50 psi) may be used in cleaning.

CAUTION

Be sure hose tips are not metal.

   a. A dirty motor cannot properly dissipate heat.

   b. Clogged ventillating passages collect moisture and encourage insulation breakdown.

   c. Accumulated dirt slows down moving parts.

   d. Dirt on coils can cause a short circuit.

2. Every precaution must be taken to prevent oil seepage from the centrifuge or other equipment into the motor.

   a. Oil accumulated and dried onto the windings deteriorates the protective coats of varnish and leads to motor burnout.

   b. Stiff, inflexible windings create stress.

   c. Shrunk windings create air spaces.

3. Remove caked-on oil with solvent such as Freon TF applied to a cloth. Wipe, changing cloth face until clean.

CAUTION

Do not apply solvent directly to motor parts.

4. Thoroughly dry the windings.

5. Apply new varnish—if the old has deteriorated or insulation resistance cannot be brought to specifications by drying—about three coats.

NOTE

Consult motor manufacturer for appropriate varnishing procedure.

6. For more thorough cleaning, disassembly is necessary.

NOTE

Do not clean with steam or by immersion without first referring to the motor manufacturer instructions.

7. If filters are provided, they should be periodically inspected and replaced.

B. DRYING

1. When windings or other parts of the motor have become damp or wet, they must be dried prior to any testing, repairing, or operating:

   a. Small motors may be dried in an oven.

   b. Larger motors are covered with canvas under which several electric space heaters are distributed.

   c. Heat must be evenly distributed and slow (75°C to 80°C).

2. Measure resistance at regular intervals and record the measurements (rise in resistance) until they have stabilized at the figure recommended by the manufacturer.

3. During drying, air must be able to pass freely through the motor to carry off moisture; otherwise, the windings will not dry:

   a. Remove plugs, covers, etc., as needed.

   b. If a motor fan is not available, air circulation may be induced or enhanced with a combination of forcing air in at one end and vacuuming air out at the opposite end.

NOTE

Do not overuse the fan. Overcooling slows down drying.

BULLETIN 442
REVISION 3

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

RECOMMENDED INDOOR STORAGE AND RUST PREVENTION PROCEDURES FOR NEW CENTRIFUGES

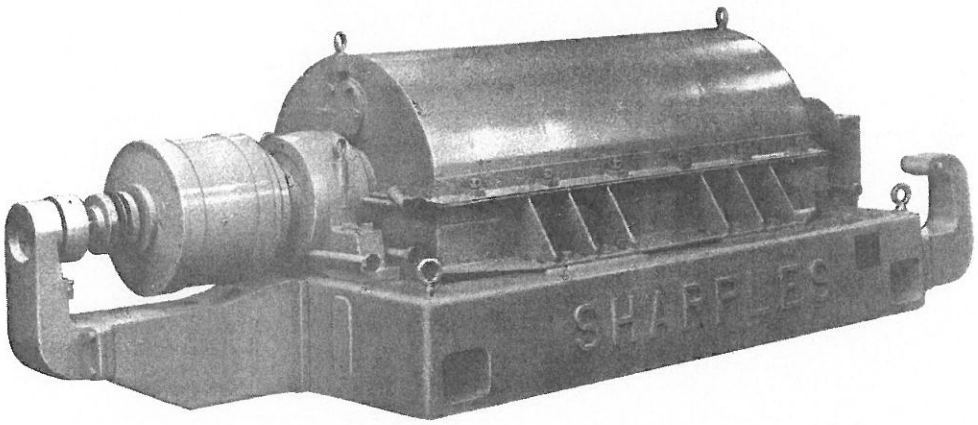
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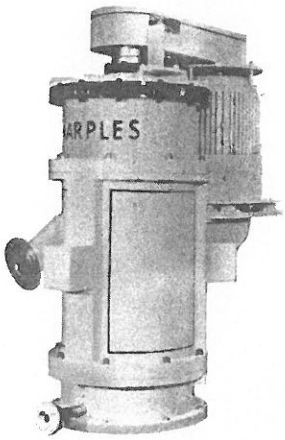
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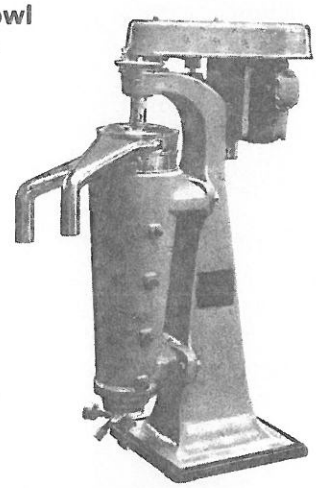
TYPICAL SHARPLES CENTRIFUGES



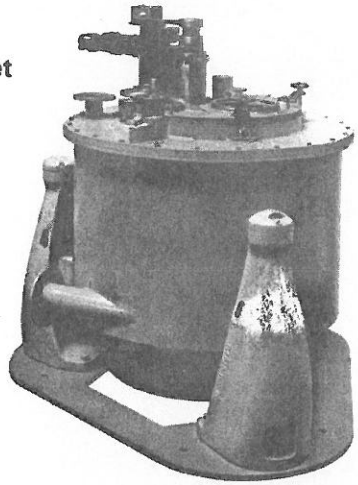
Super D-Canter® Centrifuges



Tubular Bowl Centrifuge



Vertical Basket Centrifuge





Disc Centrifuges

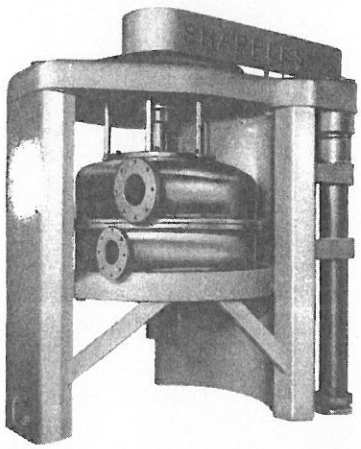


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I. INTRODUCTION

Before shipment, Sharples centrifuges are prepared with rust preventives and are then packaged to offer protection from rust and corrosion for up to one year with indoor storage. Beyond this period, the rust preventives must be reapplied and packaging maintained as required.

Where maintenance of bearings, etc., may not be required (Chapter III), the equipment may be left in the original factory packaging. However, if this packaging must be removed while still in storage, certain guidelines must be followed.

> **NOTE**
>
> **The owner assumes full responsibility for the protection and maintenance of the equipment after shipment from Pennwalt.**

II. FACTORY PREPARATION

GENERAL — Applicable to all equipment

A. The Skid Base:

1. The skid base is made of wood and suitable for fork lift transit.
2. All skid-mounted assemblies are covered with heavy-gauge transparent plastic. An excess of the covering material is provided at the ends and is to be used as access for maintenance of bearings, etc., during storage.

B. Ferrous Surfaces:

All unpainted and unplated ferrous surfaces are covered with tape, masonite, overwrap, oil, etc., as practical.

C. Centrifuge Assembly:

1. The centrifuge is mounted on a skid base.
2. All accessible openings are closed with tape, masonite, overwrap, etc., as practical.

D. Starter Panel or Control Console (As Supplied):

1. The panel is mounted on a skid base.
2. Corrosion inhibitor and desiccant are included inside the cabinet.
3. Exterior openings are closed with tape, masonite, overwrap, etc., as practical.

E. Drive Motor:

The motor shaft ends are coated with a metal protector and overwrapped.

F. Tools and Small Spare Parts:

All unpainted and unplated ferrous surfaces are coated with a metal protector and, where practical, the items are overwrapped and then packed in a box which is mounted on a skid.

G. Spare Bearings:

Spare bearings should not be removed from their original manufacturer packaging.

SPECIFIC — In addition to the above general factory preparation, each type of centrifuge has its own special requirements as noted below.

A. Super-D-Canter Centrifuge:

1. On grease-lubricated horizontal Super-D-Canters, the pillow block bearings are filled with the specified grease.
2. On oil-lubricated Super-D-Canters, the lube system has been flushed with a mixture of nine parts specified oil and one part Rust Veto concentrate. The oil reservoir is drained prior to shipment.
3. The heat exchanger (if supplied) has been drained of water and blown dry.
4. Spare Rotating Assembly:
   a. All unpainted and unplated ferrous surfaces are coated with a metal protector and where practical, overwrapped.
   b. All non-process openings to the interior are closed with overwrap.
5. The spare gear box, if supplied, is overfilled with the recommended gear oil.

CAUTION

BEFORE PLACING IN OPERATION, DRAIN EXCESS OIL TO OBTAIN CORRECT OPERATING OIL LEVEL IN GEAR BOX. FAILURE TO DO THIS WILL RESULT IN DAMAGE TO GEAR BOX AND WILL VOID WARRANTY.

B. Vertical Basket Centrifuge:

1. Centrifuge Assembly:
   Corrugated paper is wrapped around the outside of the curb with steel bands. Blocks of wood are then wedged between the curb and the balancing stands.

2. Hydraulic Drive (If Supplied):
   The system is flushed with the specified oil and then drained.

3. Heat Exchanger (If Supplied):
   The heat exchanger is drained of water and blown dry.

C. Disc Centrifuge:

1. Air Hydraulic Pump (If Supplied):
   The pump is flushed with a mixture of oil and rust preventive and then drained.

2. Bearing Assembly:
   The bearing assembly is flushed with the recommended lube oil and then drained.

III. STORAGE AREA REQUIREMENTS AND STORED EQUIPMENT MAINTENANCE

A. General — Applicable to all equipment

1. Storage Environment:
   Storage of centrifuge, motor, control console, and backdrive (if supplied) to be indoors, in a temperature controlled environment, protected from the elements. ''Temperature controlled environment'' is an area that is thermostatically controlled with adequate air ventilation to prevent stratification and have a temperature range maintained between 50° and 90°F. If a temperature controlled environment is not available, power must be provided to motor heaters and control panel space heaters, as a minimum protection against accumulation of condensate. If heaters are not provided, then commercial space heaters should be acquired for use during storage.

NOTE CONCERNING OUTDOOR STORAGE

Although Sharples centrifuges are capable of outdoor operation, Sharples does not recommend *storing*

centrifuges outdoors. The difference is that the bearing lubricants of operating centrifuges continuously cover and protect the bearings due to circulation and distribution.

If storing outdoors cannot be avoided, then the centrifuge only may be stored outdoors for up to one month. It must be suitably protected from the direct impingement of the elements. All control and drive components must be stored indoors. Outdoor storage of centrifuges in corrosive environments, typical of coastal regions, must be avoided entirely.

2. To prevent bearing fret, the storage area, whether indoors or outdoors, should not be subjected to constant vibration.

3. Openings:

   Keep all openings leading to the interior of the equipment sealed.

4. Painted Parts:

   a. Clean the parts. Refer to the cleaning section of this bulletin.

   b. Touch up or repaint as necessary.

NOTE

Do not paint rotating shafts or threaded parts.

5. Lubrication:

At the beginning of the storage period, lubricate all grease lubricated centrifuge bearings and drive motor and backdrive motor (if supplied) bearings in accordance with lubrication instructions. Thereafter grease every six months while in storage. On motors, all drains must be fully operable while in storage and/or the drain plugs removed. All breathers and automatic "Tee" drains on motors must be operable to allow breathing at points other than through the bearing fits.

6. Maintenance Log:

Maintain a log to record each task performed during storage of equipment.

B. Motors:

1. Every six months and just prior to placing in operation, measure the resistance of motor windings with a megger. Minimum reading is 1 megohm. If below this reading, drying is necessary. Contact motor manufacturer.

2. Monthly, rotate the shafts of motors at least 10 revolutions to keep the bearings lubricated and prevent their rusting and brinelling.

C. Control Consoles:

Change corrosion inhibitors once a year. Refer to Paragraph VI.

D. Programmable Controllers (If Supplied):

Observe humidity recommendations and replace batteries as directed in programmable controller manufacturer's instructions.

E. Super-D-Canter® Centrifuge:

1. Initially when placed in storage, and monthly thereafter, rotate bowl by hand at least 20 revolutions. Hold pinion shaft (shaft protruding from the gear box) while rotating bowl.

WARNING

DO NOT PLACE HANDS NEAR PULLEYS, BELTS, AND OTHER PINCH POINTS WHILE ROTATING BOWL.

NOTE

Ideally, if possible, the centrifuge should be installed and run a minimum of one hour at least once a week. If this is possible, then lubrication interval should be the same as an operating centrifuge.

2. If equipped with a backdrive motor or eddy-current brake, monthly rotate shafts at least 10 revolutions.

3. On Super-D-Canters equipped with a fluid coupling, rotate coupling, jack shaft and drive motor. Overfill jack shaft bearing reservoirs with nine parts recommended oil mixed with one part Rust Veto Concentrate while in storage. Drain to proper level before startup.

F. Vertical Basket Centrifuge:

Monthly open inspection cover and rotate basket by hand at least 20 revolutions.

WARNING

KEEP HANDS AWAY FROM PINCH POINTS.

IV. PRESTARTUP PROCEDURES

GENERAL — Applicable to all equipment

A. If Equipment Has Been Stored More Than One Year:

1. Before startup, inspect all seals, gaskets, O-rings, belts and other elastomeric parts to determine their condition, since these parts can become brittle in time.

2. If the equipment has been exposed to low temperture for an extended period of time, unpacking it before it has reached room temperature can cause water condensation on the cold surfaces. This must be avoided, especially with motors, since the presence of moisture can cause electrical failures.

B. If Equipment Has Been Stored More Than Two Years:

Replace all bearings, seals, gaskets, O-rings, belts, and other elastomeric parts.

C. Motor:

1. Be sure all lubrication passages are clear of hardened lubricant.
2. Purge bearings of grease to their proper operating quantity.
3. If motor has been stored for more than six months, measure the resistance of motor windings with a megger. If reading is less than 1 megohm, contact motor manufacturer for drying procedure.
4. If stored more than three years, the motor should be completely dismantled and inspected by an authorized service facility of the motor manufacturer.

D. Electrical Controls:

1. If dirty, vacuum clean. Do not use metal tipped hoses.
2. Check and tighten all terminal connections.
3. Check for moisture and corrosion. Do not operate until all corroded parts have been replaced or repaired.
4. Remove desiccant and corrosion inhibitor.

E. Coated Parts:

If parts have been coated with rust preventive materials, refer to that section of this bulletin to determine if these have to be removed before startup.

F. Lubrication:

Lubricate equipment before placing in service.

SPECIFIC — In addition to the above general requirements, note the following:

Super-D-Canter® Centrifuge:

1. Gear Box:

   If the gear box has been stored for more than one year, completely drain and fill with recommended quantity of fresh specified oil (spare gear boxes have been overfilled).

2. Reservoir Lube System:

   Before use, flush and fill with recommended quantity of fresh specified oil.

3. Backdrive Motor (If Supplied):

   Purge bearings of grease to proper operating quantity.

4. Main Drive Jack Shaft Bearing Reservoirs (If Supplied):

   Drain excess oil to proper level.

V. CLEANING

A. *Vacuum Cleaning:*

Vacuuming is efficient in removing dust from most equipment, but is especially necessary with electrical controls, and is the only method recommended.

B. *Solvent Cleaning:*

Specific types and concentrations of cleaners, and appropriate methods can be recommended by the Sharples Metallurgical Department. Generally, parts (other than electrical) are completely immersed using baskets or hooks. They may then be spray rinsed or dipped in clear water.

Steel parts must be thoroughly dried to prevent rust.

C. *Abrasive Cleaning:*

Adhering dirt may require scrubbing with a stiff bristle brush or abrasive paper.

D. *Rust Removal:*

Rust may be removed by the careful use of fine abrasive paper, or swabbing the area down with a metal-prep acid cleaner (e.g., phosphoric acid).

CAUTIONS

Observe all safety precautions when handling chemicals.

Handle machined surfaces carefully.

Surface cleaned with an acid or other strong solvent must be thoroughly rinsed and dried before application of a rust preventive.

Remove burrs or rough spots with an abrasive, but corrective measures should not be so extensive as to alter the dimensions of the parts involved.

Do not use compressed air for cleaning.

VI. TYPICAL PROTECTIVE MATERIALS USED BY SHARPLES

A. Wraps

1. Overwrap:

An overwrap is any self-adherent, grease, oil and water-proof material which can be molded around parts:

"MarvelPak 22" by Ludlow Corp.

"Scotch-Wrap" by Minnesota Mining & Mfg. Co.

NOTE

Tears in the covering must be kept repaired.

2. Unit Covering:

A heavy gauge plastic completely covers the equipment.

To protect equipment against cold and humidity, desiccant, space heaters or electric dehumidifiers can be used.

NOTE

Tears in the covering must be kept repaired.

B. Coatings and Oils:

At regular intervals during storage, all exposed machined surfaces, unpainted steel parts, shafts, cast iron parts, piping, couplings, etc., should be examined for signs of rust and moisture.

Affected parts must be thoroughly cleaned and coated with the appropriate material listed below:

1. Molykote Metal Protector (Dow Corning):

   A wax type rust preventive which is sprayed, brushed, or dipped onto bare steel parts. It dries to a hard, dry film and is practically invisible. An overwrap is used.

2. Rust Veto 342 (Houghton Co.):

   A soft, amber-colored material leaving a transparent, dry plastic film on coated parts. Applied by brushing, dipping, or spraying, it is used for maximum heavy duty protection on interior or exterior surfaces with or without a covering.

   Before using parts, remove Rust Veto with solvent.

3. Rust Veto 377 (Houghton Co.):

   A light, polar type water-displacing oil. It is used on metal parts stored indoors. It can be sprayed on intricate parts and bearings. An overwrap is used.

   Since it is lightweight, removal is not necessary before use.

   An equivalent is "AntiRust #77" WD Oil by International Chemical.

4. Rust Veto Concentrate (Houghton Co.):

   A rust preventive base that is mixed in one part with nine parts lubricating oil, or hydraulic oil, etc. It is circulated through hydraulic systems and then drained before shipment.

   It is compatible with most hydraulic oils and removal is not necessary before use.

5. Ferrocote 346 (Quaker Chemical Co.):

   A heavy oil which leaves a soft, paste-like film on a surface. For outdoor storage, it must be used with an overwrap.

   Before parts are used, Ferrocote must be removed with a solvent.

NOTE

Contact each manufacturer as required to determine if the rust preventives are compatible with the type of oils you are using.

C. ***Vaporizers and Desiccants (For Electrical Enclosures):***

1. Foam Corrosion Inhibitor (Hoffman Engineering Co.)

   These are foam shapes of various sizes impregnated with special patented chemical inhibitors, buffers, and anti-oxidants.

The chemicals vaporize and then condense on all surfaces of the enclosed area. Vapors will redeposit as needed in the event of condensation of moisture on surfaces. These vapors reach every part of an enclosure, protecting all interior components (ferrous and non-ferrous metal parts) from corrosion.

These inhibitors eliminate the need for spraying, wiping, greasing, precoating, special wrapping or drying agents.

The vapors have no deleterious effect on the commonly used plastics, rubbers, paints, and adhesives.

The inhibitors have an expected lifetime of one year unless they are subjected to:

- Extended air exchange
- Temperatures above 120°F
- Direct contact with water
- pH below 4.5 or above 10.5

The foam shapes are supplied in three sizes. The area of protection listed below refers to non-ventillated (sealed) enclosures:

Sharples Spec. No.	Capacity
#14EF14	40 cubic feet
#14EF15	5 cubic feet
#14EF16	1 cubic foot

NOTE

Reduce volume if:

a. **Cabinet doors are opened frequently (more than once daily).**

b. **Cabinet located in extremely corrosive area.**

2. Desiccant:

Such as:

"Humisorb", Multiform Desiccant Products, Inc.

Reusable—Reactivate by heating at 245°—260°F for 16 hours.

Complies with MIL-D-3464 Type I, and MIL-P-116 Method II.

Dry, dustless, inert, odorless, tasteless, nontoxic, non-corrosive, non-deliquescent.

BULLETIN 576ECBDC
Revision 5

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

CENTRIFUGE LUBRICATION INSTRUCTIONS

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SHARPLES-STOKES DIVISION

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III. PILLOW BLOCK BEARING LUBRICATION SYSTEM 4

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Table 1. Typical Centrifuge Log Sheet

Figure 1. Oil Lubricating System

Figure 2. Greasing Schematic

I. GENERAL

This bulletin covers procedures for lubricating the various components of the Super-D-Canter, lists intervals, and approved lubricants. This is a general lubrication bulletin. In some cases a specific lubrication bulletin may be provided. If this is the case, that bulletin will supersede bulletin 576.

IMPORTANT

There may be other lubricants asserted to be equivalent to those specified by Pennwalt. Only those specified have been performance tested in Pennwalt Sharples centrifuges. Pennwalt has no significant experience with other lubricants and will not recommend their use. Damage which is the result of lubricants other than those recommended will not be covered by any warranty in force. If any of the recommended products cannot be purchased locally, purchase them from the Pennwalt Sharples parts department. The recommended products are compatible with all products previously recommended by Pennwalt.

II. LUBRICATION SCHEDULE

CAUTION

FAILURE TO FOLLOW THE RECOMMENDED SCHEDULE COULD RESULT IN SERIOUS DAMAGE TO THE CENTRIFUGE COMPONENTS.

A. GEAR BOX

1. Frequency:
   3 Months — check oil level
   Yearly — Drain and replace oil (One shift per day operation)
   6 Months — Drain and replace oil (24 hour operation)

2. Capacity:
   15 quarts

3. Lubricant:
   Chevron Borate E.P. Lubricant 220
   (Viscosity of 1100 SSU @ 100 ° F)

4. Draining and Filling Procedure:
   Refer to the gear box maintenance section of the Operation and Maintenance Manual.

B. CONVEYOR BEARINGS

1. Frequency:

CONDITION	INTERVAL
a. Continuous Service (24 hours per day, 7 days per week) with process temperature up to 220° F	Monthly
b. Intermittent Service (8-12 hours per day, 5-6 days per week)	Weekly
c. C.I.P. Service (except sewage - refer to a. or b. above for sewage)	
Low Speed C.I.P. (Bowl stationary or turning slowly - Backdrive turning conveyor)	Regrease after each cleaning operation
High Speed C.I.P. (Bowl turning at normal operating speed)	Regrease Weekly
d. Chemical or special application including process temperatures in excess of 220° F	Weekly
e. Application requiring frequent washing and/or steam cleaning	At end of each cleaning

2. Capacity:

   13 Pounds grease total both ends

3. Lubricant:

   Keystone Zeniplex 1 (N.L.G.I. No. 1 Multipurpose grease)
   Keystone Division Pennwalt Corp., 21st & Lippincott Sts.,
   Phila., Pa. 19132 (215) 225-2550

NOTE:

Generally, for edible processes, Nevastane HT/AW-1 (Keystone Division, Pennwalt Corp.) is recommended. Consult Pennwalt Sharples engineering department for any applications where this is not satisfactory.

4. Greasing Procedures:

   1. If possible lubricate with machine warm.

2. Grease fittings and air escape holes are provided for each conveyor bearing. Refer to centrifuge assembly drawing in centrifuge operation and maintenance bulletin for location.

CAUTION

Remove 1/8 inch pipe plugs in air escape holes before greasing conveyor bearings. Reinstall after greasing. Failure to remove plugs will result in damage to conveyor bearing seals. When greasing gear box end conveyor bearing, note that on some gear box adapters there are two air escape holes and on some, just one. It is extremely important to remove both plugs, if so equipped. A good method of determining the number of air escape holes is by counting the total number of holes in the adapter excluding mounting screw and jack screw holes. If there are five total there are two air escape holes. If there are less than five total, then there is one air escape hole.

3. Conveyor should be rotated slowly to help distribute grease. If centrifuge is equipped with a D.C. backdrive, run backdrive motor at its lowest R.P.M. With other arrangements, turn pinion shaft by hand. DO NOT run main drive motor.

4. Do not use a pressurized grease gun. It can generate too much pressure and damage conveyor bearing seals. Continue greasing until grease coming out escape holes is the same consistency of new grease.

C. PILLOW BLOCK BEARINGS

1. Frequency:
   Weekly—Check oil level
   6 Months—Change oil

2. Capacity:
   10 Gallon reservoir

3. Lubricant:
   Sunvis 921 (Petroleum lubricating oil refined to turbine oil quality having a viscosity of 180-215 SSU @ 100° F)

   OR

   Chevron G S T, Grade 46 (Petroleum lubricating oil refined to turbine oil quality having a viscosity of 200 SSU @ 100° F)

   OR

   Keystone KLC-15, Keystone Div., Pennwalt Corporation (General purpose oil having a viscosity of 200 SSU @ 100°F equivalent to SAE 20)

4. Procedures:
   a. Replace oil filter element every 6 months.
   b. At the same time, clean the two strainer screens located in the pipe lines next to the pillow blocks.
   c. Clean the reservoir every 3 years.

D. BACKDRIVE JACKSHAFT BEARINGS

1. Frequency:
   Monthly

2. Lubricant:
   Keystone Zeniplex 1 (N.L.G.I. No. 1 Multipurpose grease)

E. BACKDRIVE ASSEMBLY

Refer to manufacturer's instructions.

III. PILLOW BLOCK BEARING LUBRICATION SYSTEM

A. COMPONENTS

Figure 1. The lubrication system provides the necessary lubricating oil to the pillow block bearings. The complete system consists of a resevoir on which are mounted:

The motor driven pump

Heat exchanger

Filter

Temperature gauges

Relief valve

Temperature Switches [165°F (74°C) Setting]

Pressure gauge

Flow switches

Coolant valve

Monitoring system control panel

Solenoid valve

NOTE

The centrifuge drive motor cannot be started until the lubrication system is first placed in operation.

B. STARTING PROCEDURE

1. Fill the lubrication oil reservoir with approximately 10 gallons of recommended oil.

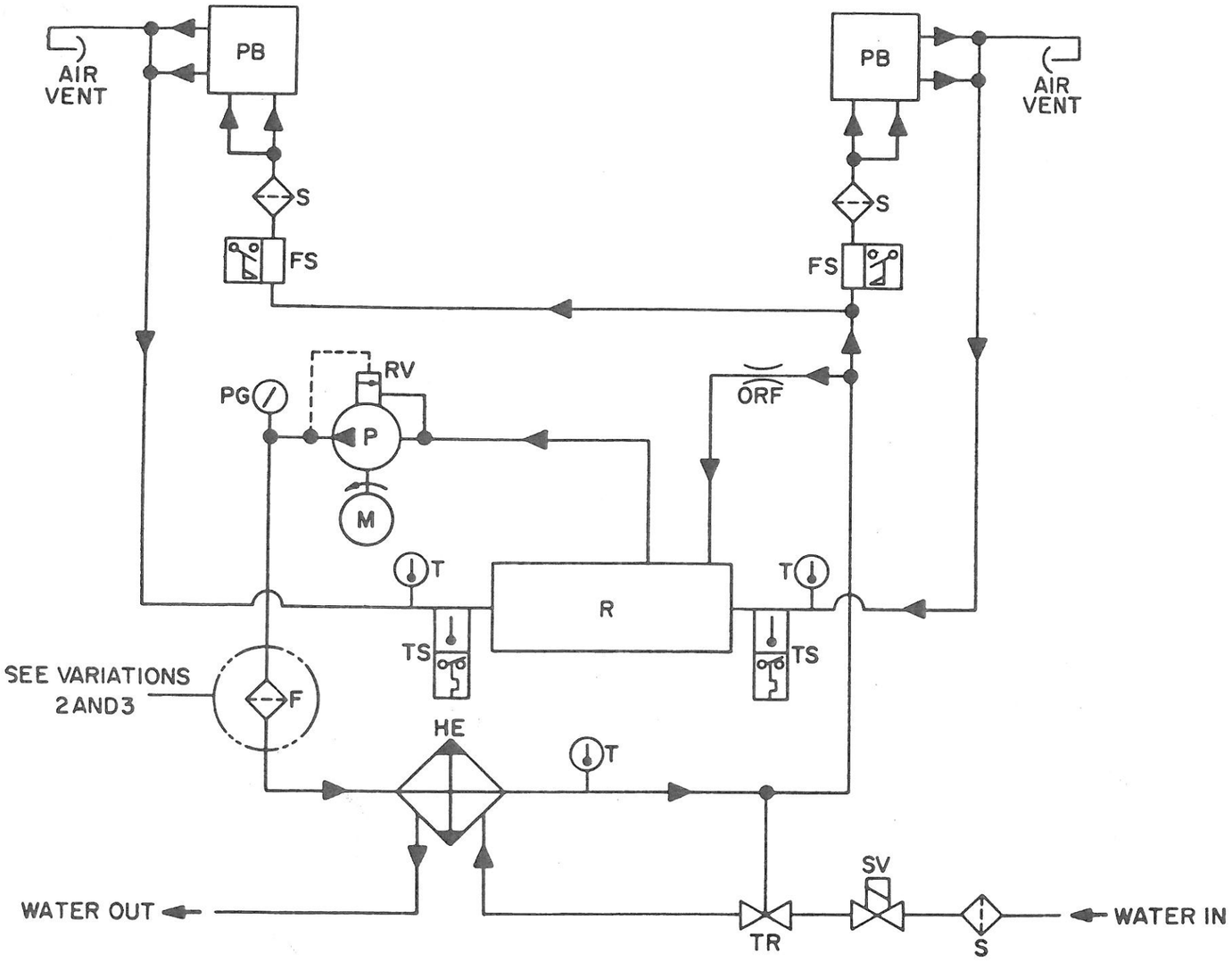
2. Start the flow of cool water to the heat exchanger.

3. Start the pump - flow switches should close as soon as oil flows through the system. If trip point requires setting, refer to separate flow monitor bulletin. Set at 0.2 GPM.

4. Check oil level in reservoir.

TABLE 1.
TYPICAL CENTRIFUGE LOG SHEET
(CENTRIFUGE ON STREAM)

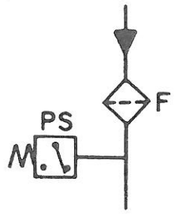
PILLOW BLOCK BEARING OIL TEMPERATURE			PRESSURE GAUGE 15 - 20 PSI	FLOW MONITOR (GPM)		RESERVOIR OIL LEVEL RUN (Minimun)	TORQUE EXCITATION 0– 100°F	OPERATOR	MACHINE NO.	DATE	TIME
INLET	OUTLET										
100°F (Maximum)	155°F (Maximum)										
	FRONT	REAR		FRONT	REAR						



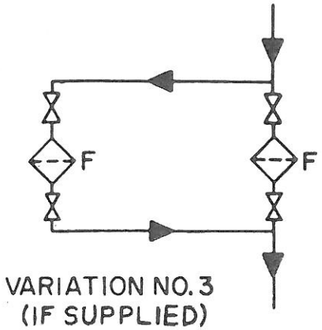
VARIATION NO. 1
(IF SUPPLIED)

LEGEND

PB — PILLOW BLOCK
S — STRAINER
FS — FLOW SWITCH
PG — PRESSURE GAUGE
T — THERMOMETER
RV — RELIEF VALVE
ORF — ORIFICE
P — PUMP
R — RESERVOIR
F — FILTER
HE — HEAT EXCHANGER
TS — TEMPERATURE SWITCH
TR — TEMPERATURE REGULATOR
PS — PRESSURE SWITCH
SV — SOLENOID VALVE
M — MOTOR



VARIATION NO. 2
(IF SUPPLIED)



VARIATION NO. 3
(IF SUPPLIED)

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PENNWALT-
SHARPLES
CENTRIFUGES
WARMINSTER, PA. 18974

OIL LUBRICATING SYSTEM

FIGURE - 1

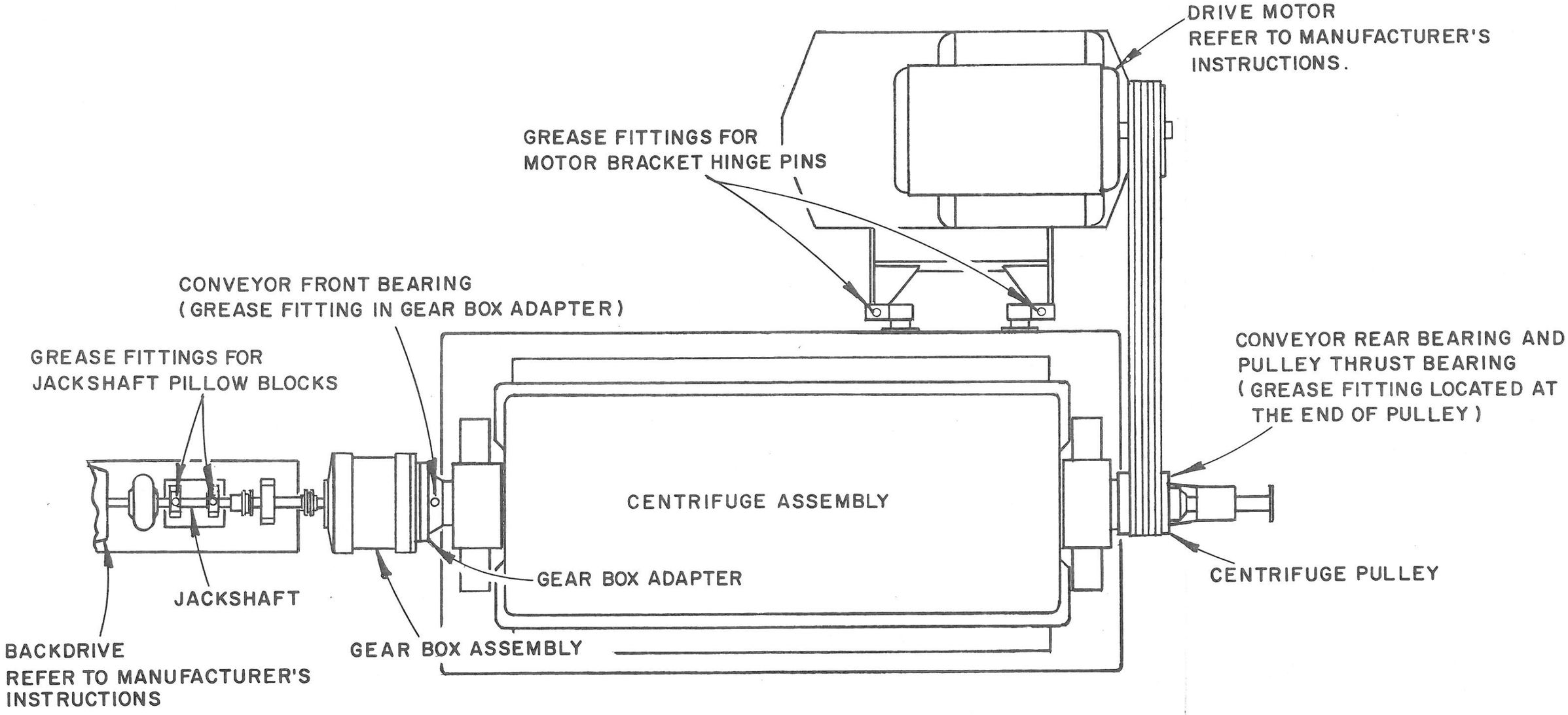


FIGURE -2

GREASING SCHEMATIC

BULLETIN 293, REV. 2

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

INSTRUCTIONS

FOR THE

SARCO T-44 COOLING CONTROL

PENNWALT CORPORATION . . . 955 MEARNS ROAD, WARMINSTER, PA. 18974
SHARPLES-STOKES DIVISION

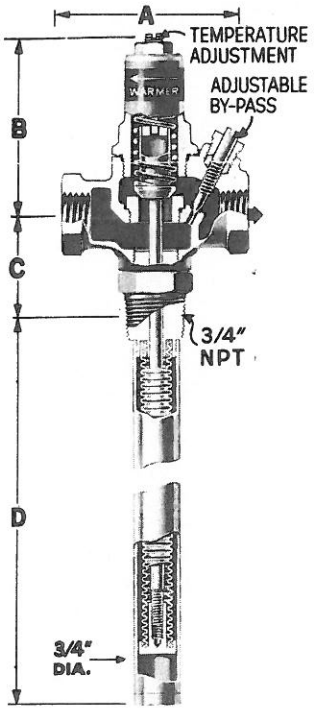


Fig. 1—Type T-44 Cooling Control.

A. DESCRIPTION

Single seated valve for use with water-containing scale-forming minerals. Cast red brass body. Renewable, stainless steel valve head, valve stem and spring. Removable stainless steel seat. Copper thermostat.

Standard 50° adjustment ranges between 85 and 135°F.

B. PIPING HOOKUP

The T-44 Cooling Control can be installed with the thermostat directly in the liquid being cooled, i.e., oil and solvent coolers or in the cooling water discharge line in the case of condensers, compressor jackets and solvent recovery coils.

A three valve bypass hookup is recommended on continuous service applications to permit inspection or repair without shutdowns.

A typical hookup is shown with piping details on Figure 2.

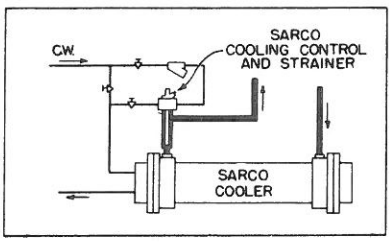


Figure 2

NOTE

When the control thermostat is installed in the cooling water discharge piping of recovery coils, and other equipment on which the load is intermittent, the piping between control valve and coil and thermostat, must be kept as short as possible. Oversized or long lengths of piping at these points increases the minimum flow required to keep the thermostat responsive to changing loads. Refer to "Bypass Valve Adjustment" section. The control should be installed vertically, and the piping in which the thermostat is located must be arranged to keep the heat exchanger and thermostat well full of cooling water at all times.

The control should be installed vertically, and the piping in which the thermostat is located must be arranged to keep the heat exchanger and thermostat well full of cooling water at all times.

C. STRAINER

If foreign material enters the valve, it will increase erosion of the valve parts, and may completely clog the valve causing overheating. To avoid these troubles, a strainer must be used to protect the control valve from pipe scale and dirt.

D. THERMOMETER

A thermometer should be installed near the control thermostat to permit proper adjustment of the control, and as a check on operation.

E. INSTALLATION

After the piping in which the thermostat will be located is assembled and checked for sufficient clearance, insert the thermostat.

When tightening the threaded connection, align the valve so the incoming cold water will flow in the direction of the arrow cast on the body.

Remove the thread protectors from the valve and make connections with piping arranged to avoid strains on the valve body. Wrenches should be applied only to the hexagonal parts of the regulator, never on the valve body.

F. OPERATION

The space between the outer thermostat tube and the packless bellows seal is filled with a fluid which gives uniform movement per degree of temperature change. When the temperature of the liquid surrounding the thermostat increases, the filling expands, moving the valve head further from its seat to increase the flow of cooling water. A decrease in the temperature at the thermostat causes the filling to contract and the valve throttles to reduce the flow of water.

G. TO SET CONTROL

Before attempting to set the control to maintain the desired temperature, the cooling water should be turned on and the built-in bypass valve stem (4) must be set closed (stem turned clockwise), then proceed as follows: Figure 3.

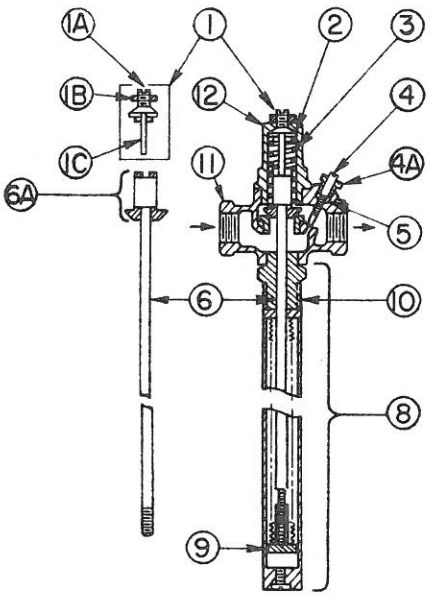


Figure 3

1. After equipment is in operation, observe the thermometer and wait for temperature to stabilize.

2. If it is necessary to make an adjustment to obtain the desired temperature:

   a. Loosen locknut (1B).
   b. Using a screw driver, turn adjustment screw (1A) in direction indicated on the name band. Clockwise to increase temperature, counterclockwise to decrease temperature.
   c. Adjustments must be made gradually, allowing time for thermostat to reach equilibrium. Excessive force on the stem assembly (1) can damage the thermostat.

G. INSPECTION AND CLEANING

To inspect and clean the regulator: Figure 3

1. Unscrew cap (12).
2. Lift out spring (3).
3. With a screwdriver in the slot of adjustment head (6A), unscrew the valve head and stem assembly (6).
4. Lift assembly (6) out of body (11).
5. Remove dirt and all deposits.
6. Badly worn parts should be replaced.

CAUTION

Do not damage seating surfaces.

H. REASSEMBLY

1. Insert valve head and stem assembly (6) in place.
2. Put valve spring (3) in place.
3. Loosen locknut (1B).
4. Place cap (12) with adjustment stem assembly (1) in place over valve spring (3).
5. Press cap and associated parts downward, compressing valve spring (3), at the same time turning adjusting screw (1A) with a screw driver so adjustment key (1C) engages the slot in adjustment head (6A).
6. Push cap (12) downward until it engages the threads in body (11).
7. Turn adjustment screw (1A) clockwise three turns to engage thread at bottom of stem.
8. Reset control to desired temperature and tighten locknut (1B).

I. REPLACE THERMOSTAT

1. Loosen locknut (1B).
2. Turn adjustment screw (1A) counterclockwise unscrewing valve head and stem assembly (6) from diaphragm cap (9).
3. Using a wrench on tank union (10), unscrew the thermostat assembly (8) from valve body (11).

4. Slide new thermostat in place over valve head and stem assembly (6).

5. Tighten tank union (10) securely in place in body (11).

6. Readjust the regulator to the temperature required and tighten locknut (1B).

PRESSURE DROP	CAPACITIES, GPM WATER							
	3/8" & 1/2"				3/4" & 1"			
	TEMPERATURE CHANGES							
	5°F	10°F	15°F	20°F	5°F	10°F	15°F	20°F
10 psi	3.3	5.7	8.0	9.4	4.6	7.9	11.4	13.7
20 psi	4.4	8.3	11.4	13.5	6.8	11.8	16.5	20.0
30 psi	5.1	10.0	13.7	16.4	8.6	14.8	20.6	25.5
40 psi	5.5	11.4	15.4	18.6	10.0	17.2	24.0	30.0

BULLETIN 572S

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

DESCRIPTION AND OPERATION

of the

FLOW SWITCH

used with

SHARPLES CENTRIFUGE LUBRICATION SYSTEMS

PENNWALT CORPORATION . . . 955 MEARNS ROAD, WARMINSTER, PA. 18974
SHARPLES-STOKES

INTRODUCTION

The lubrication system supplied with your centrifuge is provided with a flow switch known as the Flo-Eye Indicator Alarm which is manufactured by the Schutte & Koerting Company. The Description, Installation, Operation, and Performance Characteristics of this Flow Switch are described on Pages 1 and 2.

To obtain the correct flow in g.p.m. of oil, refer to the instruction manual for the percent scale setting, for your particular centrifuge. Always make sure that the Flow Switch is set correctly before the centrifuge is started.

DESCRIPTION

The Type 1885-CDA Flo-Eye Indicator Alarm consists of a compact visual flow indicator housing and a metering plug with an encapsulated magnet. The alarm switch assembly is a hermetically sealed reed type switch, biasing magnet and mounting bracket. The switch assembly is enclosed in an open type housing. The unit is furnished with one Low Switch which is adjustable over the full range of the indicator.

A remotely located relay should be used in conjunction with the alarm unit. The recommended relay specifications are listed on Page 2.

INSTALLATION

Install the unit in a vertical position and refer to the wiring diagram for making the proper power supply connections. The power and/or alarm circuit wires are fed into the enclosure through the hole in the base-plate which accommodates a standard 3/4'' conduit fitting.

To set the alarm switch in its proper location, position the float for minimum allowable flow. Raise the switch until the alarm device is actuated. To check the alarm switch setting, return the float to the normal operating position and then lower it to the point of minimum allowable flow. If necessary, readjust position of switch bracket. Repeat this procedure until the alarm device is actuated just as the float approaches the point of minimum allowable flow.

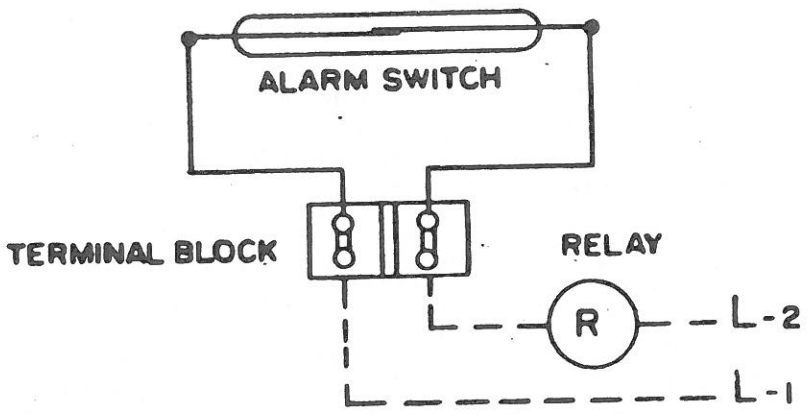
NOTE: When installing a replacement switch, the switch MUST be moved to the lowest possible position on the extension well and then repositioned to the required setting. This procedure will restore the switch to its original memory setting.

OPERATION

The alarm switch contacts are normally open on no flow, and as the magnet in the float extension passes the alarm switch, it either interrupts or completes a magnetic circuit within the alarm switch caused by the biasing magnet. This causes the alarm switch contacts to open or close which in turn opens or closes the alarm circuit.

PERFORMANCE CHARACTERISTICS

On-Off Differential:----------	Approximately 4 millimeters.
Alarm Switch:----------	15 VA maximum resistive up to 1 amp and up to 250 V.
	Inductive Load - Contact protection required or derate to at least 10 VA.
	Lamp Load - Derate, recommended 10 Watts.
Relay Coil:----------	Relay coil rating must not exceed the inductive load rating of the switch.
Pressure Rating:----------	125 psig at 125°F.



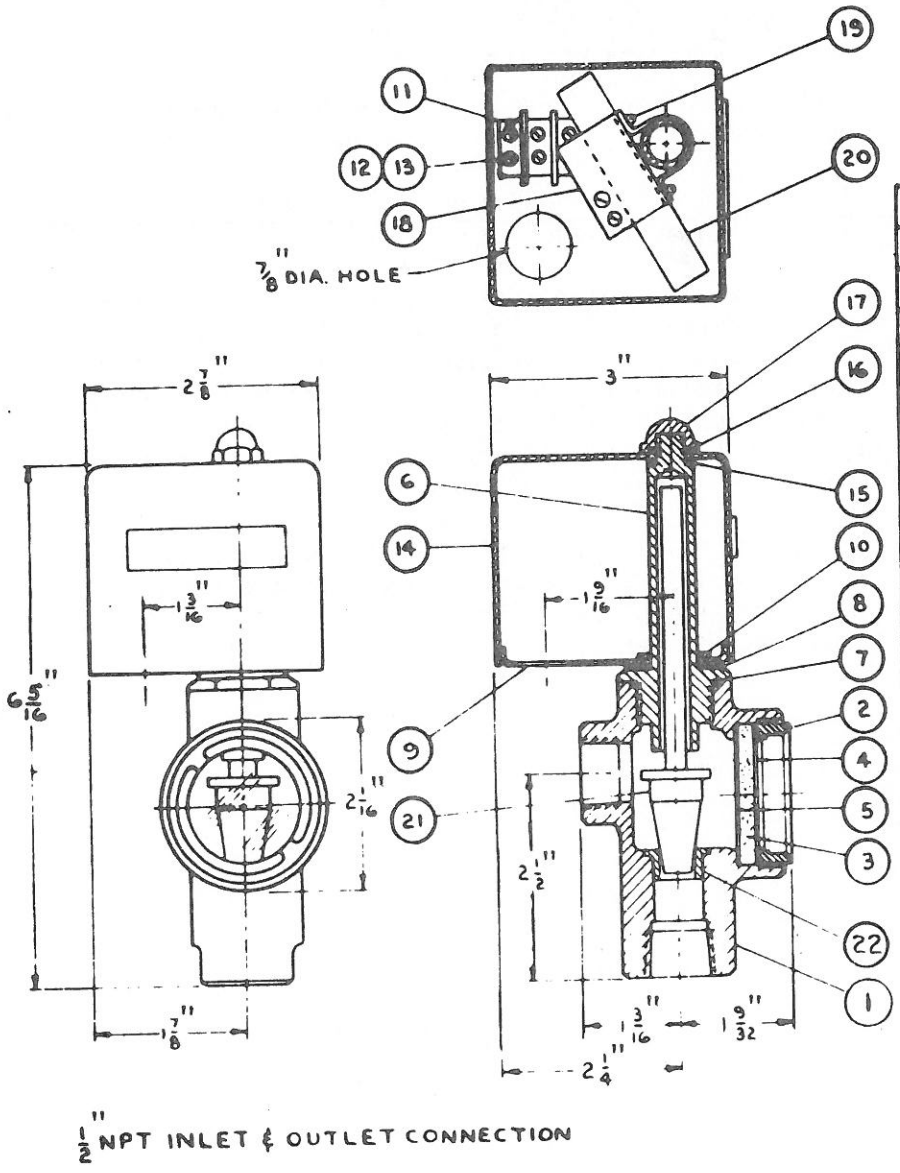
INSTALLATION INSTRUCTIONS FOR INSTALLING A NEW FLOAT AND ORIFICE

Disassemble by removing the extension well and enclosure assembly at the body, with a thin open end wrench. Remove the float assembly (21).

Press the new orifice in place. Install the float assembly in the body and replace extension well and enclosure assembly.

To set the alarm switch in its proper location, position the float for minimum allowable flow. Raise the switch until the alarm device is actuated. To check the alarm switch setting, return the float to the normal operating position and then lower it to the point of minimum allowable flow. If necessary, readjust position of switch bracket. Repeat this procedure until the alarm device is actuated just as the float approaches the point of minimum allowable flow.

NOTE: After installing the replacement float, the switch must be moved to the lowest possible position on the extension well and then repositioned to the required setting. This procedure will restore the switch to its original memory setting.



1/2" NPT INLET & OUTLET CONNECTION

PARTS LIST	
NO	DESCRIPTION
1	BODY
2	RING
3	SIGHT GLASS
4	OUTER GASKET
5	INNER GASKET
6	EXTENSION WELL
7	"O" RING
8	GASKET
9	BASEPLATE
10	RETAINING RING
11	TERMINAL BLOCK
12	MOUNTING SCREWS
13	HEX NUTS
14	ENCLOSURE
15	WASHER
16	"O" RING
17	CAP NUT
18	SWITCH BRACKET & STRAP
19	CLAMPING SCREWS
20	SWITCH ASSEMBLY
21	FLOAT ASSEMBLY
22	ORIFICE

UNLESS OTHERWISE NOTED, DIMENSIONS ARE IN INCHES
BOLT HOLES STRADDLE ℄'S

CERTIFIED FOR _____ DATE _____
ORDER NO. _____
S & K ORDER NO. _____ BY _____
DO NOT USE FOR CONSTRUCTION
UNLESS CERTIFIED FOR A SPECIFIC ORDER

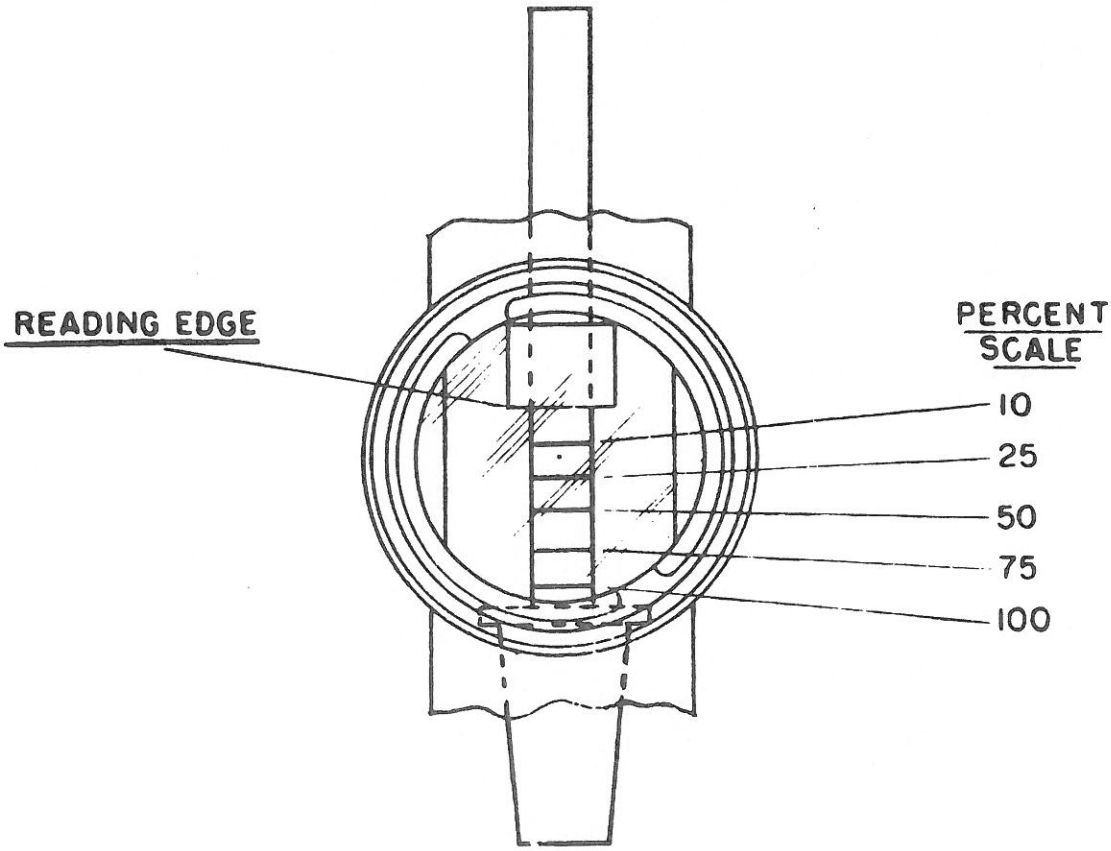
PIC'S NO	1885-CDA
S/M	66-101-M
P.O.	M66-51778
DRAWN	[illegible]
CHECKED	
SCALE	HALF SIZE
MADE FROM	61-S-512-M

OUTLINE DIM. DWG.
& PARTS LIST
FLOW INDICATOR ALARM

SCHUTTE & KOERTING CO.
MANUFACTURING ENGINEERS
CORNWELLS HEIGHTS BUCKS COUNTY, PENNA.

66-S-165-M

REV.



FLOW BEING PASSED IS INDICATED WHEN ENGRAVED LINE COINCIDES WITH READING EDGE.

1/2" TYPE 1885-CDA
FLOW-EYE
INDICATOR ALARM
DATA

SCHUTTE & KOERTING CO.
MANUFACTURING ENGINEERS
CORNWELLS HEIGHTS BUCKS COUNTY, PENNA.

INSTALLATION AND SERVICE INSTRUCTIONS

FOR SERIES LA – LE PUMPS

GENERAL INFORMATION
- Pumping Principle ..... Page 1
- Seal ..... Page 1

INSTALLATION
- Selection ..... Page 1
- Method of Drive ..... Page 2
- Strainer Protection ..... Page 2

SERVICE
- Disassembly of Seal ..... Page 3
- Disassembly of Pump ..... Page 3
- Inspection ..... Page 3
- Assembly of Pump ..... Page 3
- Pump Performance Test ..... Page 3
- Assembly of Seal ..... Page 3
- Trouble-Shooting Hints ..... Page 4

REPLACEMENT PARTS LISTS
- Relief Valve Detail Model LEV ..... Page 6
- Model LA ..... Page 7
- Model 2LA ..... Page 8
- Model LE ..... Page 9
- Model 2LE ..... Page 10

Tuthill Corporation ®

Tuthill Pump Division

12500 South Pulaski Road
Chicago, Illinois 60658
312 389-2500
Telex #6974251
3781847

INSTALLATION AND SERVICE INSTRUCTIONS

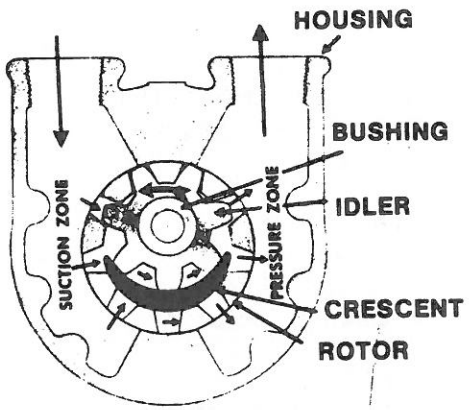
FOR SERIES LA – LE PUMPS

GENERAL DESCRIPTION

The Tuthill Series LA-LE is a compact highly efficient, positive displacement, rotary internal gear type pump with mechanical seal. Built in five sizes, it provides capacities from 20 to 360 gallons per hour and pressures up to 500 psi and is available with 2-bolt flange in the LA Series and 3-bolt flange in the LE Series. Optional mounting feet are available. It is multi-directional in rotation and designed for direct drive at standard motor speeds, with modifications available for indirect drive.

PUMPING PRINCIPLE

These pumps employ the Tuthill internal gear principle which is based upon the use of a rotor, idler gear and a crescent-shaped partition that is cast integrally with the cover. (See accompanying figure.) Thus, only two moving parts comprise this efficient pumping element. Power is applied to the rotor and transmitted to the idler gear with which it meshes. The space between the outside diameter of the idler and the inside diameter of the rotor is sealed by the crescent. When the pump is started, there is an increase in volume as the teeth come out of mesh. This creates a partial vacuum, drawing the liquid into the pump through the suction port. The liquid fills the spaces between the teeth of the idler and rotor and is carried past the crescent partition to the pressure side of the pump. When the teeth mesh on the pressure side, the liquid is forced from the spaces and out through the discharge port.



COUNTERCLOCKWISE ROTATION

SEAL

The seal is a device to prevent leakage between the stationary pump body and rotating drive shaft. A rotating lapped surface is attached to the shaft by an elastomer bellows. This rotating face is spring loaded to rub against a stationary lapped surface in the housing plug bushing. The clearance between these two surfaces is so minute that resistance to flow is great enough that fluid will not leak out and air will not be drawn in.

SELECTION

The Series LA and LE pumps are designed for working pressures up to 500 psi and are required to develop 25″ mercury vacuum at 0 psi on factory test. While these pumps will develop as high as 27″ of vacuum, it is sound engineering to avoid extreme vacuum whenever possible. Select pipe size to reduce line friction loss to a minimum. On transfer service, place pump as close to supply tank as conditions will permit, and eliminate the use of foot valves or check valves in the suction line whenever possible. The LA and LE pumps are self priming and particularly suited to handle liquids of 35 SSU to 1000 SSU viscosity. Higher viscosities can be handled at reduced speeds. It is important that the piping used in connecting the pump be clean and free of chips or scales.

Consult us in selecting the proper pump and size of motor, giving us all the following information:

1. Capacity required
2. Maximum and minimum liquid temperature when entering the pump.
3. The viscosity at the minimum temperature.
4. Total length of suction pipe and discharge pipe, including pipe sizes.
5. Suction lift and height to which the pump must force the liquid.

METHOD OF DRIVING

Direct motor drive through a flexible coupling is the most satisfactory method.

NOTE: **LA and LE pumps can be driven in either direction of rotation.** The seal chamber communicates with the neutral zone and therefore the seal is subjected to one-half of the discharge pressure.

Viewing the pump from the shaft end, the inlet port is on the right-hand side for clockwise rotation, on the left-hand side for counter-clockwise rotation.

Pumps with built-in relief valves are uni-directional. Therefore, rotation, clockwise or counter-clockwise, facing the shaft end, must be specified.

1. All pump and motor units are properly aligned at the factory. However, misalignment may occur due to abuse or conditions beyond our control.
2. Pipe strains often force the pump and motor shafts out of alignment. See that all piping leading to the pump is properly supported by wall brackets. Do not expect the pump to act as a pipe support.
3. Provide for proper expansion of pipes when handling hot liquid.
4. Series L pumps are not designed to take end thrust toward the cover. Provide sufficient clearance, 1/16" to 1/8" between coupling halves with shafts in closest operating position, to allow for end wear in the driving shaft.
5. Never align the pump and motor supplied with pin type coupling without first removing the pins.
6. Never depend upon sight or feel for freeness in aligning a pump.

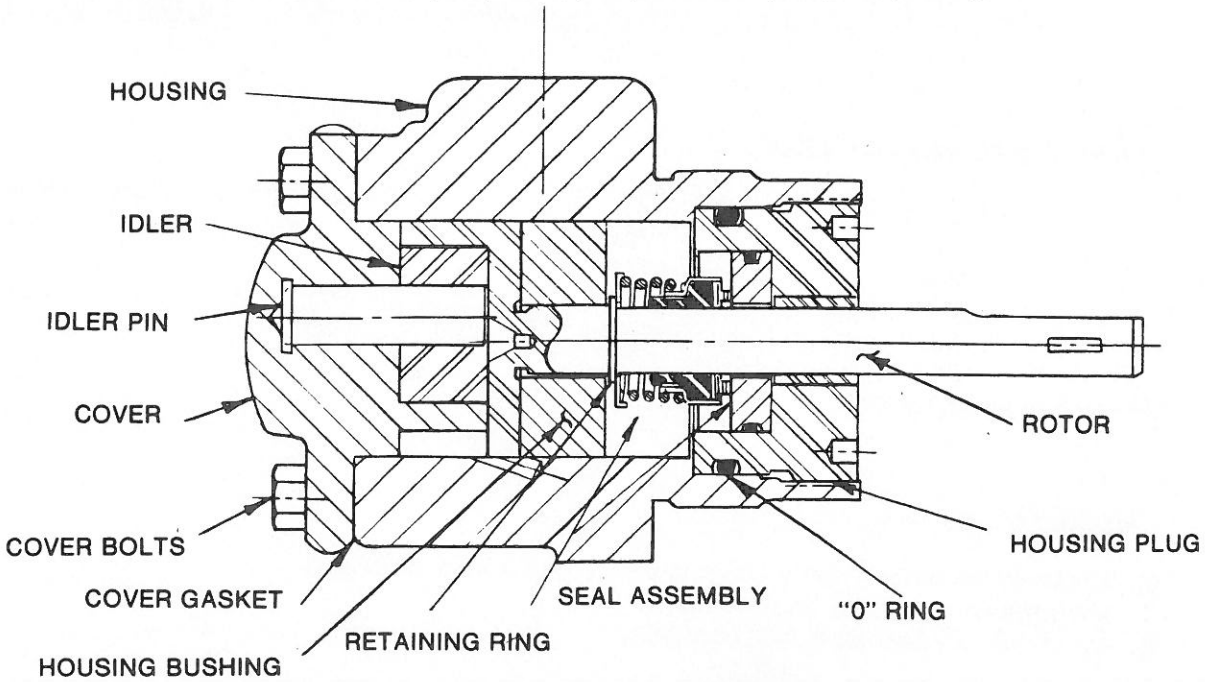
LA and LE pumps should be filled with oil at installation and should never be allowed to run dry.

STRAINER PROTECTION

Strainers are used to remove contaminating particles from the hydraulic system and every Tuthill pump should be protected from these particles by a strainer in the suction line.

1. Strainer size and mesh of screen is determined by rate of flow and viscosity of fluid. Consult strainer manufacturer for recommendations.
2. Never use a strainer with a built-in automatic by-pass on the suction line set to open under 30" Hg. vacuum.
3. Install strainer according to arrows or flow designation.
4. Have strainer accessible for servicing.
5. Use a duplex type where shutdown during service is not permitted.
6. Provide a vacuum gage in the suction line for determining when the strainer requires cleaning.
7. Make certain strainer baskets are properly reinforced so as not to collapse under 30" Hg. vacuum.

Series LA-LE pumps should always be installed with both ports pointing upward to insure proper priming. If it becomes necessary to install the pump with the ports pointed to the side, then the top port should be the suction port. When the pump is installed above the supply tank, an inverted "U" bend should be incorporated in the suction line close to the pump to trap liquid in the pump for priming.



DISASSEMBLY OF SEAL

The seal assembly of the LA and LE pump may be changed without dis-assembly of the rest of the pump.

1. Place the pump in vise, shaft facing up, so that one jaw grips across the two ports. Do not tighten excessively as pump housing may be distorted.
2. Inspect shaft at keyway, flat or drive tang. Any burrs will interfere with removal of housing plug bearing assembly.
3. Remove housing plug with face type spanner wrench (available from Tuthill as part No. OL506).
4. Remove the seal from shaft. The rubber boot will be bonded to the shaft, so it is necessary to push down on the seal to break this bond. Grasp the metal outer shell with any suitable device and pull the seal assembly upwards. The spring and washer should also be removed.
5. The 30LA through 1LA and 30LE through 1LE pump assemblies have a snap ring on the shaft to back up the seal assembly. Do not remove this snap ring unless you are completely disassembling the pump. The 2LA and 2LE pumps do not have a snap ring. A step on the shaft is used as the seal back up.
6. Remove stationary seal face from housing plug by pressing out from opposite side.
7. If damaged, remove the O-ring from O.D. of housing plug.

DISASSEMBLY OF PUMP

Seal assembly must be removed before disassembly of pump. Also remove snap ring on shaft on 30LA through 1LA and 30LE through 1LE.

Mark cover and body of the pump for proper reassembly. Remove cap screws, cover, idler and rotor from housing.

INSPECTION

Check pump housing, rotor, idler gear, idler pin and crescent for wear, chipped or broken teeth.

Housing bore and rotor O.D. may be checked for wear by positioning rotor in the housing and check for clearance in the bearing. The shaft must turn freely without any detectable side play. Any side play will require replacement of the housing, rotor or both. If both housing and rotor require replacing, it is economically advisable to replace the pump.

ASSEMBLY OF PUMP

The following must be carefully followed when pump is reassembled:

1. Clean all parts thoroughly using great care to eliminate all dirt.
2. Install rotor in pump body.
3. Apply gasket to cover. Use new gasket if old one is damaged.
4. Place idler gear on pin in cover assembly.
5. Place cover assembly with gear on pump. (Align matching marks for proper location.)
6. Install cover cap screws. Pull down gradually and alternate from a screw on one side to one on the opposite side.
7. Install snap ring on shaft.

PUMP PERFORMANCE TEST

PUMP SIZE	SPEED (RPM)	PRESSURE(PSI)	CAPACITY (GPM)
30L	1750	100	.30
00L	1750	100	.75
0L	1750	100	1.50
1L	1750	100	2.70
2L	1750	100	5.70

Performance data based on pumping a liquid of 200 SSU viscosity.

ASSEMBLY OF SEAL

1. Clean all parts thoroughly using great care to eliminate all dirt.
2. Oil shaft with suitable lubricating oil.
3. Oil inside of new rotary seal assembly.

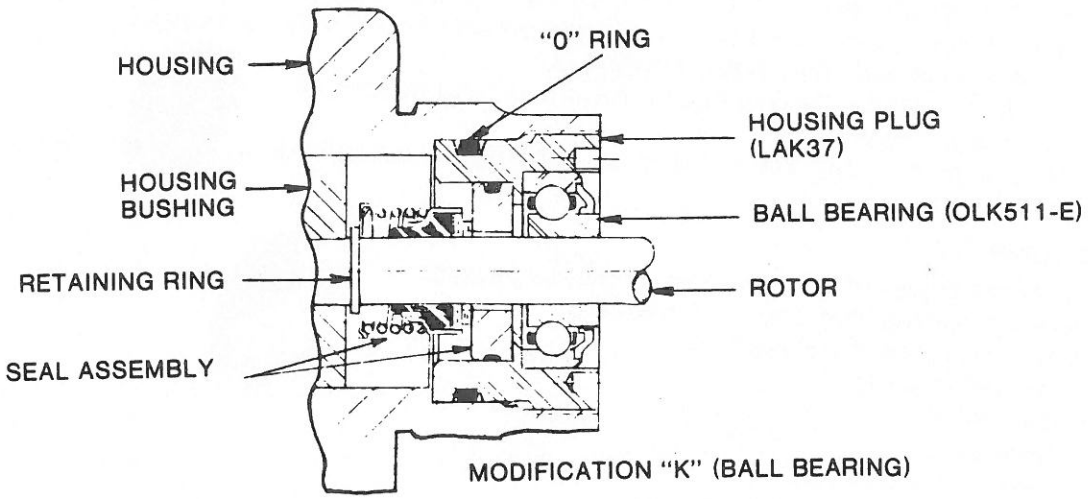
For standard full length shafts with flat and/or keyway:

a. Place rotary seal assembly on pump shaft.
b. Push seal down with your fingers to a position approximately half way down shaft.

For Mod. "A" tang shafts:

a. Use plastic seal assembly tapered sleeve. (Available from Tuthill as part No. 1LPF531-7010.)
b. Oil seal assembly sleeve.
c. Place rotary seal assembly on sleeve. Tapered end of sleeve fits into spring end of assembly.
d. Place slotted end of sleeve on bench. Press down on carbon face of seal with your fingers and slide seal about mid-point on sleeve.
e. Place slotted end of tool over tang on pump shaft. Line up outside diameters of sleeve and shaft by eye.
f. Push seal down with your fingers so that it passes from the assembly sleeve to a position half way down the shaft.

4. Press stationary face into housing plug. Lapped surface must be up. Protect this lapped surface by covering it with a piece of paper when pressing down on face. Use your fingers for this operation.
5. Place new O-ring on O.D. of housing plug, if required, and lubricate with oil.
6. Lubricate carbon face liberally with lube oil.
7. Reassemble housing plug into position over the pump shaft. Do not nick seal face by hitting pump shaft. Tighten the housing plug with spanner wrench (OL506). Rotating seal will automatically be positioned by this operation.
8. If pump is equipped with ball bearing ("K" Model only), press bearing on to shaft. Press on bearing inner race with suitable sleeve. Do not hammer into position or press on bearing outer race.
9. Check pump for free rotation by turning shaft with suitable wrench. There will be a definite resistance to turning because of the seal load. The pump must turn freely without binding.



MODIFICATION "K" (BALL BEARING)

TROUBLE-SHOOTING HINTS

WHAT TO LOOK FOR WHEN

NO OIL IS DELIVERED.

a. Suction lift too high for vapor pressures of liquid pumped. While Tuthill pumps will develop as high as 27 inches of vacuum, it is good engineering practice to reduce the vacuum to a minimum.
b. Bad leaks in suction line or port passages can be detected by submerging pressure line from discharge side of pump into a pail of oil, where the air will be seen in the form of bubbles.
c. Pump shaft not rotating.
   Coupling defective - tongue and groove or gear not engaged.

CAPACITY IS TOO LOW.

a. Suction lift too high.
b. Air leaks in suction line.
c. Suction line too small.
   Can be detected by installing a vacuum gage directly at the pump suction. The maximum vacuum at the pump suction should never exceed 15 inches of mercury. It is necessary to keep below 15 inches, not because of the inability of the pump to handle a higher vacuum, but primarily because of the vaporization that is liable to take place at a higher vacuum. Vaporization caused by higher vacuums will generally result in capacity drop-off.
d. Pump speed too slow.
e. Strainer too small or obstructed.
f. Suction pipe or port not immersed in the liquid deep enough.
g. Piping improperly installed, permitting air pocket to form in pump.
h. Increased clearances or wear in the pump will sometimes cause the pump to deliver an insufficient supply of liquid.

PUMP WORKS SPASMODICALLY.

a. Leaky suction lines.
b. Suction lift too high.
c. Air or vapor in liquid.
d. Coupling slipping on pump shaft.

PUMP WASTES POWER.

a. Pressures too high.
b. Liquid more viscous than desired.
c. Suction or discharge lines obstructed.
d. Mechanical defects.
   End thrust on pump shaft. (Tuthill pumps are not designed to take end thrust toward the pump cover and extreme care must be taken to prevent thrust in this direction.)
   Driving shaft and pump shaft misaligned.
   The pump may be binding due to insufficient end clearance.
   Pump shaft bent.
   Misalignment within pump due to strains built up by bad piping or installation of pump into equipment.

PUMP IS NOISY.

a. Machine or part of it is acting as a sounding board.
b. Misalignment or bad design of coupling.
c. Coupling set up too close to pump.
d. Vibration of pump.
   Bent Shaft
   Worn pump.
   Inferior workmanship.
e. Air leaks into suction side of pump.
f. Suction lift so high that vapor forms within liquid.

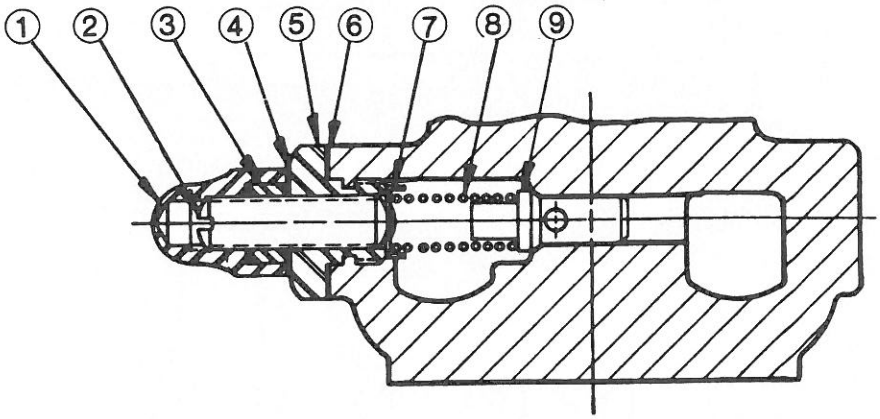
PUMP LEAKS.

a. Cover bolts need tightening, or cover gasket is defective.
b. See seal under service instructions.

HANDLE WITH CARE.

If it becomes necessary to remove pump from your equipment to return to the manufacturer, plugs should be inserted in the ports to prevent foreign material from getting into the moving parts. Tuthill pumps are precision-built and should be given every reasonable care.

TYPICAL RELIEF VALVE ASSEMBLY
MODEL "LEV"

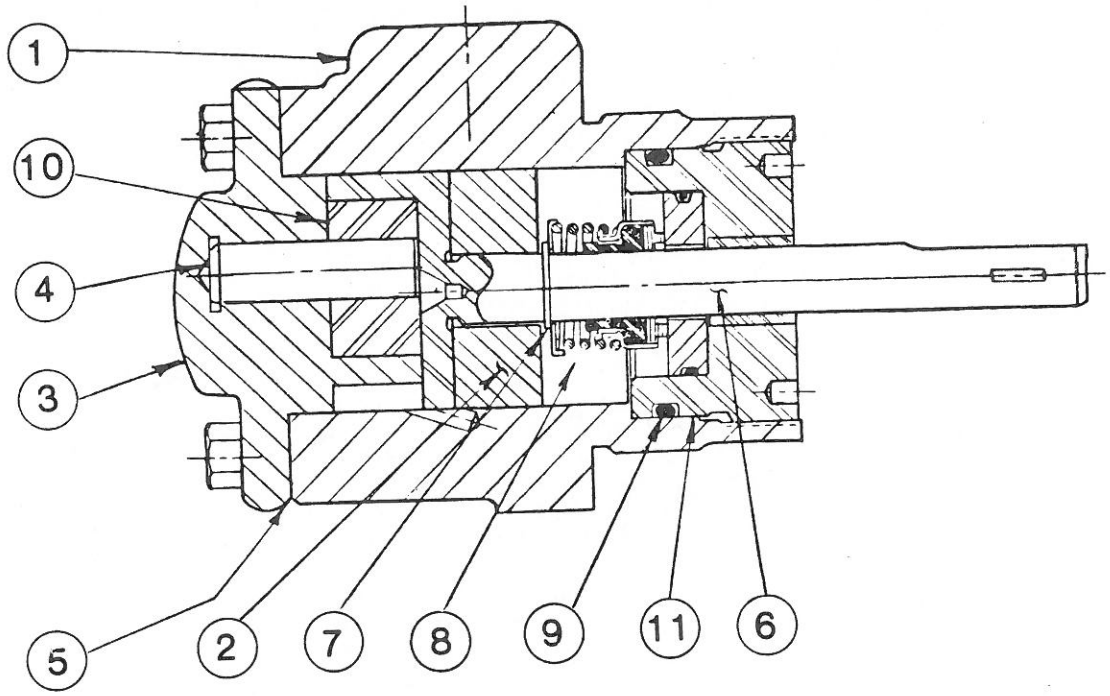


REPLACEMENT PARTS LIST FOR LEV VALVE ASSEMBLY

ITEM NUMBER	PART NUMBER	PART DESCRIPTION
1	30LE56	Valve Cap Cover
2	P103-11	5/16-18 NC2 X 1-3/8" Long Set Screw
3	30LE528	Nut
4	30LE64-A	Valve Cap Cover Gasket
5	OLWV56	Valve Cap
6	30F64 X 201	Valve Cap Gasket
7	30EN92	Spring Retainer
8	* *	Spring (See Chart Below)
9	OLV58 X 201	Plunger

* * Relief Valve Springs
Standard Relief Valve setting is 55 psi unless otherwise requested.

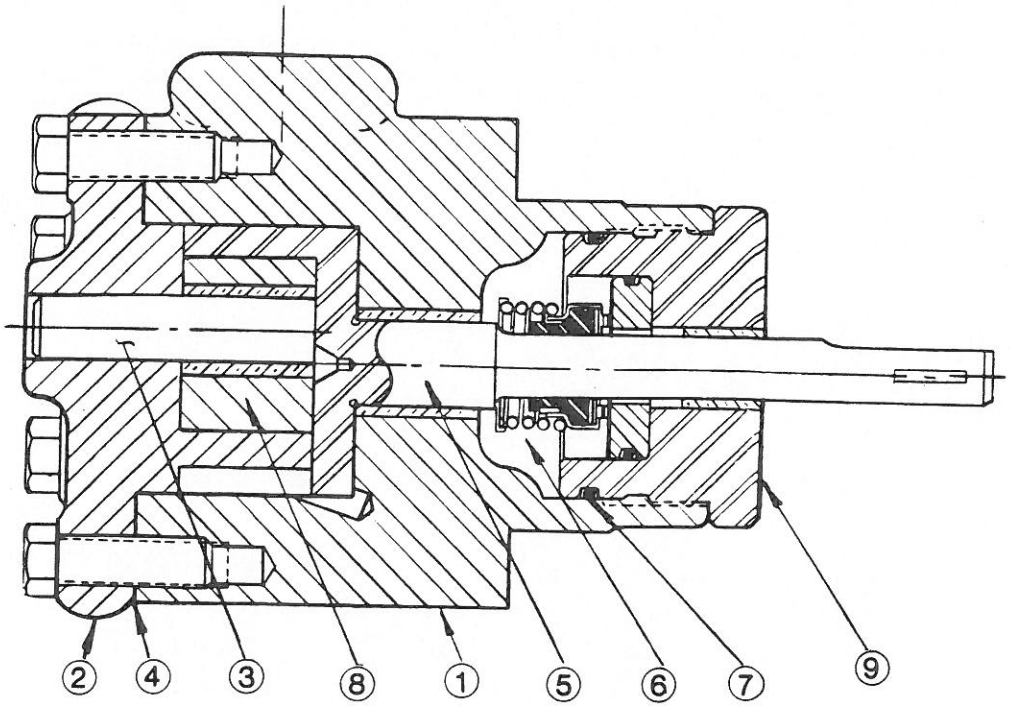
PUMP SIZE	30F80-X min-max	OC62 X201 min-max	OC62 X299 min-max	OLWV63 min-max	OLWVH63 min-max	OLPV63 min-max	OLV63X min-max	OLVH63 X478 min-max
30	15-30	30-35	35-55	55-120	60-170	200-375	376-600	600-850
00	---	25-35	35-55	55-120	60-170	200-375	376-600	600-850
0	---	25-35	35-55	55-120	60-170	200-375	376-600	600-850
1	---	25-35	35-55	55-120	60-170	200-375	376-600	600-850
2	---	---	35-55	55-120	60-170	200-375	376-600	600-850



SERIES LA PUMP PARTS LIST

ITEM NO.	PART DESCRIPTION ALL MODELS	SIZE 30 PART NO.	SIZE 00 PART NO.	SIZE 0 PART NO.	SIZE 1 PART NO.
1	Housing	30LA20	0LA20	0LA20	1LA20
2	Housing Bushing Cover Assembly	30LA71	1LA71	1LA71	1LA71
3	Cover	30L6	00L6	0L6	1L6
4	Idler Pin	30L35	00L35	0L35	1L35
5	Cover Gasket	30L31	1M31	1M31	1L31
6	Rotor	30B34	0B34	0B34	0B34
7	Retaining Ring	30LA24	00LA24	0LA24	1LA24
8	Seal Assy (Buna N)	P206-34	P206-34	P206-34	P206-34
9	O-Ring (Buna N)	1LA9	1LA9	1LA9	1LA9
		P701-34-37	P701-34-37	P701-34-37	P701-34-37
	MODEL LA				
10	Idler Gear	30L32	00B32-1	0B32-1	1L32-1
11	Housing Plug Assy	30LA11	1LA11	1LA11	1LA11
	MODEL LAH				
10	Idler Gear	30L32	00B32	0B32	1L32
11	Housing Plug Assy	30LA11	1LA11	1LA11	1LA11
	MODEL LAK				
10	Idler Gear	30L32	00B32-1	0B32-1	1L32-1
11	Housing Plug	30LAK37	1LAK37	1LAK37	1LAK37
	*Ball Bearing	0LK511-E	0LK511-E	0LK511-E	0LK511-E
	MODEL LAT				
10	Idler Gear	30L32	00B32	0B32	1L32
11	Housing Plug	30LAK37	1LAK37	1LAK37	1LAK37
	*Ball Bearing	0LK511-E	0LK511-E	0LK511-E	0LK511-E

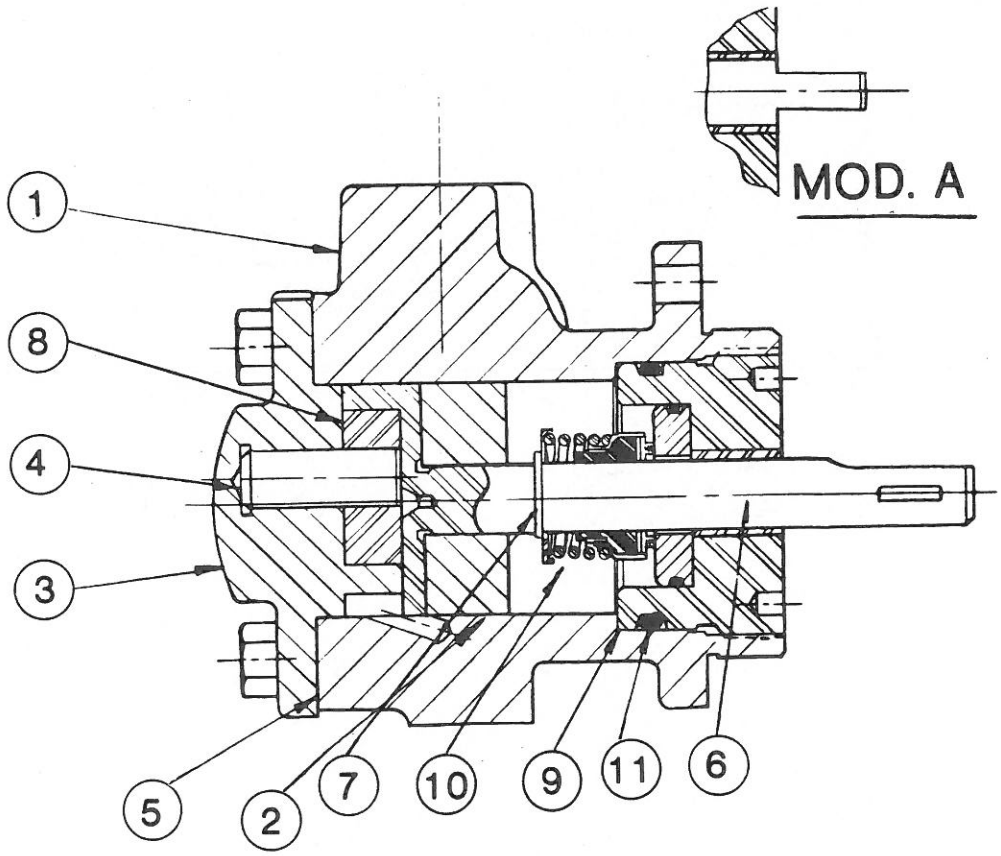
*See "K" seal construction on page 4.



SERIES 2LA PUMP PARTS LIST

ITEM NO.	PART DESCRIPTION ALL MODELS	SIZE 2 PART NO.
1	Housing Assembly	2LA2
	Cover Assembly	2L6
2	Cover	2L35
3	Idler Pin	2L31
4	Cover Gasket	2RFD34
5	Rotor	2LA24
6	Seal Assy (Buna N)	1LA9
7	O-Ring (Buna N)	P701-34-37
	MODEL LA	
8	Idler Gear	2L32-1
9	Housing Plug Assy	2LA11
	MODEL LAH	
8	Idler Gear	2L5
9	Housing Plug Assy	2LA11
	MODEL LAK	
8	Idler Gear	2L32-1
9	Housing Plug	2LAK37
	*Ball Bearing	0LK511-E
	MODEL LAT	
8	Idler Gear	2L5
9	Housing Plug	2LAK37
	*Ball Bearing	0LK511-E

*See "K" seal construction on page 4.

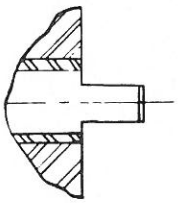


SERIES LE-LEV PUMP PARTS LIST

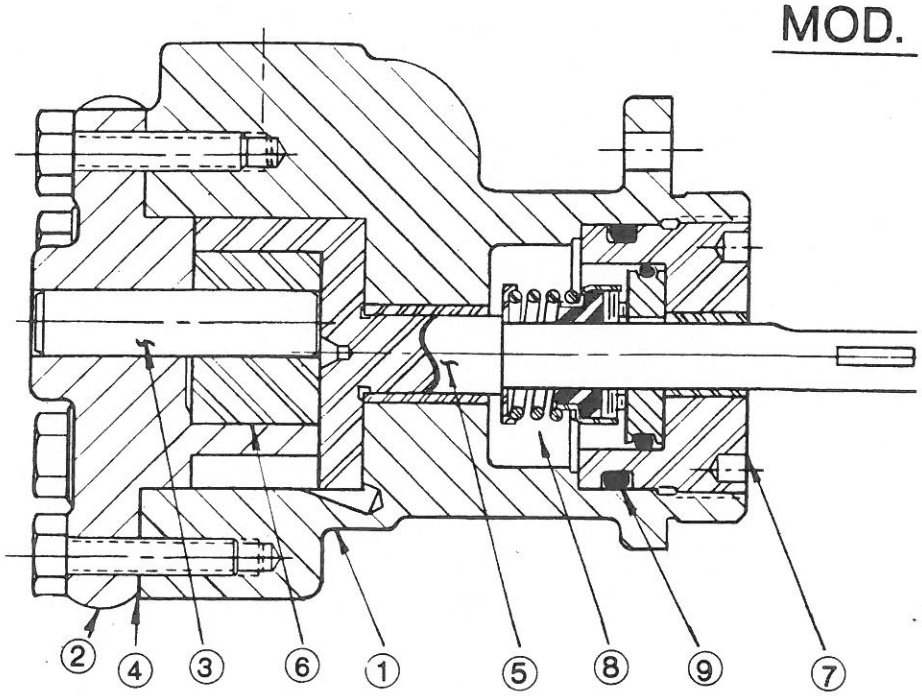
ITEM NO.	PART DESCRIPTION	SIZE 30 PART NO.	SIZE 00 PART NO.	SIZE 0 PART NO.	SIZE 1 PART NO.
1	Housing (LE)	30LE20	0LE20	0LE20	1LE20
2	Housing Bushing	30LA71	1LA71	1LA71	1LA71
1	Housing (LEV)*	30LEV20	0LEV20	0LEV20	1LEV20
2	Housing Bushing Cover Assembly	30LA71	1LA71	1LA71	1LA71
3	Cover	30L6	00L6	0L6	1L6
4	Idler Pin	30L35	00L35	0L35	1L35
5	Cover Gasket	30L31	1M31	1M31	1L31
6	Rotor**	30B34	0B34	0B34	0B34
7	Retaining Ring	30LE24	00LE24	0LE24	1LE24
8	Idler Gear (Standard Pump)	P206-34	P206-34	P206-34	P206-34
8	Idler Gear (Mod. "H" Pump)	30L32	00B32-1	0B32-1	1L32-1
9	Housing Plug Assembly	30L32	00B32	0B32	1L32
10	Seal Assy (Buna N)	1LA11	1LA11	1LA11	1LA11
11	O-Ring (Buna N)	1LA9	1LA9	1LA9	1LA9
10	Seal Assy (Viton)	P701-34-37	P701-34-37	P701-34-37	P701-34-37
11	O-Ring (Viton)	1LA9-7	1LA9-7	1LA9-7	1LA9-7
		P701-34-77	P701-34-77	P701-34-77	P701-34-77

*Specify pump rotation
**Specify if standard or Modification "A" shaft end

See page 6 for relief valve parts identification



MOD. A



SERIES 2LE-2LEV PUMP PARTS LIST

ITEM NO.	PART DESCRIPTION	SIZE 2 PART NO.
1	Housing Assembly (LE)	2LE2
1	Housing Assembly (LEV)*	2LEV2
	Cover Assembly	2L6
2	Cover	2L35
3	Idler Pin	2L31
4	Cover Gasket	2RFD34
5	Rotor**	2LE24
6	Idler Gear (Standard Pump)	2L32-1
6	Idler Gear (Mod. "H" Pump)	2L5
7	Housing Plug Assembly	1LA11
8	Seal Assembly (Std., Buna N)	1LA9
8	Seal Assembly (Viton)	1LA9-7
9	O-Ring (Standard, Buna N)	P701-34-37
9	O-Ring (Viton)	P701-34-77

*Specify pump rotation

**Specify if standard or Modification "A" shaft end

See page 6 for relief valve parts identification

BULLETIN 574WP

SHARPLES PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

INSTRUCTION BULLETIN

FOR

MODEL 5097

METRIX VIBRATION SWITCH

PENNWALT CORPORATION. . . 955 MEARNS ROAD, WARMINSTER, PA. 18974
SHARPLES-STOKES

G Range Adjustment – To verify the calibration of the rated nameplate G range proceed as follows:

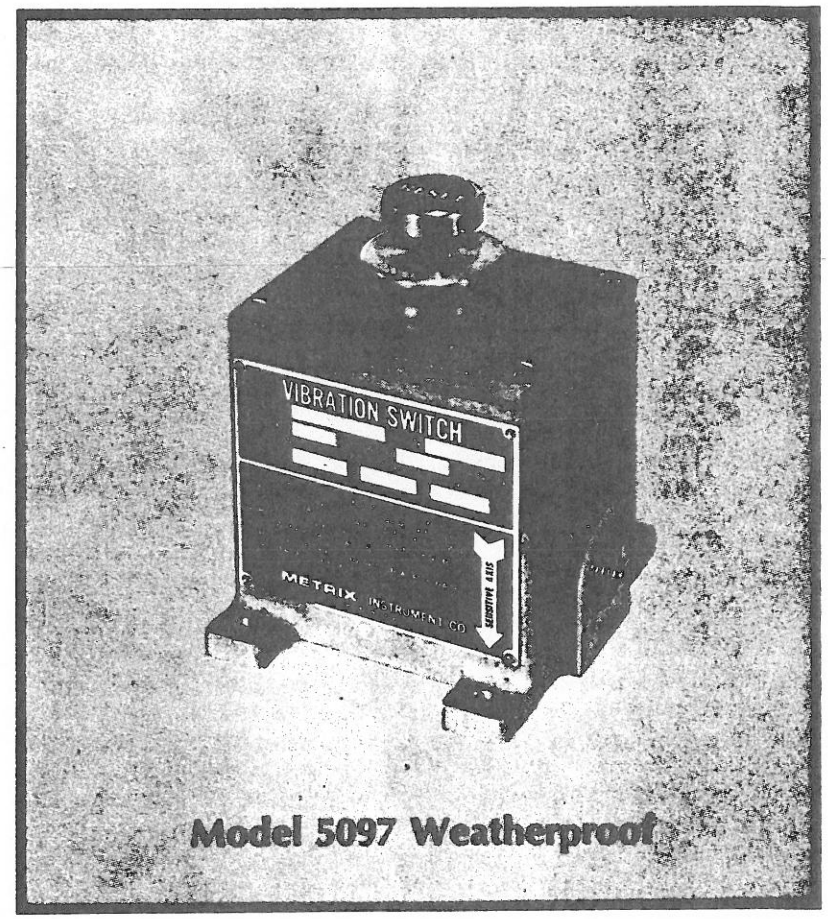
a. Turn set point adjustment knob all the way in to the stop.

b. Divide the nameplate rated G range by the nameplate calibrated turns per G to obtain the number of turns to set the unit to trip at zero G's.

c. Back out the set point adjustment knob the indicated number of turns and the unit should trip. Allow a tolerance of ±2 detent clicks.

d. The total G range can be adjusted by varying the air gap between the armature and the reset magnet when the armature is in the reset position. This is done by removing the terminal block and adjusting the armature stop screw. Loosen the jam nut and turn out the slotted screw to decrease the air gap and increase the range or vice versa. Tighten the jam nut.

VIBRATION SWITCH MODEL 5097



DESCRIPTION

The series 5000 unit is an adjustable inertia switch which provides reliable vibration and shock protection for rotating or reciprocating equipment by actuating and latching a switch if vibration or shock exceeds a predetermined set point. The unit may be mounted in any one plane. A knurled, detented, calibrated knob allows precise set point adjustment, after which the knob can be securely locked in place with a set screw. When tripped, the unit is reset manually with the reset button. Likewise, the unit may be prevented from tripping by holding the reset coil energized. The armature is suspended from a pair of tempered flexures. Hermetically sealed snap action switch, encapsulated reset coil and "O" ring sealed shafts make the Series 5000 Vibration Switches suitable for extended service in hostile environment.

INTRODUCTION

This centrifuge is provided with a Metrix Vibraswitch malfunction detector. This vibration switch must be set to shut down the centrifuge if excessive vibration occurs during unattended operation. The vibration switch can be set to actuate at various levels of vibration (G's). It has not been set on shipment of the centrifuge as each installation is different and the level of vibration with each process is different.

The method of adjustment is described in the operating instructions.

Theory of Operation – Fig. 1 shows the mechanism in the reset condition. When vibration exceeds the set point, the inertial force on the armature causes it to break away from the reset magnet. Once this occurs the forces exerted by the flexures, calibration spring and snap action switch cause the armature to continue to move away from the reset magnet until it strikes the holding magnet, where it is latched in the trip position. Since the trip position is more stable than the reset position, the armature will remain in this position even if the vibration increases far beyond the level required to trip the unit in the first place. As the armature moves from reset to the trip position, the upper flexure actuates the snap action switch, the contacts of which may be used to activate an alarm or shut down the machinery on which the unit is mounted. The vibration level at which the unit will trip is adjustable by means of the set point control, which adjusts the force on the armature exerted by the set point spring. As the control is screwed outward the vibration set point is decreased in terms of G's of acceleration. When the control is turned clockwise all the way in, the unit is set to trip at the maximum rated vibration level. Depressing the reset knob pushes the armature back to the reset magnet. Likewise, energizing the reset coil will do the same.

Installation – The preferred mounting is with the sensitive axis horizontal, since most machines vibrate more in the horizontal plane. Mount the unit solidly to the housing of the machine with the nameplate in the horizontal plane, where it will be easiest to read. The unit should be mounted, if possible, so that its sensitive axis intersects the shaft of the machine. If necessary, it is permissible to mount the unit with its sensitive axis vertical. Next, remove the lid and connect external wiring to the terminal block mounted on the underside of the mechanism. A 3/4" NPT tapped hole in the housing is provided for wiring entry and termination of conduit.

Adjusting the Set Point – The set point control is detented in 90° steps with four clicks per turn. To set the unit to trip at a desired acceleration in G's, first turn the control all the way in to the stop, where the set point is equal to the G range indicated on the nameplate. If the unit is mounted with its axis vertical, add or subtract 1 G as indicated on the nameplate. To obtain a desired G setting, turn the set point knob out (counterclockwise) in accordance with the calibrated turns per G indicated on the nameplate. In other words, if the desired set point is 2 G's and if the nameplate G range is 5 G's and the calibration is one turn/G, back out the set point control three turns (12 clicks) to obtain 5G - 3G = 2G's. The more usual way to set the unit is to start the machine and back out the set point control until the unit trips. Then turn the control back in the number of turns calculated to give a set point approximately 50% above normal vibration level. Once the set point is established, the control may be locked with the set screw provided in the bushing beneath the control. When readjusting the set point, **do not** back the set screw all the way out, but merely loosen it enough to allow turning the control with a detent action.

Reset and Lockout – When starting the machine, the Vibration Switch can be prevented from tripping on starting roughness by holding the reset coil energized during the starting phase. The reset coil is designed for intermittent duty only and should not be held energized for more than **5 minutes** continuously. Likewise, when resetting the unit it is necessary only to momentarily energize the reset coil. The reset coil is AC, which incorporates a full wave bridge rectifier to reduce chatter and eddy current heating of the armature.

Maintenance –

Snap Action Switch Adjustment – If the snap action switch fails to operate when the armature is moved from reset to trip position, remove the mechanism from the housing and proceed as follows:

a. Slowly force the armature by hand from the reset to the trip position and listen for the distinctive click of the snap action switch.

b. If it fails to operate, loosen the two screws that secure the switch mounting bar to the reset coil pole piece and adjust the bar upward or downward until the switch operates approximately in the center of the armature excursion.

c. If the switch refuses to operate, remove the mounting bar completely and replace the switch.

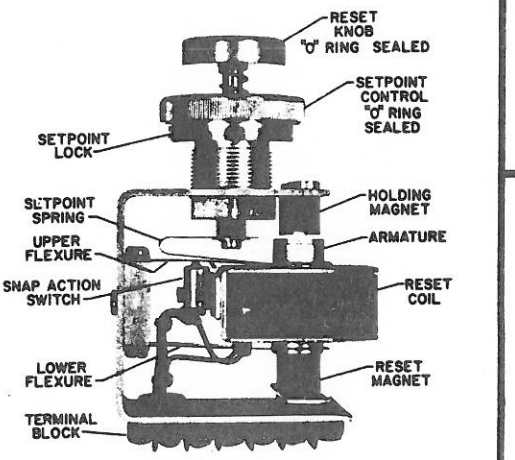
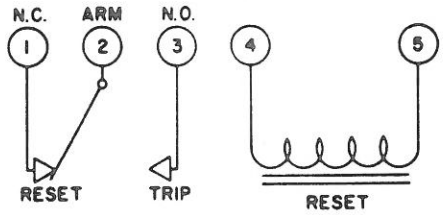
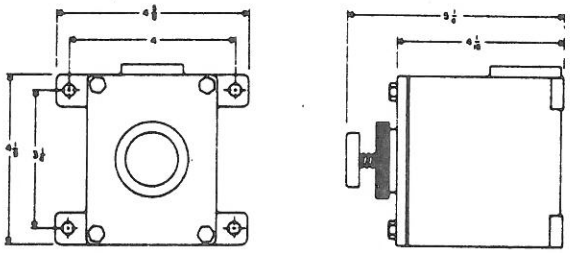


Figure 1



Wiring Diagram



Model 5097 Weatherproof

SPECIFICATIONS

Vibration Range	0-5G's, adjustable
Frequency Range	0-100Hz (0-6,000 RPM)
Switch Rating	115 VAC, 7A resistive, 5A inductive, hermetically sealed.
Reset Coil	115 VAC, 12, 24 or 48 VDC, epoxy encapsulated.
Operating Temperature	-20°F to +250°F
Enclosure	Weatherproof, rain-tight, oil tight, NEMA 4, NEMA 12. Class I, Div. 2
Cable Entry	3/4" NPT
Weight	3.2 lbs.

BULLETIN 465

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

DC BACKDRIVE SYSTEM

PENNWALT CORPORATION . . . SHARPLES-STOKES DIVISION
955 Mearns Road; Warminster, Pa. 18974

I. THEORY

The function of the centrifuge conveyor is to discharge the solids that have been separated from the liquid. To do this, a differential speed is required between the bowl and the conveyor.

Since friction, windage, and process material tend to equalize the conveyor speed with the bowl speed, a separate control is required to hold back the speed of the conveyor. This braking is accomplished by a DC Backdrive System consisting of a DC Backdrive Motor and a solid state SCR Controller.

II. DC BACKDRIVE MOTOR FUNCTION

The Backdrive motor functions as a generator sending current back into the AC power lines through the SCR Controller. The Controller converts the Backdrive's DC current into 60 cycle AC current, and functions as a valve controlling the flow of this current. The speed is adjustable through a Backdrive Potentiometer mounted on the Operator's Panel.

III. TACHOMETER GENERATOR

A feedback signal to the Controller is supplied by a tachometer generator which rotates at the speed of the DC motor. The Controller matches the input signal and the feedback signal from the tachometer and then regulates the magnitude of the power to the motor. This continuous scanning of signals allows modulation of the operating quadrants and maintains the differential speed of the conveyor under varying load conditions.

IV. A CHANGE IN SCROLLING TORQUE

As the load to the Backdrive is increased (because of feed rate, influent material, etc.), more current will be sent back into the AC line through the SCR Controller, since the SCR Controller provides DC voltage to the Backdrive in proportion to the Backdrive speed.

Example:

A change in the solids loading to the centrifuge may create a change in the scrolling torque on the conveyor. This change in torque will cause a change in bowl and conveyor differential speed; and therefore, a change in the speed of the gear box pinion.

In operation, if the gear box pinion changes speed due to changes in torque, the tachometer generator also changes speed, varying the output voltage that is used as a feedback signal to the controller. The controller senses the difference between the input signal and the feedback signal and alters the power to the motor to maintain the gear box pinion speed at its preset value.

V. SHUNT FIELD

The shunt field in the DC motor is energized by a rectified constant voltage source from the SCR controller. The shunt field generates magnetic lines of flux that induce a voltage into the armature windings as the armature rotates. This induced voltage is put back into the main power lines when the system is operating in the second or fourth quadrant; whereas, when the system operates in the first or third quadrants this induced voltage is a counter-electromotive force (CEMF) that allows the motor to operate efficiently.

VI. HIGH OR LOW SPEED

A two position selector switch, located in the SCR controller, provides high speed or low speed settings.

$$\text{Differential} = \frac{\text{Bowl Speed} - \text{Backdrive Speed}}{\text{Gear Box Ratio}}$$

CAUTION

De-energize power before changing selector switch.

VII. THE DC MOTOR

The DC motor is a four quadrant device that controls the speed of the conveyor within the operating range selected. The conveyor speed can be externally adjusted while the centrifuge is in operation, allowing optimization of the particular process.

The DC motor can double the differential conveyor speed range by operating in the second or third quadrants (reverse direction).

The DC motor, when operating in the regenerative modes, puts its generated power back into the main power lines. The regenerative modes are the second and fourth quadrants. When using a 25 horsepower DC system operating at 20 horsepower, regenerative and power equals $0.06/KWH, the annual savings are:

(20 HP) x (0.746 KW/HP) x (24 Hrs/Day) x (300 Days/Yr) x ($0.06/KWH) x (87% efficiency) = $5,607.53

VIII. WIRING

Refer to the supplied Certified Wiring Diagram for details.

The Centrifuge should be wired so the Centrifuge "Run" contactor is interlocked to turn off the feed if for any reason the Centrifuge is de-energized.

The Centrifuge should be wired so it cannot be started unless the following relays are energized and their contacts are closed:

Vibration Switch and its Control Relay
Drive Thermal Protector and its Control Relay
Drive Overload and its Control Relay
Backdrive Thermal Protector and its Control Relay
Conveyor Load Indicator and its API Meter Control Relay

The Backdrive Run Relay is energized if the following interlocks are closed:

Field Loss, Blown Fuse, Phase, Thyristor Thermo Switch, Backdrive Motor Overload, Backdrive Thermal Protector, Centrifuge Start, Backdrive Blowers (if supplied).

When the Transition Timer times out, the Centrifuge should be up to speed and the Backdrive accelerating up to speed. Feed to the Centrifuge can now be introduced.

When running, the Backdrive load is indicated on a DC ammeter and monitored by the API Meter. If the load gets above the desired high set point, the API Meter opens its contacts, both the Centrifuge and Feed shut down, and the Backdrive slows down.

IX. NORMAL SEQUENCE OF OPERATION

Refer to the supplied Certified Wiring Diagram.

X. AUTOMATIC CONTROL (Optional)

For details, refer to the supplied Certified Wiring Diagram.

The automatic control not only measures the torque changes, but also corrects the speed of the conveyor automatically to maintain the adjustable preset torque at a near constant value.

XI. TROUBLESHOOTING

PROBLEM	POSSIBLE CAUSE
Centrifuge will not start, or shuts down when running.	One or more of the safety interlocks are open.
Centrifuge starts, but stops after the Start button is released.	Backdrive circuit breaker is off or tipped.
	Blown fuses.
	Blower overloads tripped.

NOTE

Refer to the Centrifuge, Motor Control, and Motor manufacturer instruction manuals for additional trouble-shooting.

BULLETIN 698
Revision 1

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

INSTRUCTIONS

FOR THE

BACKDRIVE ASSEMBLY

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PENNWALT CORPORATION. . .955 MEARNS ROAD, WARMINSTER, PA 18974

SHARPLES-STOKES DIVISION

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II.	BELT ADJUSTMENT	2
III.	LUBRICATION	2

DRAWINGS

FIGURE 1 ..... Backdrive Assembly

FIGURE 2 ..... Flexible Coupling Assembly

FIGURE 3 ..... Lifting Procedure

I. INSTALLATION

A. Locate and secure backdrive motor support (2) with motor on foundation as shown on certified dimension drawing submitted earlier.

B. Wire the motor so it rotates counter-clockwise when facing the pulley end.

C. Loosen the screws (4) and move the motor on its sliding base (3) toward the centrifuge. Move motor by turning adjusting bolts on sliding base.

D. Line up edges of motor pulley (7) and torque arm shaft pulley (7). Use a straight edge (Figure 9-1 of centrifuge operation and maintenance section).

E. If the pulleys are lined up properly, the straight edge will touch them at the points indicated by the arrows.

F. Install the belts on the pulleys. Do not force the belts on the pulleys.

NOTE

The belts are a matched set. Always check for matching before installing belts. When replacing belts, always replace the complete set.

G. Adjust belts as follows:

1. Turn adjusting bolts on sliding base (3) to move motor away from centrifuge. Do this until slack is taken out of belts. When turning bolts, make small adjustments on each bolt. Alternate between the two bolts until full adjustment is made.

2. Figure 9-1 of centrifuge operation and maintenance section. Measure the belt span as shown.

3. Using a spring scale, pull down on one of the belts at the mid-point of its span. Measure the force required to deflect the belt 1/64 inch for every inch of span. Belt deflection force for 3V belts should be 5-1/2 to 8-1/2 pounds.

NOTE

There will normally be a drop in tension during the first 24 to 48 hours of operation. During this "run-in" period, the belts seat themselves in the pulley grooves and the initial stretch takes place. After a day or two the drive should be stopped and another check made for the correct amount of tension.

4. Make additional necessary adjustments by turning sliding base adjusting bolts as required. Tighten screws (4) to secure sliding base.

H. Install belt guard and secure to foundation.

II. BELT ADJUSTMENT

Refer to Section I.

III. LUBRICATION

A. Backdrive Motor

Refer to motor manufacturer's instructions.

B. Torque Arm Shaft Assembly (12) Bearings

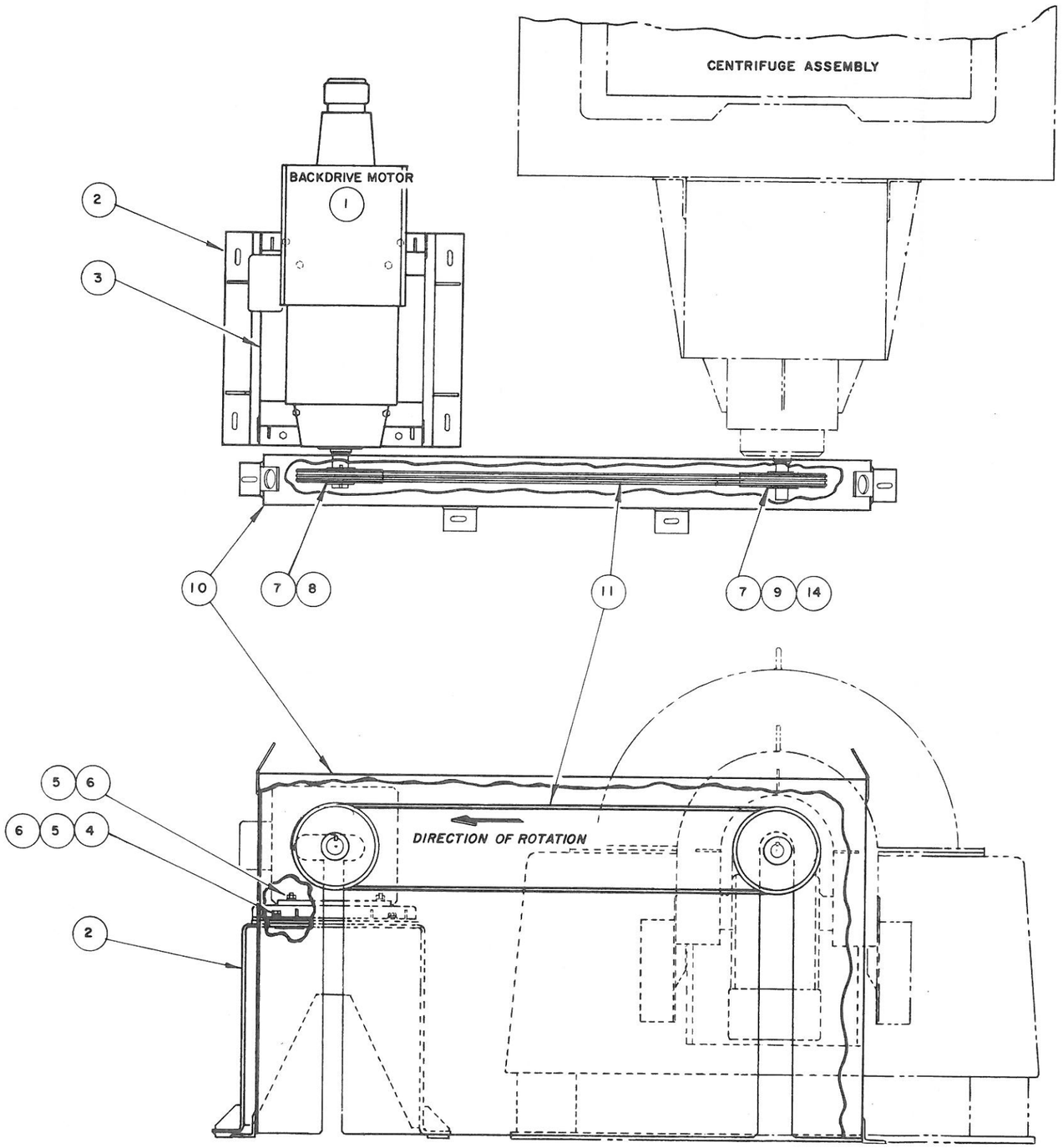
Lubricate bearings through their grease fitting (12-11) monthly. Use Keystone Zeniplex 1 (NLGI No. 1 Multipurpose grease) Keystone Division Pennwalt Corp., 21st & Lippincott Sts., Phila., Pa. 19132.

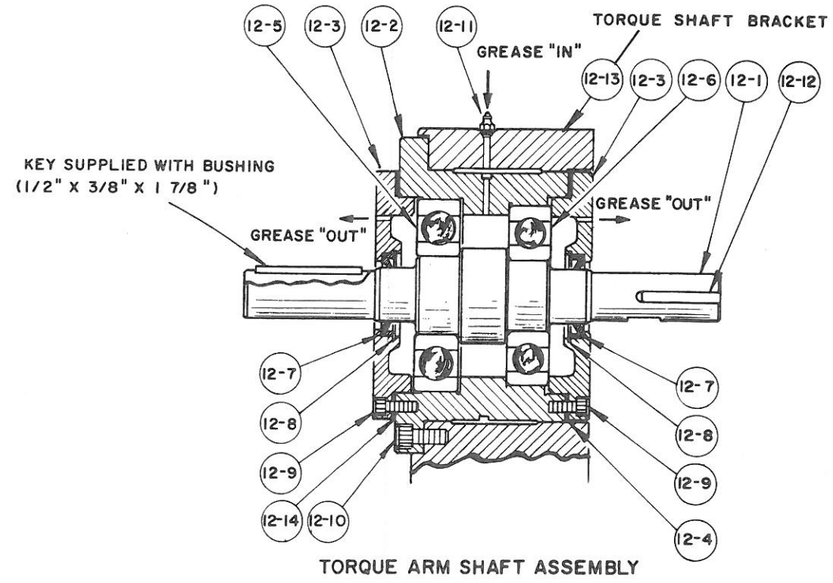
BACKDRIVE ASSEMBLY (E10253)
FIGURE 1

1. Motor
2. Motor Support
3. Motor Sliding Base
4. Hexagon Head Cap Screw (1/2″ - 13 X 1-1/2″)
5. Lockwasher (1/2″)
6. Plain Washer (1/2″)
7. Pulley (Motor and Centrifuge, 2 - Total)
8. Bushing
9. Bushing
10. Belt Guard
11. Belts (1 - Set of 3)
12. Torque Arm Shaft Assembly

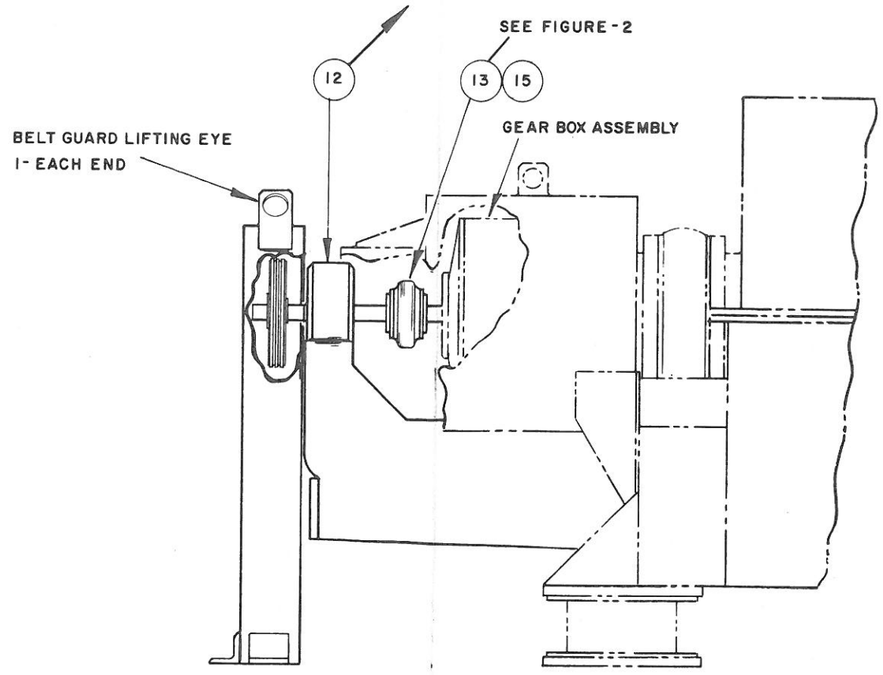
12-1. Torque Arm Shaft
12-2. Bearing Housing
12-3. Bearing Retainer
12-4. Gasket
12-5. Outboard Bearing
12-6. Inboard Bearing
12-7. Shaft Seal (2 - Total)
12-8. Seal Retaining Ring
12-9. Hexagon Socket Head Cap Screw (3/8″ - 16 X 7/8″)
12-10. Hexagon Socket Head Cap Screw (1/2″ - 13 X 1″)
12-11. Grease Fitting (1/4″ - 28 Tapered Thread)
12-12. Key
12-13. Torque Shaft Bracket
12-14. Gasket

13. Coupling
14. Key
15. Key

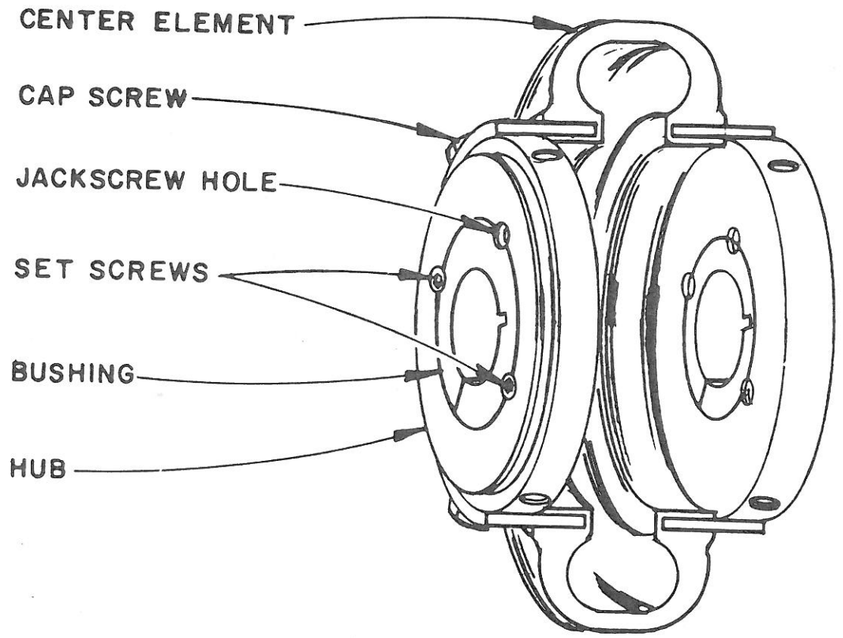


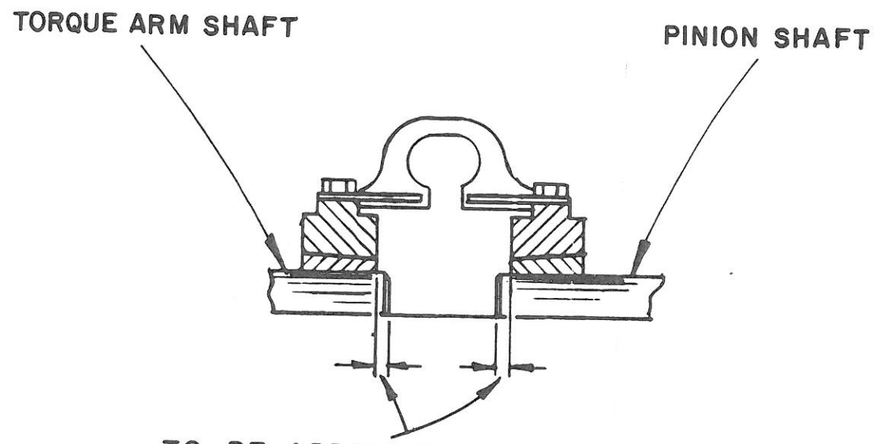


TORQUE ARM SHAFT ASSEMBLY



BACKDRIVE ASSEMBLY
Figure 1



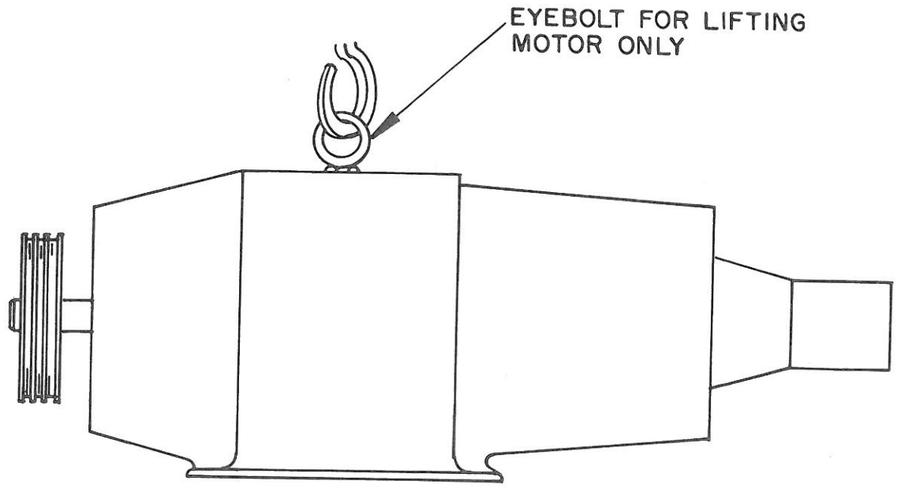


NOTE

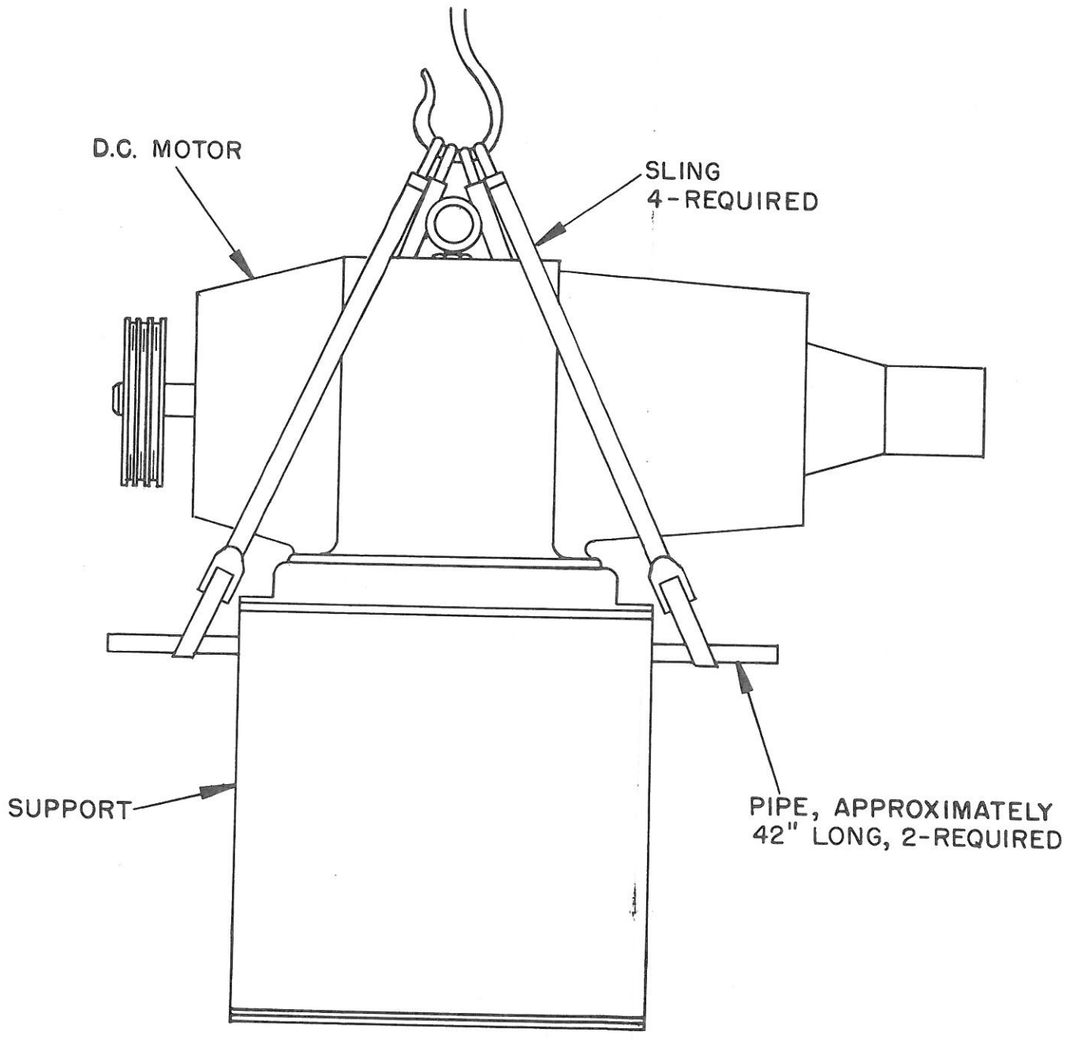
CLEAN SHAFTS, BORES, KEYS, AND KEYSEATS.
BE SURE KEYS FIT PROPERLY – FILE IF NECESSARY.

MOUNT COUPLING HUBS ON SHAFTS AS SHOWN.

FLEXIBLE COUPLING ASSEMBLY
Figure 2



D.C. MOTOR
APPROXIMATE WEIGHT = 765 LBS



BACKDRIVE ASSEMBLY
APPROXIMATE WEIGHT = 1200 LBS

LIFTING PROCEDURE
Figure 3

BULLENTIN 515DC
Revision #2

SHARPLES
PENNWALT
EQUIPMENT ■ CHEMICALS
HEALTH PRODUCTS

DC BACKDRIVE MONITORING SYSTEM WITH CENTRIFUGE OPERATING SEQUENCE

PENNWALT CORPORATION . . . 955 MEARNS ROAD, WARMINSTER, PA 18974

SHARPLES-STOKES DIVISION

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A. INTRODUCTION

The Sharples centrifuge can be equipped with a specially designed monitoring system which will detect and indicate malfunctions. It may be attached to the lubricating system oil reservoir or be remotely mounted.

B. DESCRIPTION

The monitoring system features water-tight construction, and utilizes maintenance-free components such as plug-in throw-away relays, extra-life indicator lights, and easy accessibility to all components.

The principle of the system is to monitor the centrifuge to detect malfunctions which, if gone unnoticed, would cause serious damage.

The primary function of the system is to shut down the centrifuge before damage occurs. The secondary function is to indicate the malfunction so corrective measures can be taken quickly and easily.

Electrically, there are safety interlocks that supply information to plug-in relays. If any one of them indicates a malfunction, the monitoring circuit will interrupt the centrifuge motor circuit and stop the centrifuge. The faulted interlock circuit will light an indicator light to show which input caused the shutdown. This light will be lit until the fault has been eliminated and the RESET pushbutton is depressed. The RESET pushbutton also gives a lamp test each time it is depressed.

C. CONTROL MODULE INPUTS

1. Lube oil flow to right (rear) pillow block bearing:
   Supplied by a flow switch mounted on the lube oil panel.
2. Lube oil flow to left (front) pillow block bearing:
   Supplied by a flow switch mounted on the lube oil panel.
3. Excessive bearing temperature in right (rear) pillow block bearing:
   Supplied by a thermostat mounted in line with the rear return oil line.
4. Excessive bearing temperature in left (front) pillow block bearing:
   Supplied by a thermostat mounted in line wth the front return oil line.
5. Excessive torque on the conveyor:
   Supplied by a meter relay (% excitation).
6. Excessive vibration of the centrifuge:
   Supplied by a vibration switch mounted on the centrifuge frame.
7. Excessive drive motor temperature or overload:
   Supplied by a thermal sensor imbedded in the drive motor winding or by the starter overloads.
8. Backdrive temperature or malfunction:
   Supplied by a thermal sensor imbedded in the winding of the backdrive motor, by a malfunction relay in the backdrive controller, or by the armature blown fuse module.

D. POWER SUPPLY

120 volt, 1 Phase, 60 Hertz power supply is used.

E. SEQUENCE OF OPERATION

NOTE:

Refer to the supplied certified wiring diagram for details.

1. Typical Startup:

a. Depress the lubrication oil pump START pushbutton. This energizes the lube pump motor.

b. After the oil flow switches close, the fault detector RESET/LAMP TEST pushbutton can be depressed to energize all interlocking relays. Also, all lights on the panel will light as a test.

c. All the fault detector lights should go out when the pushbutton is released. If any remain on, refer to the wiring diagram.

d. Set the Wye Delta timer for ten minutes.

NOTE:

After the first start and after acceleration time has been determined, set the timer for a length of time 30 seconds to 1 minute longer than required acceleration time.

e. Press the centrifuge START pushbutton. This energizes the centrifuge drive motor in the Wye (starting) mode, backdrive motor, and deenergizes the transition and deceleration timers. The deceleration timer is held from timing until shutdown. The backdrive operates on low speed.

f. If a polymer system is used, immediately introduce about 10 G.P.M. of flushing water through the polymer tube to prevent the polymer zone from plugging.

g. When the centrifuge is on RUN speed (transition timer is timed out and motor is on the Delta or run mode), the backdrive switches from low speed to the operating (adjustable) speed. At this point, start the polymer pump if used.

h. Shut off the flushing water.

i. Start feed pump and increase its speed to provide desired feed rate.

j. Set cake concentration by adjusting backdrive speed.

k. This backdrive system has one meter relay with two contacts for controlling various functions. The higher contact should always be used to shut off the centrifuge in an over-torque situation. The lower contact should be used to shut off the feed to the machine before a high torque shutdown and can admit flush water to the bowl.

2. Typical Shutdown:

NOTE:

At shutdown, the objective is to minimize the amount of solids remaining in the bowl.

a. Turn the feed pump to minimum flow. Then shut off.

b. Turn on 100 to 150 G.P.M. flushing water to feed tube, if polymer system is used, turn on flushing water to polymer tube.

ATTENTION

If grease is present in the process and the centrifuge is equipped with a vane stack at the liquid end of the conveyor, it is possible that the vanes may become plugged with grease. Provision must be made for a hot water flush to keep vanes clear.

c. Shut off the polymer pump if used.

d. Depress the centrifuge STOP pushbutton, to stop centrifuge drive motor.

e. The backdrive motor will switch to the low speed setting to rapidly scroll out all solids from the centrifuge.

f. Continue flushing the centrifuge until bowl speed coasts to 100 RPM. Then shut off flushing water.

ATTENTION

Water will be rejected and leak around the feed tube if flushing is continued below 100 RPM.

g. The lubrication pump will automatically shut down after the bowl coasts to a stop (deceleration timer times out) and fault detector will be deenergized. Sufficient time for coastdown must be present on deceleration timer.

F. MALFUNCTION

1. **When a Malfunction Occurs:**

a. The respective relay will be deenergized, thus resulting in deenergization of centrifuge motor starter.

b. The failed input will show up on the indicator panel as a light and stay lit until the problem is corrected and the RESET pushbutton is depressed.

2. **When the Malfunction Has Been Corrected:**

a. Depress the RESET pushbutton to turn off the fault lights and reset the relays.

b. Follow normal starting Procedure.

3. **Motor Thermal Protector**

The motor thermal protector unit can be either a motor thermal protector in the drive motor or the motor overload relays in the centrifuge starter.

G. ALARM

An audio alarm is also provided. When a fault occurs, the centrifuge will shut down and the alarm will sound.

To silence the alarm, depress the ALARM SILENCE pushbutton. After correcting the malfunction, depress the RESET pushbutton and follow normal starting procedure.

RELIANCE ELECTRIC

DATA TRANSMITTAL AND CERTIFICATION

CUSTOMER ORDER NO.	DATE	REQ. NO.	S.O. NO.
PC51034	09/18/87		01KA583587

REFER TO THIS NUMBER IN ALL CORRESPONDENCE

SOLD TO
PENNWALT CORP
955 MEARNS RD
WARMINSTER PA 18974

SHIP TO:
SAME AS "SOLD TO" UNLESS SHOWN
PENNWALT CORP
955 MEARNS RD
WARMINSTER PA 18974

DATA PROVIDED WITH THIS TRANSMITTAL AND CERTIFICATION IS:

- ☐ FOR CUSTOMER APPROVAL BY DATE: _____
  Return of approval prints by the above date is required to assure scheduled shipment, delay in return and/or revision of approval prints may require shipment reschedule. Return approved D/S to data source.
- ☒ FINAL, APPROVED FOR CONSTRUCTION OR INSTALLATION.
- ☐ PRELIMINARY, ENGINEERING IS COMPLETED.
- ☐ REVISED, SUPERSEDES DATA PREVIOUSLY ISSUED.
- ☐ SEE REMARKS.

DATA SOURCE
TRANSMITTAL AND CERTIFICATION ISSUED BY: R.W. Snyder DATE 1-12-88 CK BY T. Cupp DATE 1-12-88
GAINESVILLE PLANT
4349 AVERY DRIVE
GAINESVILLE, GA. 30542

DATE PRINTED: 01/11/88

MOTOR OR GEN. DATA

ITEM	USED FOR	USERS PLANT	MOTOR OR GEN. D/S:
A	RPM III		609551-2

QTY.	FRAME		HP	SERV. FA	TYPE	R.P.M.	C BOX D/S
3	LC 2512ATZ	25		1.00	TR	2500/3000	609559-1

PH/HZ/VOLTS-WINDING	DUTY	ENCLOSURE	AMB./INSL.	PWR. CODE	MOTOR OR GEN. C/D:
DC / 500/STAB	CONT	TEFC	40 /F /	C	406770-1

BEARINGS	MOUNTING & METHOD OF DRIVE	RAILS OR BASE	MODEL NUMBER	REDUCER OR AUX D/S:
BALL	F1 DRCT			

ROTAT FROM OPP. DR. END	D-C FIELD EXCITATION	DOUBLE SHAFT EXTEN.	BRAKE OR AUX. D/S
REV	SEP 300		

REDUCER DATA

REDUCER STYLE	CLASS	FRAME	RATIO	OUTPUT RPM	ASSEMBLY	BLOWER MOTOR PH/HZ/VOLTS/HP

BRAKE DATA

BRAKE TYPE	SIZE	RATING FT/LB	DUTY	P.O.

DATA FOR CONTROL

D-C MOTOR ARMATURE CURRENT: 41.00 AMPS

FIELD CHARACTERISTICS PER CURVE:

F_1—F_2, 1.68 MAX. AMPS .93 FLD AMPS FOR 3000 RPM
F_{11}—F_{22}, _____ MAX. AMPS _____ _____ RPM
F_3—F_4, _____ MAX. AMPS _____ _____ RPM

A-C MOTOR INFORMATION FOR SELECTION OF STARTER HEATERS:
CODE: _____ LOCKED AMPS: _____
F.L. CURRENT: _____ AMPS.

SPCL. INSTALLATION FEAT. AND MISC. DATA

ADDITIONAL MOTOR OR GEN DATA:
PHASE: DC HERTZ: VOLTS: 500
LD LOC - STD
FR CONST RGD
WDG PROT QTY 1 DESCRIPTION N/C THERMOSTAT
TACH TYPE: SPY
TACH VOLTS: 50 VOLTS PER 1000 RPM

SPECIAL MARKS:
15-NLH-043

SPECIAL FEATURES:
C/ECO% NO. 705029-2S
BRUSHES (HEAVY SULPHER CONDITIONS). XT FEATURES. CSA SPECS & N/P. SIMILAR TO 1KA583301 EXC. NO SENSORS & CSA REQ'D.

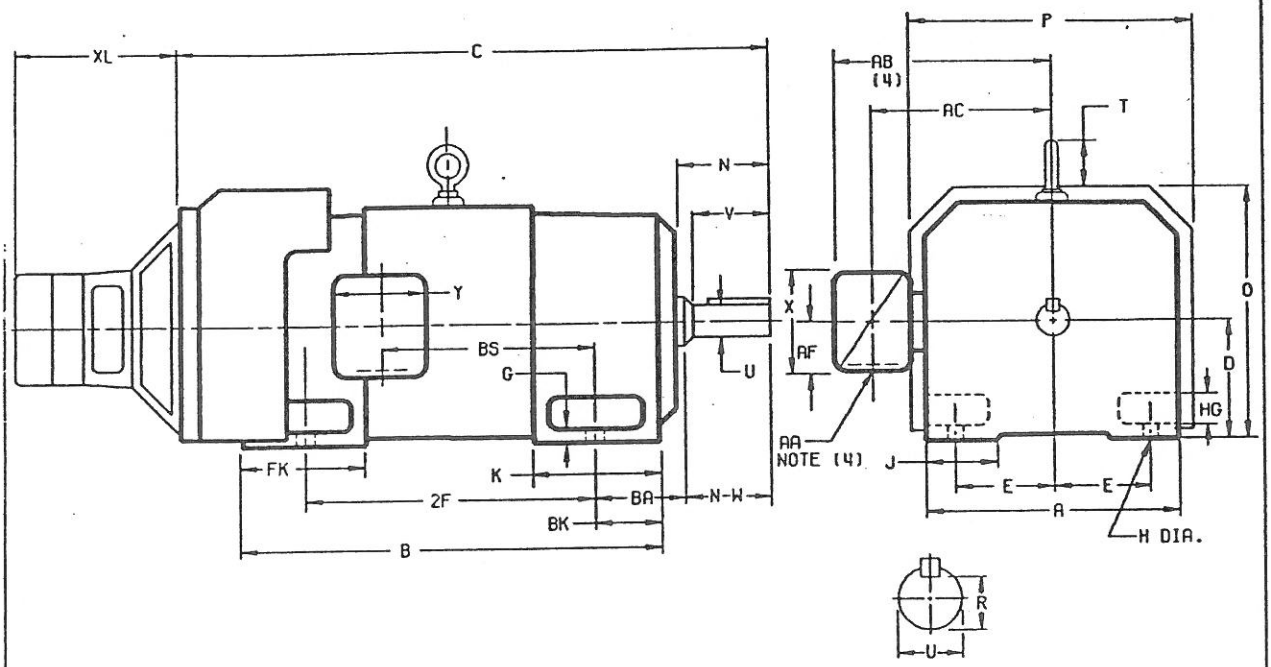
CERTIFIED DRAWINGS AND DATA:

INDUSTRIAL DIRECT CURRENT MOTORS AND GENERATORS - RPM III

ENCLOSURE: TOTALLY ENCLOSED
MOUNTING: FOOT
METHOD OF DRIVE: COUPLED OR BELTED

COOLING: FAN COOLED
ACCESSORIES: FLANGE MOUNTED TACHOMETER

FRAMES SC2113ATZ THRU LC2812ATZ



DIMENSIONS ARE IN INCHES

FRAME	A	D(1)	E	G	H	HG	J	O	P	T	BA	K	FK	BK
SC2113ATZ-LC2113ATZ	10.25	5.25	4.25	.44	.44	1.38	1.75	11.62	12.75	1.38	3.50	5.19	6.81	2.38
→ SC2512ATZ-LC2512ATZ	12.31	6.25	5.00	.50	.56	1.62	2.00	13.62	14.75	1.94	4.25	6.06	8.00	3.00
MC2812ATZ-LC2812ATZ	13.78	7.00	5.50	.62	.56	1.88	2.75	15.06	16.12	2.31	4.75	6.75	9.19	3.50

FRAME	C	B	BS	2F	DRIVE END SHAFT AND KEY N	N-W	U(2)	V	R(3)	SQ.	LGTH.	WT. LBS.
SC2113ATZ	32.19	22.50	11.38	18.00	4.00	3.75	1.875	3.50	1.591	.500	2.50	355
MC2113ATZ	33.44	23.75	12.62	18.00	4.00	3.75	1.875	3.50	1.591	.500	2.50	380
LC2113ATZ	35.06	25.38	14.25	18.00	4.00	3.75	1.875	3.50	1.591	.500	2.50	410
SC2512ATZ	35.94	25.06	12.06	20.00	4.50	4.25	2.125	4.00	1.845	.500	3.00	555
MC2512ATZ	37.44	26.56	13.56	20.00	4.50	4.25	2.125	4.00	1.845	.500	3.00	590
→ LC2512ATZ	38.94	28.06	15.06	20.00	4.50	4.25	2.125	4.00	1.845	.500	3.00	630
MC2812ATZ	41.62	29.94	14.25	22.00	5.00	4.75	2.375	4.50	2.021	.625	3.50	835
LC2812ATZ	43.88	32.19	16.50	22.00	5.00	4.75	2.375	4.50	2.021	.625	3.50	900

TACH.	XL	WT LBS.
RE-007,RE-020	6.88	25
RE-045G. WITH K45M1000 (5)	8.50	20
RE-210	17.88	45
BC-42	15.88	45
BC-46	18.31	60
BC-46/K460	21.00	65
"X/P" BC-42	17.50	45
"X/P" BC-46	18.69	60
RD-11 RD-12	12.69	20
RD-51	19.19	60
RD-61,RD-62	12.19	20
← 5PY (5)RPY	10.75	20
M627,M628 M727,M737,M738	12.94	35
DYNAPAR 74C	10.25	20
RESOLVER CU9-1093-020	10.88	12
TS-2014N	6.00	15

(1) "D" DIMENSION WILL NOT BE EXCEEDED. SHIMS UP TO .03 INCHES IN THICKNESS ARE USUALLY REQUIRED FOR COUPLED OR GEARED MACHINES.
(2) "U" VARIES----+.000 -.001
(3) "R" VARIES----+.000 -.015
(4) TERMINAL BOX VARIES WITH H.P. FOR DIMENSIONS "AA", "AB", "AC", "AF", "X" AND "Y". SEE DRAWING NUMBER 609959-1.
(5) WHEN THE RE045 OR 5PY TACH IS MOUNTED ON "C2113" OR "C2512" FRAME SIZE, SUBTRACT 1.00 FROM "XL" DIMENSION.

TERMINAL BOX CAN BE ROTATED FOR LEAD OUTLET AT TOP, SIDES OR BOTTOM. TERMINAL BOX LOCATED ON OPPOSITE SIDE WHEN F-2, W-1, W-4, W-5, W-7, OR C-1 MOUNTING IS SPECIFIED. BOX LOCATED ON TOP WHEN SPECIFIED. MOTOR WEIGHT MAY VARY 15% FOR NON-STANDARD RATINGS AND/OR ACCESSORIES. IF MOUNTING CLEARANCE DETAILS ARE REQUIRED, CONSULT FACTORY.

FRAME- _____ TYPE- _____ TACH _____ CERTIFIED FOR- _____

ORDER- _____ ITEM _____ HP- _____ RPM- _____ VOLTS- _____ ARM. VOLTS _____ FIELD VOLTS _____

RELIANCE SALES ORDER- _____ APPROVED BY- _____ DATE- _____

RELIANCE ELECTRIC

DR. BY A.FOOTMAN
CK. BY I.CUFR
APP. BY I.EVON

DIMENSION SHEET **609951-2**

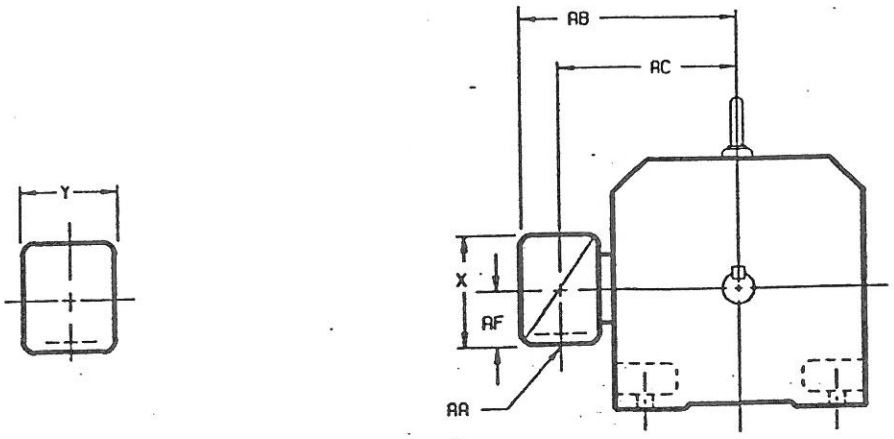
ISSUE DATE OCTOBER 10, 1986

INDUSTRIAL DIRECT CURRENT MOTORS AND GENERATORS - RPM III

STEEL AND CAST IRON TERMINAL BOX DIMENSIONS

STANDARD SIZE AND ONE SIZE LARGER

FRAMES C2113ATZ THRU C2812ATZ



DIMENSIONS ARE IN INCHES

STEEL TERMINAL BOX DIMENSIONS

FRAME SIZE	MAX. AMPS	STANDARD SIZE AA(1)	AB	AC	AF	X	Y	PART NUMBER	ONE SIZE LARGER AA(1)	AB	AC	AF	X	Y	PART NUMBER
C2113ATZ (2)	40	3/4 & 1"	9.44	7.75	1.94	4.38	5.00	705028-1-R	1-1/4 & 1-1/2	10.44	8.31	2.50	5.50	6.12	705029-1-R
	96	1-1/4 & 1-1/2	10.44	8.31	2.50	5.50	6.12	705029-1-R	2" & 2-1/2	11.56	8.69	3.19	7.00	7.62	705030-1-R
	208	2" & 2-1/2	11.56	8.69	3.19	7.00	7.62	705030-1-R	2" & 2-1/2	11.56	8.69	3.19	7.00	7.62	705030-1-R
C2512ATZ (2)	40	3/4 & 1"	10.44	8.75	1.94	4.38	5.00	705028-1-R	1-1/4 & 1-1/2	11.44	9.31	2.50	5.50	6.12	705029-1-R
	96	1-1/4 & 1-1/2	11.44	9.31	2.50	5.50	6.12	705029-1-R	2" & 2-1/2	12.56	9.69	3.19	7.00	7.62	705030-1-R
	208	2" & 2-1/2	12.56	9.69	3.19	7.00	7.62	705030-1-R	2" & 2-1/2	12.56	9.69	3.19	7.00	7.62	705030-1-R
C2812ATZ	128	2"	14.00	10.38	4.25	8.44	7.25	74874-R	3"	14.44	11.06	4.25	8.44	7.25	74874-24-R
	185	3"	14.44	11.06	4.25	8.44	7.25	74874-24-R	4"	15.88	11.69	5.38	10.56	9.00	700308-3-R
	269	4"	15.88	11.69	5.38	10.56	9.00	700308-3-R	5" (4)	18.19	12.81	7.00	12.75	15.00	76870-9-R

CAST IRON TERMINAL BOX DIMENSIONS

FRAME SIZE	MAX. AMPS	STANDARD SIZE AA(3)	AB	AC	AF	X	Y	PART NUMBER	ONE SIZE LARGER AA(3)	AB	AC	AF	X	Y	PART NUMBER
C2113ATZ	18	3/4	10.44	8.31	2.50	5.00	5.75	705028-2-S	1"	10.44	8.31	2.50	5.00	5.75	705028-2-T
	40	1"	10.44	8.31	2.50	5.00	5.75	705028-2-T	1-1/2	11.38	8.81	3.00	6.00	7.00	705029-2-R
	96	1-1/2	11.38	8.81	3.00	6.00	7.00	705029-2-R	2"	11.38	8.81	3.00	6.00	7.00	705029-2-S
	208	2"	11.38	8.81	3.00	6.00	7.00	705029-2-S	2-1/2	13.06	9.19	3.62	7.88	9.25	705030-2-R
C2512ATZ	18	3/4	11.44	9.31	2.50	5.00	5.75	705028-2-S	1"	11.44	9.31	2.50	5.00	5.75	705028-2-T
	40	1"	11.44	9.31	2.50	5.00	5.75	705028-2-T	1-1/2	12.38	9.81	3.00	6.00	7.00	705029-2-R
	96	1-1/2	12.38	9.81	3.00	6.00	7.00	705029-2-R	2"	12.38	9.81	3.00	6.00	7.00	705029-2-S
	208	2"	12.38	9.81	3.00	6.00	7.00	705029-2-S	2-1/2	14.06	10.19	3.62	7.88	9.25	705030-2-R
C2812ATZ	128	2"	12.75	10.19	3.00	6.00	7.00	75460-T	3"	14.44	10.56	3.62	7.88	9.25	76700-R8
	185	3"	14.44	10.56	3.62	7.88	9.25	76700-R8	4"	15.75	11.44	4.12	9.50	10.50	76708-RR
	269	4"	15.75	11.44	4.12	9.50	10.50	76708-RR	5" (4)	18.19	12.81	7.00	12.75	15.00	76870-S

(1) "AA" CONDUIT.
(2) STEEL TERMINAL BOX FOR C2113ATZ AND C2512ATZ FRAMES PROVIDED WITH DOUBLE KNOCKOUT.
(3) "AA" PIPE TAP.
(4) TERMINAL BOX 76870-S AND 76870-9R EXTENDS BELOW MOTOR FEET.

TERMINAL BOX CAN BE ROTATED FOR LEAD OUTLET AT TOP, SIDES OR BOTTOM.
TERMINAL BOX LOCATED ON OPPOSITE SIDE WHEN F-2, W-1, W-4, W-5, W-7, OR C-1 MOUNTING IS SPECIFIED. BOX LOCATED ON TOP WHEN SPECIFIED.
FOR " X/P"TERMINAL BOX DIMENSIONS SEE 609959-2.
FOR MILL TYPE TERMINAL BOX DIMENSIONS SEE 609959-3.

FRAME- _____ TYPE- _____ TERMINAL BOX- _____ CERTIFIED FOR- _____

ORDER- _____ ITEM _____ HP- _____ RPM- _____ WDG- _____ ARM. VOLTS _____ FIELD VOLTS _____

RELIANCE SALES ORDER- _____ APPROVED BY- _____ DATE- _____

RELIANCE ELECTRIC
CLEVELAND, OHIO 44117 U.S.A.

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THIRD ANGLE PROJECTION (E)

Installation, Operation
and Maintenance of

RPM III®
D-C Motors

- Frames C210ATZ-C360ATZ
- Specifically designed for operation from rectified power.

Reliance
Electric

D-C MOTORS

We're keyed to your need.

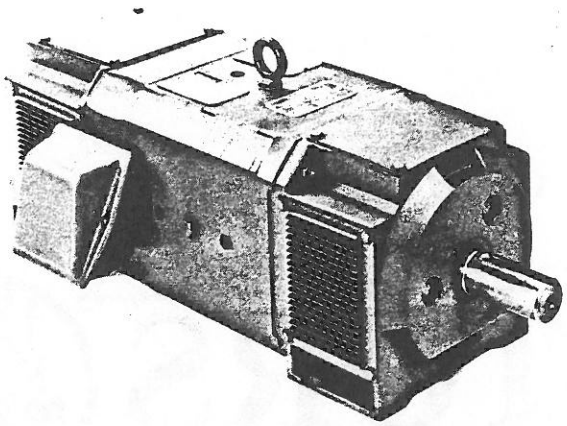
Instruction Manual C-3088-2
June, 1986

IMPORTANT

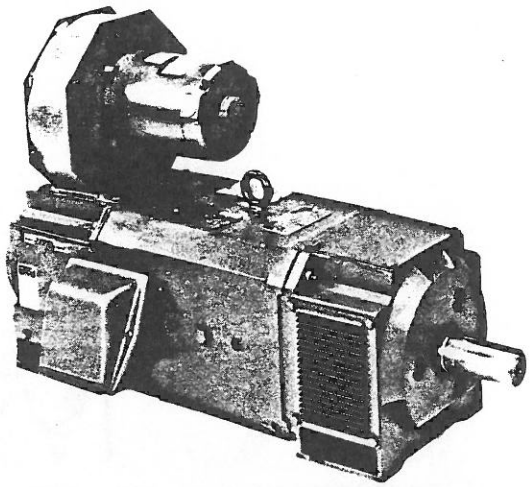
It is important that these instructions be studied by personnel installing and operating this equipment. Read thoroughly before starting. Keep these instructions for future reference.

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Typical Drip-Proof Fully-Guarded RPM III Motor Frames C210ATZ — C360ATZ.



Typical Blower-Ventilated RPM III Motor Frames C210ATZ — C360ATZ.

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GENERAL DESCRIPTION

The RPM III Frames C210ATZ — C360ATZ Industrial D-C Motors and Generators are designed specifically for use on rectified power. The basic design includes Class F Insulation, 1.0 Service Factor, 40°C ambient, continuous duty, drip-proof guarded and force-ventilated enclosure with horsepower and speed ratings, overload and voltage in accordance with NEMA Standards. A wide variety of modifications, enclosures and accessories is available. Motors must be properly installed, operated and maintained in accordance with these instructions.

RECEIVING AND HANDLING

ACCEPTANCE

Thoroughly inspect this equipment before accepting shipment from the transportation company. If any of the goods called for in the bill of lading or express receipt are damaged or the quantity is short, be sure the freight or express agent makes an appropriate notation on your freight bill or express receipt. If any concealed loss or damage is discovered, notify your freight or express agent at once and request him to make an inspection.

Reliance Electric will assist you in collecting claims for loss or damage in shipment. However, this does not remove the transportation company's responsibility in reimbursing you for collection of claims or replacement of material. Claims for loss or damage in shipment *must not* be deducted from the Reliance Electric invoice, nor should payment of the Reliance Electric invoice be withheld awaiting adjustment of such claims, as the carrier guarantees safe delivery.

If considerable damage has been incurred and the situation is urgent, contact the nearest Reliance Electric District Office for assistance. Please keep a written record of all such communications.

HANDLING

WARNING

EYEBOLT(S) OR LIFTING LUG(S) ARE INTENDED FOR LIFTING THE MOTOR OR GENERATOR ONLY WITH THE STANDARD ACCESSORIES SUCH AS TACHOMETER, BRAKES, ETC., MOUNTED BY RELIANCE ELECTRIC. THE LIFTING MEANS ON THE MOTOR OR GENERATOR MUST NOT BE USED TO LIFT THE UNIT PLUS ADDITIONAL EQUIPMENT. THE LIFTING MEANS ON THE MOTOR OR GENERATOR CANNOT BE USED TO LIFT ASSEMBLIES OF MOTOR AND GENERATOR OR OTHER EQUIPMENT MOUNTED ON A COMMON BASE. THESE ASSEMBLIES MUST BE LIFTED BY OTHER LIFTING MEANS.

In all cases, care should be taken to assure lifting in the direction intended in the design of the lifting means. Lift using all lugs provided. Likewise, precautions should be taken to prevent hazardous overloads due to deceleration, acceleration or shock forces. Angle of lift with rope or chain must be greater than 45° from horizontal.

For unusual conditions, such as side-wall and ceiling mounting of horizontal motors and installation of vertical motors shipped in a horizontal position, special precautions must be taken and it is recommended that an experienced rigger be employed.

STORAGE

Motors or generators must be stored in a clean, dry area protected from extremes of temperature, moisture, shock and vibration. Storage temperatures of 50°F to 120°F with a maximum relative humidity of 60% must be observed. In addition, motors subjected to extended storage must be handled and treated per the requirements of Reliance Electric Service Bulletin A-8017 available from your Reliance Electric District Sales Office.

INSTALLATION

WARNING

D-C MOTORS HAVE CHARACTERISTICS WHICH CAN CAUSE SERIOUS OR FATAL INJURY UNLESS THEY ARE SELECTED, INSTALLED, MAINTAINED AND OPERATED BY QUALIFIED PERSONNEL FAMILIAR WITH SPECIAL REQUIREMENTS OF D-C MACHINES. RELIANCE® D-C MOTORS ARE DESIGNED AND BUILT IN ACCORDANCE WITH *SAFETY STANDARD FOR CONSTRUCTION AND GUIDE FOR SELECTION, INSTALLATION AND USE OF ELECTRIC MOTORS AND GENERATORS* PUBLISHED BY THE NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA) PUBLICATION MG-2-1983 (ANSI C51.1). RELIANCE ELECTRIC RECOMMENDS THAT THIS PUBLICATION BE REFERRED TO WHENEVER YOU SELECT OR INSTALL ANY D-C MOTOR. COPIES MAY BE OBTAINED FROM NEMA, 2101 L. STREET, WASHINGTON, D.C., 20037.

IN ADDITION, ALL MOTORS MUST BE INSTALLED IN ACCORDANCE WITH THE NATIONAL ELECTRIC CODE AND APPLICABLE LOCAL CODES.

THE APPLICATION OF MOTORS AND OTHER ELECTRICAL EQUIPMENT IN HAZARDOUS LOCATIONS IS RESTRICTED BY THE NATIONAL ELECTRIC CODE, ARTICLE 500. CUSTOMERS MUST OBSERVE THESE REGULATIONS AND CONSULT WITH LOCAL CODE INSPECTION AND ENFORCEMENT AGENCIES TO INSURE COMPLIANCE.

LOCATION

Locate the machine where the ambient temperature is not over 40°C or 104°F and where clean air has free access to ventilating intake and outlet openings. Except for machines with a suitable protective enclosure, the location should be clean and dry.

IMPORTANT — Sufficient clearance must be provided on all inlet and outlet openings to provide for unrestricted flow of air. Separately ventiled motors with exhaust to ambient (pipe-in only) must have at least 6 inches of clearance between the opening and adjacent walls or floor.

AIR SUPPLY

Cooling air through a self-ventilated or forced-ventilated motor must be clean and have relative humidity between 30% and 100% with no free water in the air. Use of damp, cool outside air with high humidity and free water may cause the motor to flash over. Use of excessively dry air may cause excessive brush and commutator wear. Cooling air temperature must not exceed the maximum ambient temperature indicated on the motor nameplate (Standard 40°C). Cooling air temperature must not be lower than 0°C to provide base speed and regulation with NEMA limits. Use of outside air below 0°C may cause excessive brush and commutator wear due to the low humidity. Cooling air absolute humidity must be at least 2 grains per cu. ft.

NOTE: *Motors located in damp, moist environment must have space heaters or fields energized at 50% voltage to protect against condensation when motor is not operating.*

Separately ventilated motors must have the following volume of air to adequately cool the motor unless the motor nameplate specifies a different value.

Frame	Base Speed, rpm	Air Volume, cfm.	Static Pressure Inches of H_2O
C210ATZ	All	300	2.25
C250ATZ	All	425	2.0
C280ATZ	All	550	3.25
C320ATZ	All	800	3.50
C360ATZ	All	1000	4.00

POWER SUPPLY

Check the motor nameplate to be sure the voltage and type of power rating is the same as that of the power source.

A code stamped on the nameplate identifies the type of power supply that must be used to supply armature power to the motor in order to obtain the rated nameplate output. Since the code letter has been selected in alphabetic order of increasing magnitude of ripple current, a motor may be operated on a power supply having a letter designation prior in the alphabet to the letter stamped on the nameplate, with no loss in nameplate rating. For example, a motor designed for a D type of power supply may be used on a C power supply having the same voltage rating. The types of power supplies are defined as follows.

INSTALLATION (Continued)

Description	Code (1)
D-C Generator, battery or twelve pulse/cycle, 6ϕ, full control	A
Six pulse/cycle, 3ϕ full control 230 or 460 volt, 60 Hz input to rectifier	C
Three pulse/cycle, 3ϕ, semi-bridge, ½ control 230 or 460 volt, 60 Hz input to rectifier .	D
Three pulse/cycle, 3ϕ, ½ wave (single way) 460 volt, 60 Hz input to rectifier	E
Two pulse/cycle, 1ϕ, full wave (bridge circuit with 2-controlled rectifiers and 2-uncontrolled rectifiers with free wheeling rectifier) 230 volt, 60 Hz input	K

(1) When the armature power supply cannot be designated by a single letter code (A, K, etc.) the power supply shall be identified by the following code stamped on the motor nameplate.

M/N F-V-H-L

where M = Total pulses per cycle

N = Total controlled pulses per cycle

F = Free wheeling (if used)

V = Nominal line-to-line a-c voltage to rectifier

H = Line frequency — Hz

L = Value of series inductance (in millihenries) to be added externally to the motor armature circuit.

Examples:

A. "6/3 F-380-50-12" defines a power supply having 6 total pulses per cycle, 3 controlled pulses per cycle (S-3), with free wheeling, 380 volts, 50 Hz a-c input to bridge, and a 12 millihenry choke to be added externally to the motor armature circuit.

B. "3/3 480" defines a power supply having three total pulses per cycle, three control pulses per cycle, 480 volts line-to-line input to the rectifier, 60 Hz power supply and no external inductance required in the armature circuit. Note that since the power source is 60 Hz and no series inductance is required, both quantities may be omitted from the code. If one of the quantities is indicated, both must be included to avoid confusion.

CONDUIT BOX

Conduit boxes can be rotated in 90° increments for lead outlet at top, sides or bottom.

Conduit box locations can be changed from F1 to F2 or F2 to F1 by rotating the frame 180° around the shaft axis and reconnecting the brush stud leads. (Refer to factory for reconnecting brush stud leads.)

To obtain proper planity between the integral mounting feet on the front and back end brackets, a smooth level surface should be used to align the brackets when they are assembled to the frame.

CONNECTIONS

CAUTION: If motor has parallel leads, all lugs with the same marking: For example, A1, A1, must be connected together.

BASIC D-C MOTOR AND GENERATOR CONNECTIONS

Type	Rotation Facing Commutator End	
	Counter-Clockwise	Clockwise
Motor	+A1 ↘ ↘ - S2 A2 ↘ +F1 S1 ↘ —F2	A1 ↘ —S2 +A2 ↘ +F1 S1 ↘ —F2
Generator	A1 ↘ - S2 +A2 ↘ —F1 S1 ↘ +F2	A1 ↘ S2 +A2 ↘ +F1 - S1 ↘ — F2

If machine has no series field, disregard S1 and S2 above. For machines with special windings, refer to motor or generator and controller diagrams.

THERMOSTAT (THERMAL PROTECTOR)

IMPORTANT — Motors may have one or more thermostats (leads marked P1, P2, etc.) to indicate motor overheating. Thermostat contacts must be connected in the motor control or indicating circuit. Failure to connect the thermostat leads will void the motor warranty. Thermostat contact ratings are listed below. Motors having thermistors or resistance temperature detectors to indicate motor over temperature must have these devices connected in the proper control circuit to protect the motor.

	110V 60 Hz	220V 60 Hz
Max. Continuous Current	3.0 amps	1.5 amps
Min. Continuous Current	.2	.1

WARNING

MOTORS HAVING AN OVERSPEED SWITCH MUST HAVE THE OVERSPEED SWITCH TERMINALS PROPERLY CONNECTED IN THE CONTROL CIRCUIT TO REMOVE ARMATURE POWER WHEN THE SWITCH REACHES THE SET SPEED.

INSTALLATION (Continued)

GROUNDING

WARNING

MOTOR MUST BE GROUNDED PROPERLY TO AVOID INJURY TO PERSONNEL. GROUNDING METHOD MUST BE IN ACCORDANCE WITH NATIONAL ELECTRIC CODE AND APPLICABLE LOCAL CODES. THE GROUND CONNECTION SHOULD BE A SOLID AND PERMANENT METALLIC CONNECTION BETWEEN THE GROUND POINT, THE MOTOR OR GENERATOR TERMINAL HOUSING AND THE MOTOR OR GENERATOR FRAME. A GROUND STUD FOR THE ATTACHMENT OF A GROUND LEAD IS PROVIDED INSIDE THE TERMINAL BOX.

MOUNTING

Motors must be mounted on a rigid, solid base or foundation. (Poor base construction may cause resonances in the motor/base assembly which can result in bearing failure and other motor damage.) All hold down bolts must be the correct grade for the type of mounting and must be torqued to their recommended value. Recommend bolt torques for SAE Grade I foot bolts are given in the following table.

Frame	Hole Diameter H Inch	Bolt Size and Thread	Recommended Torque for SAE Grade I Dry Components-Not Lubricated Foot-Pounds
C210ATZ	.44	3/8-16	16
C250ATZ	.56	1/2-13	39
C280ATZ	.56	1/2-13	39
C320ATZ	.69	5/8-11	77
C360ATZ	.81	3/4-10	135

Belted Drive

Motor slide bases or rails, when used, must be securely anchored to the foundation with the proper bolts.

IMPORTANT — The motor shaft and the load shaft must be parallel and the sheaves aligned. Refer to *Motor Application Data* Section for sheave and belt data.

Coupled Drive

IMPORTANT — Flexible couplings must be used between the motor shaft and the load shaft. Motor shaft and load shaft must be aligned to values recommended for the specific coupling before coupling is connected.

Standard RPM III motors Frames C210ATZ — C360ATZ will operate successfully mounted on the floor, wall or ceiling, and with the shaft at any angle from horizontal to vertical. Special mountings, duty or thrust demands may however require a different bearing system. Handhole covers can be interchanged as necessary.

CAUTION: Vertical mount hand hole covers are required to provide protection to vertically mounted Drip-Proof motors. Stock motors and other motors designed for horizontal mounting can be adapted for vertical mounting by ordering vertical mount hand hole covers from Reliance Electric.

Motor C-Face is intended for mounting auxiliary equipment such as pumps, gears, etc. When mounted horizontally, these motors should be supported by the feet and not by the C-Face. Installations requiring a horizontally mounted motor without feet should use a D-flange bracket.

WARNING

SURFACE TEMPERATURE OF MOTOR ENCLOSURE MAY REACH TEMPERATURES WHICH CAN CAUSE DISCOMFORT OR INJURY TO PERSONNEL ACCIDENTALLY COMING INTO CONTACT WITH HOT SURFACES. (WHEN INSTALLING, PROTECTION SHOULD BE PROVIDED BY USER TO PROTECT AGAINST ACCIDENTAL CONTACT WITH HOT SURFACE).

DIRECTION OF ROTATION

Unless otherwise ordered, brush rigging is assembled for NEMA standard direction of rotation, counter-clockwise for motors and clockwise for generators facing the commutator end. RPM III machines will operate *in either direction of rotation* without changing the angle of the brush holders for normal field weakened speed ranges. Extended field weakened speed range motors should have the direction of rotation specified.

DRIVE

The RPM III machines C210ATZ — C320ATZ are supplied with a shaft suitable for a belt or coupled drive.

C360ATZ frame sizes will be supplied with a short shaft for coupled drives unless specified for belt duty.

Proper alignment is a key step for long life of bearings, shafts and belts, and minimum downtime. Misalignment

INSTALLATION (Continued)

can cause excessive vibration and damaging forces on shaft and bearings. For direct coupled drives, flexible couplings facilitate alignment. For belt drives, the driving and driven tension must be adjusted as required for proper operation. The belt sheave should be placed as close as possible to the motor bracket.

WARNING
ALL BELTS, CHAINS, AND OTHER MOVING PARTS MUST BE GUARDED TO PREVENT INJURY TO PERSONNEL.

SHIPPING BLOCKS

Motors supplied with roller bearings at the drive end are shipped with wooden blocking to prevent axial movement of the shaft during shipment. Remove the blocking and bolts securing it and discard. Make sure motor shafts turn freely. If motor is to be reshipped, blocking of bearing is required.

MOTOR APPLICATION DATA

MAXIMUM SAFE SPEED

The speeds given in Table I are the maximum mechanically safe operating speeds for frames with standard construction. These speeds must not be exceeded under any condition. Motor control must hold the maximum speed under any load condition including no-load within the maximum safe speed. Drive systems whose design characteristics inherently prevent the D-C motor from exceeding the Motor Maximum Safe Operating Speed must prevent the motor from exceeding the Maximum Safe Speed if a single component failure should occur.

WARNING
THE MACHINERY BUILDER IS RESPONSIBLE FOR INSURING THAT DRIVEN MACHINERY AND ALL DRIVETRAIN MECHANISMS NOT SUPPLIED BY RELIANCE ELECTRIC AND PROCESS LINE MATERIAL ARE CAPABLE OF SAFE OPERATION AT THE MAXIMUM SPEEDS, AS SHOWN IN TABLE I. FAILURE TO DO SO CAN RESULT IN DESTRUCTION OF MECHANISM OR MATERIAL AND FLYING FRAGMENTS, ENDANGERING OPERATING PERSONNEL.

TABLE I — MAXIMUM SAFE SPEED

Frame Diameter	Maximum Safe Speed rpm
C210ATZ	4500
C250ATZ	4500
C280ATZ	4000
C320ATZ	3600
C360ATZ	3000

With special construction maximum safe speed may differ from the above values. In all cases, the maximum safe speed is indicated on the motor nameplate.

NOTE: Normal operating speeds must be limited to those listed on price pages in order to meet nameplate rating and assure validity of warranty.

MINIMUM V-BELT SHEAVE DIAMETERS

APPLICATION OF PULLEYS, SHEAVES, SPROCKETS AND GEARS ON MOTOR SHAFTS

To avoid excessive bearing loads and shaft stresses, belts should not be tightened more than necessary to transmit the rated torque. The pre-tensioning of the V-belt drive should be based on the total tightening force required to transmit the horsepower divided by the number of belts. This procedure avoids the excessive load caused by tightening individual belts to a prescribed level recommended by belt manufacturers.

The value of "d" calculated in the formula on page 8 may indicate a minimum sheave diameter which is smaller than is practicable to assemble on the motor shaft extension.

Shaft stresses and bearing and belt loads will be reduced if shave diameters larger than the calculated minimum are used, but the number of belts should be reduced accordingly.

The maximum V-belt velocity is 6500 feet per minute.

The calculated minimum pitch diameter of the V-belt sheave is based on the following:

1. Belt service factor of approximately 1.6 with belts tightened to the belt manufacturer's recommendations.
2. Speed reduction not exceeding 5:1.
3. Mounting of sheave on motor shaft in accordance with MG1-1407.
4. Center-to-center distance between sheaves approximately equal to five times the pitch diameter of the smaller sheave.

MOTOR APPLICATION DATA (Continued)

The horsepower ratings for belt drives may be found in ANSI Standard B5512 or in "Specifications for Drives Using Narrow Multiple V-Belts (3V, 5V and 8V Cross Sections)" published by Rubber Manufacturers Association and Mechanical Power Transmission Association or in Dodge Division Bulletin 30E.

Mounting

In general, the closer pulleys, sheaves, sprockets or gears are mounted to the bearing on the motor shaft, the less will be the load on the bearing. This will give greater assurance of trouble-free service.

The center point of the belt, or system of V-belts, must not be beyond the end of the motor shaft.

The inner edge of the sheave or pulley rim should not be closer to the bearing than the shoulder on the shaft but should be as close to this point as possible.

The outer edge of a chain sprocket or gear must not extend beyond the end of the motor shaft.

Minimum Pitch Diameter for Drives Other Than V-Belt

To obtain the minimum pitch diameters for flat belt, timing-belt, chain and gear drives, apply the multiplier given in Table II to the minimum sheave diameter calculated for V-belt drives.

SHAFT EXTENSION AND METHOD OF DRIVE

RPM III frames C210ATZ — C320ATZ are supplied with a shaft and bearing system suitable for either coupled or belted drives.

C360ATZ frame sizes are supplied with a larger shaft when belted drives are specified.

TABLE II — MULTIPLIERS FOR DRIVES OTHER THAN V-BELT

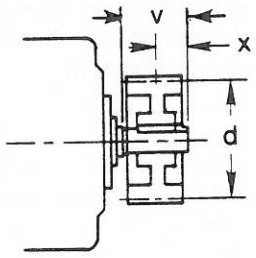
Drive	Multiplier
Flat Belt (See Note 1)	1.33
Timing Belt (See Note 2)	0.9
Chain Sprocket	0.7
Spur Gear	0.75
Helical Gear	0.85

NOTE 1: *The above multiplier is intended for use with conventional single-ply flat belts. When other than single-ply flat belts are used, the use of a larger multiplier is recommended.*

NOTE 2: *It is often necessary to install belts with a snug fit. However, tension should be no more than that necessary to avoid belt slap or tooth jumping.*

PREFERRED V-BELT DRIVES — SHEAVE CENTERLINE IS TOWARD MOTOR FROM END OF SHAFT.

Minimum pitch diameters of sheaves must not be smaller than the values calculated by the following formula where the sheave centerline is toward the motor from the end of the shaft.



$$d_{inches} = \frac{hp}{100}(A - Bx); \quad d_{millimeters} = \frac{kw}{100}(C - Dx)$$

where:

d = minimum pitch diameter of V-belt sheave in inches or millimeters.

hp = rated horsepower at base speed.

kw = rated kilowatts at base speed.

x = axial distance of the sheave centerline from the end of the shaft in inches or millimeters. The distance is measured from the end of the shaft (x is negative if centerline is beyond the end of the shaft and positive if toward the motor). The formula should not be used for negative values of x greater than one half of the V dimension of the shaft extension.

A, B, C and D = constants from Table III corresponding to the base speed of the motor.

SHAFT LOADS — AXIAL AND RADIAL

RPM III D-C motors are suitable for limited shaft loads as shown in Tables IV and V. Recommended maximum thrust loads depend on the mounting position, either horizontal or vertical. For recommendations for loads in excess of those shown, refer to the local Reliance Electric office.

MOTOR APPLICATION DATA (Continued)

TABLE III — CONSTANTS FOR CALCULATING THE MINIMUM SHEAVE DIAMETERS FOR V-BELT DRIVES

Frame		"V" Dim.	Constant	BASE RPM 850	1150	1750	2500
C210ATZ	inches	3.50	A	40.6	30.0	19.77	14.63
			B	7.26	5.43	3.56	2.09
	millimeters	88.9	C	1384	1022	674	499
			D	9.73	7.28	4.77	2.80
C250ATZ	inches	4.00	A	23.33	18.25	12.67	9.47
			B	3.58	2.3	1.17	.57
	millimeters	101.6	C	795	622	432	323
			D	4.80	3.08	1.57	.76
C280ATZ	inches	4.50	A	20.28	16.17	11.2	8.32
			B	2.94	1.75	.84	.43
	millimeters	114.3	C	691	551	382	284
			D	3.94	2.35	1.13	.58
C320ATZ	inches	5.00	A	18.47	14.25	9.97	—
			B	2.00	1.24	.59	—
	millimeters	127.0	C	630	486	340	—
			D	2.68	1.66	.79	—
UC360ATZ	inches	6.25	A	10.42	8.08	5.89	—
			B	.46	.25	.13	—
	millimeters	158.8	C	355	275	201	—
			D	.62	.34	.17	—

TABLE IV — AXIAL THRUST CAPACITY IN POUNDS/KILOGRAMS

Frame		Horizontal Mounting 2500 rpm	1750 rpm	1150 rpm	850 rpm	Vertical Mounting (1) 2500 rpm	1750 rpm	1150 rpm	850 rpm
C210ATZ	pounds	480	560	680	778	508 ± 105	593 ± 105	710 ± 105	811 ± 105
	kilograms	218	254	308	353	230 ± 48	269 ± 48	322 ± 48	368 ± 48
C250ATZ	pounds	509	600	722	828	541 ± 125	629 ± 125	755 ± 125	865 ± 125
	kilograms	231	272	327	376	245 ± 57	285 ± 57	342 ± 57	392 ± 57
C280ATZ	pounds	590	700	850	975	644 ± 200	754 ± 200	905 ± 200	1038 ± 200
	kilograms	268	318	386	442	292 ± 91	342 ± 91	411 ± 91	471 ± 91
C320ATZ	pounds	705	835	1020	1170	770 ± 335	905 ± 335	1095 ± 335	1250 ± 335
	kilograms	320	379	463	531	349 ± 152	411 ± 152	497 ± 152	567 ± 152
C360ATZ	pounds	875	1075	1350	1525	830 ± 500	1020 ± 500	1300 ± 500	1475 ± 500
	kilograms	397	488	612	692	376 ± 227	463 ± 227	590 ± 227	669 ± 227

(1) Thrust capacity for vertical mounting includes a constant whose value is plus or minus depending on the direction of the thrust load. The constant is plus for thrust loads acting upward against the force of gravity and minus for loads acting downward with gravity.

TABLE V — RADIAL LOAD CAPACITY

Frame	Radial Load Capacities at the End of the Shaft in Lbs. (1) 2500 rpm	1750 rpm	1150 rpm	850 rpm
C210ATZ	875	875	875	875
C250ATZ	1375	1525	1525	1525
C280ATZ	1550	1755	1755	1755
C320ATZ	1685	1900	1900	2000
UC360ATZ(2)	2550	2875	3300	3310

(1) **CAUTION:** The use of these radial load capacities requires the accurate calculation of the radial load for the application. Radial loads for gears, sprockets, and flywheel are usually accurately determined but the radial loads due to V-belt drives are subject to miscalculations because they do not include all of the pre-tension load (belt tightening). The calculations of the radial load for a V-belt drive must include the pre-tension for transmitting the horsepower, pre-tension for centrifugal force on the belts, pre-tension for high start torques, rapid acceleration or deceleration, pre-tension for drives with short arc-of-contact between the V-belt and sheave, and low coefficient of friction between belt and sheave caused by moisture, oil or dust.

(2) Data for motors with roller bearings at the drive end (back end). Motors with ball bearings at the drive end are for coupled duty only.

OPERATION

BALANCE

Motors are dynamically balanced to commercial limits unless ordered differently. Balance is done with a full length ½ height shaft key. A full shaft key is shipped with motor. Sheave or coupling should be balanced with a ½ height shaft key.

STD. DYNAMIC BALANCE LIMITS

Highest Rated Speed, rpm	Max. Amplitude in Inches
3,000 — 4,000	0.0010
1,500 — 2,999	0.0015
1,000 — 1,499	0.0020
Up to 999	0.0025

SERIES WOUND MOTORS

WARNING

SERIES WOUND MOTORS MUST BE SOLIDLY CONNECTED TO THE DRIVEN MACHINE AND NEVER OPERATED WITHOUT LOAD TO AVOID POSSIBLE DESTRUCTIVE HIGH SPEEDS.

MOTOR START-UP

WARNING

BEFORE INITIAL START-UP OR WHEN STARTING MOTOR AT ANYTIME, OBSERVE THE FOLLOWING PRECAUTIONS.

1. REMOVE ALL UNUSED SHAFT KEYS AND LOOSE ROTATING PARTS TO PREVENT THEM FROM FLYING OFF. REPLACE COVERS AND PROTECTIVE DEVICES.
2. MAKE CERTAIN THAT ALL SEPARATELY EXCITED FIELDS ARE EXCITED AT THEIR RATED VOLTAGE AND THAT RELATIVE POLARITIES OF ALL FIELDS ARE CORRECT. REFER TO CHECKING RELATIVE POLARITY OF D-C MOTOR FIELDS.
3. WHEN MOTOR OR GENERATOR IS SUPPLIED AS PART OF DRIVE SYSTEM, REFER TO THE DRIVE SYSTEM INSTRUCTION MANUAL FOR OPERATING INSTRUCTIONS. TACHOMETER FEEDBACK MUST BE PROPERLY CONNECTED FOR CLOSED LOOP OPERATION. REVERSE POLARITIES OR BROKEN CONNECTIONS CAN CAUSE DANGEROUS OVERSPEEDS.

MAXIMUM SAFE MECHANICAL OPERATING SPEEDS ARE SHOWN IN TABLE I, PAGE 7, MAXIMUM SAFE SPEEDS. MOTOR CONTROL MUST PREVENT MOTOR SPEEDS FROM EXCEEDING THESE VALUES.

In addition to observing the above precautions, the following items must be checked before starting and during operation.

1. The armature should rotate freely and be clear of any obstructions.
2. The brushes should move easily in their holders and should make proper contact on the commutator.
3. The interior of the motor should be clean and dry.
4. Connections should be tight.
5. The driven machine should be unloaded if possible.

When starting, small sparks may appear on the commutator due to particles of dirt. Other than this, there should be little, if any, sparking at the brushes.

IMPORTANT — Machines designed for cooling by a separate source of forced ventilation must not be operated without the air supply. Be sure blower is running in proper direction.

While operating the motor, observe the performance. It should run smoothly with little noise. The bearings should not overheat and should reach a leveling of temperature. Any undue noise, overheating, sparking or erratic performance should be investigated and necessary corrective action taken immediately to prevent serious damage. Before attempting any repairs, please contact the local Reliance Electric Sales/Service office.

All RPM III motors are lubricated before shipment and will operate for a long period before regreasing is required. The period will vary depending on environmental and service conditions. Refer to Maintenance Section.

WARNING

SURFACE TEMPERATURE OF MOTOR ENCLOSURE MAY REACH TEMPERATURES WHICH CAN CAUSE DISCOMFORT OR INJURY TO PERSONNEL ACCIDENTALLY COMING INTO CONTACT WITH HOT SURFACES. (WHEN INSTALLING, PROTECTION SHOULD BE PROVIDED BY USER TO PROTECT AGAINST ACCIDENTAL CONTACT WITH HOT SURFACE).

D-C MOTOR FIELD HEATING

CAUTION: Motors designed for forced ventilation as standard must have cooling air when fields are excited at rated voltage. Installations having the air supply interrupted when the motor is not operating must have field disconnected or field voltage reduced to 67% rated by means of field economizing resistor and relay.

Standard continuous duty DPG, TEFC and TENV stabilized shunt wound RPM III D-C motors have continuous duty fields capable of continuous excitation at standstill (armature circuit not energized) under normal industrial conditions.

Standard continuous duty self-ventilated motors are suitable for rated load at rated speed operation at field voltages up to 110% of rated value. However, motor temperature will exceed the normal class F rise with resulting reduction in insulation life if operated below approximately 90% of base speed at rated voltage for prolonged periods. Refer to Reliance Electric for torque derating curves for motors operated continuously below base speeds.

CHECKING RELATIVE POLARITY OF D-C MOTOR FIELDS

Motor speed is unstable if speed increases due to an increase in load current. As a result of instability, motor speed may hunt or overspeed. These are unsatisfactory, possibly dangerous, drive conditions.

One of the possible causes of unstable performance of shunt wound D-C motors is incorrect series field polarity relative to the shunt field due to improper connection. Relative polarity of the shunt and series fields can be checked as follows:

1. Connect a low scale (3 volts) D-C voltmeter across the shunt field terminals (F1, F2) with F1 connected to the positive (+) terminal of the meter. At least one of the shunt field leads must be disconnected from the controller.
2. Use two flashlight batteries as a source of low voltage (3 volts). Hold or connect the negative, bottom of the battery to contact the S-2 series field terminal. Hold one end of a wire conductor to the positive (+) center terminal so that the other end of the wire can be used to make and break contact with the S-1 series field terminal.
3. The procedure is to watch the deflection of the voltmeter needle when contact is made with S-1 and when contact is broken.
4. When contact is made, the needle will first deflect in either the up scale or down scale direction and then return to zero. Deflection will be in the opposite direction when contact is broken.
5. Relative polarities of the shunt and series fields are correct (ampere-turns are cumulative) if the voltmeter needle deflects up scale when contact is made and down scale when contact is broken.
6. Relative polarities of the shunt and series fields are incorrect (ampere-turns are differential) if the voltmeter needle deflects down scale when contact is made and up scale when contact is broken.

Relative polarity can be incorrect because of an error in the connections to the control or because the series fields leads are improperly marked. In any case, the motor connections must be changed so that relative polarity is correct.

If only one series field terminal is available at the controller, use it and the available armature terminal for the test. For example, use S-2 and A-1 if S-1 and A-2 are connected together at the motor and not brought to the controller.

MAINTENANCE

WARNING

INTERNAL PARTS OF THIS MOTOR MAY BE AT LINE POTENTIAL EVEN WHEN IT IS NOT ROTATING. BEFORE PERFORMING ANY MAINTENANCE WHICH COULD RESULT IN CONTACTING ANY INTERNAL PART, BE SURE TO DISCONNECT ALL POWER FROM THE MOTOR.

- MOTORS USING RECTIFIED POWER UNITS, DISCONNECT ALL A-C LINE CONNECTIONS.
- MOTORS USING ROTATING POWER UNITS, DISCONNECT ALL D-C LINE CONNECTIONS.

WARNING

SURFACE TEMPERATURE OF MOTOR ENCLOSURE MAY REACH TEMPERATURES WHICH CAN CAUSE DISCOMFORT OR INJURY TO PERSONNEL ACCIDENTALLY COMING INTO CONTACT WITH HOT SURFACES. (WHEN INSTALLING, PROTECTION SHOULD BE PROVIDED BY USER TO PROTECT AGAINST ACCIDENTAL CONTACT WITH HOT SURFACE).

INSPECTIONS

Regular inspection at intervals dependent upon service conditions is the best insurance against costly maintenance and breakdown. Experience is the best guide. Record inspection results and maintenance action required or performed.

CLEANLINESS

Keep the interior parts of machines *clean and dry*. Remove dust, dirt, corrosion, grease, oil and moisture. If used, ventilating air filters must be kept clean or replaced to insure full volume of cooling air.

WARNING

HIGH VOLTAGE AND ROTATING MACHINERY CAN CAUSE SERIOUS OR FATAL INJURY. VENTILATING AIR FILTERS SHOULD NOT BE CLEANED OR REPLACED WHILE MACHINE OR AUXILIARY A-C BLOWER MOTOR IS ENERGIZED OR ROTATING.

TABLE VII

Amount of grease to be added to RPM III motors. See Table IX for relubrication interval. Use Chevron SRI-2 or equivalent grease unless motor nameplate specifies special grease.

Frame Size	Coupled Duty				Belted or Tandem Duty			
	Volume		Weight		Volume		Weight	
	Cubic Inches	Cubic Centimeter	Ounces	Grams	Cubic Inches	Cubic Centimeter	Ounces	Grams
C210ATZ — C280ATZ	1.0	16	.5	14	1.0	16	.5	14
C320ATZ — C360ATZ	2.0	32	1.0	28	2.0	32	1.0	28

TABLE VIII — SERVICE CONDITION

Determine service condition on the basis of the most severe operating parameter; that is temperature, bearing load, atmosphere, or operating hours per day.

Service Condition	Ambient Temperature	Bearing Load	Atmosphere	Operating Hrs. Per Day
Standard	−18°C to 40°C (0°F to 104°F)	Steady	Clean	8
Severe	−30°C to 50°C (−22°F to 122°F) (1)	Medium Shock, Vibration (less than .2 in/sec)	Medium Dirt, Abrasives, Corrosion	8 to 24
Extreme (2)	−54°C to 65°C (−65°F to 149°F) (1)	Heavy Shock, Vibration (more than .44 in/sec)	Heavy Dirt, Abrasives, Corrosion	8 to 24

(1) Motors must be specially designed for operation in ambients outside the range of −30°C to 40°C (−22°F to 104°F).
(2) "EXTREME" service conditions are rare in actual practice. Corresponding lubrication cycles should therefore be applied with caution. In addition, it is advisable to check with Reliance Electric Co. (Cleveland Service Department) for related special instructions.

TABLE IX — RELUBRICATION PERIODS FOR RPM III MOTORS — FRAMES C210ATZ — C360ATZ

Refer to Table VIII for definition of service conditions.

Maximum Normal Operating Speed rpm (1)	Frame	Relubrication Interval in Months (2)		
		Standard Service	Severe Service	Extreme Service
3450 and higher	All	9	4	1
2400 thru 3449	C210ATZ thru C250ATZ C280ATZ thru C360ATZ	24 9	9 3	3 1
1700 thru 2399	C210ATZ thru C320ATZ C360ATZ UC360ATZ	36 18 9	12 6 3	3 2 1
800 thru 1699	C210ATZ thru C320ATZ C360ATZ UC360ATZ	36 36 18	24 12 6	8 3 1
500 thru 799	C210ATZ thru C320ATZ C360ATZ UC360ATZ	48 36 18	36 24 12	12 8 4
499 and lower	C210ATZ thru C360ATZ UC360ATZ	48 24	36 18	12 6

(1) Maximum speed occupying more than 30% of operating time.
(2) For Tandem drives increase frequency of lubrication by multiplying values by .8.

LUBRICATION — FRAMES C210ATZ — C360ATZ

RPM III machines are designed with the exclusive Reliance Electric Positive Lubrication System PLS® which routes new grease directly into the bearing. The relubrication periods shown in Table IX are offered as a guide for varying service conditions, speeds, bearing types and operating hours.

NOTE: *Certain special motors may have a lubrication instruction plate permanently attached. These specific lubricating instructions must be followed.*

LUBRICATION PROCEDURE

1. Relubrication with the shaft stationary is recommended, and a warm motor if possible.

WARNING
IF RELUBRICATION IS DONE WHILE MOTOR IS RUNNING, STAY CLEAR OF ROTATING PARTS.

2. Locate the grease inlet at the top of the bearing hub, clean the area and replace the ⅛-inch pipe plug with a grease fitting if the motor is not equipped with grease fitting.
3. Remove grease drain plug located opposite the grease inlet.
4. Using a manual grease gun, pump in the recommended grease in the amount shown in Table VII. This amount of grease will provide an ample supply of lubricant between lubrication periods as determined from Table IX for the service condition listed in Table VIII.

   Use Chevron SRI-2 grease or equivalent unless motor nameplate specifies special grease. Use only clean, fresh grease from clean containers and handle so as to keep it clean.

   In general, mixing of greases is not recommended. However, if an incompatible grease is used, the lube system must be repacked completely with the new grease.
5. Wipe away any excess grease at the grease drain or relief and replace drain plugs.

REPACKING BEARINGS OR GREASING NEW BEARINGS

When existing bearings have been completely cleaned of old grease or when bearings are replaced, use this procedure for packing the bearing.

1. Apply one bead of grease all around inboard side of bearing between bearing and inner cap making sure that grease adheres to balls or rollers.
2. Apply one bead of grease all around outboard side of bearing, making sure grease adheres to balls or rollers.
3. Completely fill grease inlet and outlet passage holes with grease.
4. Fill outboard bearing cavity 60% to 90% full of grease.
5. If possible, rotate shaft of assembled machine at least three revolutions by hand to distribute grease within bearings before starting motor.

BEARINGS

RPM III designs provide a mounting for anti-friction bearings to give:

1. Maximum protection to windings and interior of machine by preventing grease leakage from bearing housing.
2. Maximum protection to bearings against excess lubricant, insufficient lubricant, dirt and moisture.

Various types of anti-friction bearings are used in the wide range of RPM III frames as needed to meet specific load, speed and service requirements.

Most commonly used bearings are:

1. Single row, open ball bearings for coupled and belted duty for frames C210ATZ thru C320ATZ.
2. Single row, open ball bearings for coupled duty for frames C360ATZ.
3. Cylindrical roller bearings at drive end for belted duty frames UC360ATZ.

Frequent bearing checks are recommended. If temperatures become excessive, investigate immediately for the cause. **Total** bearing temperatures should not exceed 90°C (194°F). Causes for high bearing temperature are:

1. Contaminated grease.
2. Insufficient grease or excessive amount.
3. Incorrect grease.
4. Excessive load or thrust due to misalignment or motor overload.
5. Loose bearings.
6. Bearing failure.
7. Excessive ambient temperature.

Replacement bearings should be ordered from Reliance Electric in order to obtain the same carefully selected bearing as the original. RPM III frame bearings should never be exposed by disassembly of the motor unless absolutely necessary for inspection or replacement of the bearing or maintenance in other parts of the machine. Protect good bearings from dirt and contamination at all times. Most bearing failures are caused by dirt.

The open ball bearings for the RPM III motors frame C210ATZ thru C320ATZ are the same regardless of whether application is coupled or belted. Belted duty for frame UC360ATZ requires the use of roller bearings. Coupled duty uses ball bearings.

BRUSHES

Brush pressure is correctly established at the factory and maintained at the correct value throughout the life of the brush by means of a constant pressure design. Brushes and brush-holders should be clean so that the brushes are free to move in the holders. Replace brushes with new brushes of the same grade before wear permits the rivet or tamped pigtail to score the commutator. It is best to change out complete set.

Change brushes with the following procedure:

1. Remove hand hole covers from each side of the commutator end bracket.
2. Loosen four (4) hex head cap bolts which hold the rocker ring assembly to the bracket. (Figure 1)
3. Brushes are removed from the holder by lifting the brush finger and removing the hex head cap bolt which secures the brush lead to the holder. New brushes are installed by following the reverse procedure.
4. Rotate the rocker ring by hand 90° to replace brushes located in 12 and 6 o'clock position.
5. Return rocker to orignial position and change brushes in the 3 and 9 o'clock position.
6. Re-align the neutral setting mark on the rocker ring in line with the mark on the bracket boss.
7. Tighten the four hex head cap bolts which hold the rocker ring to the bracket.
8. Fit the face of new brushes to the contour of the commutator with sandpaper only, no emery abrasive. Keep

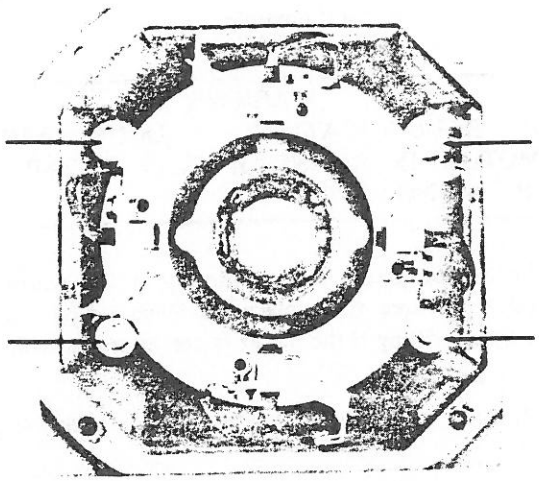


FIGURE 1 — Loosen four (4) bolts to allow rocker to rotate.

brush lead (pigtail) connections tight. Replacement brushes should have sleeved pigtails.

9. Install the hand hole covers to each side of the commutator bracket.

WARNING

HIGH VOLTAGE AND ROTATING MACHINERY CAN CAUSE SERIOUS OR FATAL INJURY. BRUSHES SHOULD NOT BE TOUCHED OR REPLACED WHILE MACHINE IS ENERGIZED OR ROTATING.

COMMUTATOR

A commutator in good condition is clean and smooth with a medium polish and a light brown color. Keep clean by occasionally wiping with a canvas pad. *Use no lubricant or emery abrasive*. If a commutator becomes rough, it needs to be resurfaced. Roughness can be easily detected with the machine running by resting a pencil-like rod of insulating material (dry wood) on one of the brushes. In mild cases, a commutator dressing stone can be used. Very rough or out of round commutators require turning in a lathe. In every case, maintain concentricity and remove the minimum material required for proper cleanup. Undercut the mica approximately 1/16" and polish. Adjust brush holders for approximately 3/32" clearance to commutator.

The finished diameter and the minimum diameter of the commutator for the various frames sizes are as follows:

Frame	New Diameter		Minimum Diameter	
	Inches	Millimeters	Inches	Millimeters
C210ATZ	5.03	127.8	4.59	116.6
C250ATZ	5.78	146.8	5.34	135.6
C280ATZ	6.53	165.9	6.09	154.7
C320ATZ	7.53	191.3	7.09	180.1
C360ATZ	8.70	221.0	8.26	209.8

The commutator should be replaced if the final diameter would have to be turned down to a value less than minimum limits.

TABLE X — COMMUTATION PROBLEM QUICK CHECK CHART

Symptom	Identified By	Possible Cause
1. Excessive sparking at motor or generator commutator.	Sparking	1. Dirty or corroded commutator due to dirt, ambient contaminants, oil or oil mist, etc. 2. Brushes incorrectly seated. 3. High or feather-edged mica. 4. Faulty machine adjustment. 5. Interpoles failed or improperly adjusted. 6. Loss of brush spring tension. 7. Brushes sticking in brush holder. 8. Unit overload. 9. Defective commutator or armature. 10. Unequal spacing of holders around commutator.
2. High commutator bars produce a rough commutator.	Generally associated with sparking and noisy operation of the brushes on the commutator.	1. Loose commutator.
3. Low commutator bars produce rough commutator.	Generally associated with sparking and noisy operation of the brushes on the commutator.	1. Loose commutator. 2. High mica. 3. Open or high resistance connection at commutator.
4. Streaking at threading of commutator surface.	Rough commutator with associated sparking. Fine lines in brush track.	1. Low average current density in brushes due to light machine loading. 2. Contaminated atmosphere. 3. Oil on commutator or oil mist in air. 4. Humidity too low. 5. Lack of film forming properties in brush. 6. Brush too abrasive.
5. Bar etching or burning.	Rough commutator with associated sparking and eventual flashover.	1. High mica. 2. Operation of machine with brushes off neutral. 3. Commutator dirty. 4. Incorrect spring tension. 5. Machine overload or rapid load change such as plugging.
6. Bar marking at pole-pitch spacing.	1. Two bars marking 180° apart on 4-pole machine at start. 2. Three bars marking 120° apart on 6-pole machine at start. 3. As pitch bar marking progresses, it will eventually show at all bars on the machine. 4. Associated sparking and eventual flashover.	1. Shorted commutator bars or coils. 2. Open armature or field circuit. 3. Unequal air gap. 4. Cyclic disturbance either electrical or mechanical.
7. Bar marking at slot-ptich spacing.	Sparking and marking of one or more bars at equal spacing around commutator according to bar-per-slot ratio with eventual flashover.	1. Unequal compensation of armature coils. The energy unbalance is reflected into the last coil in the slot to undergo commutation, and will result in a spark at the brush.
8. Rapid commutator or brush wear.	Bright commutator surface.	1. Abrasive material under brush. 2. Too abrasive a brush. 3. Low average brush current density due to light machine loading. 4. Contaminated atmosphere. 5. Humidity too low. 6. Incorrect brush tension.

WARNING

INTERNAL PARTS OF THIS MOTOR MAY BE AT LINE VOLTAGE EVEN WHEN MOTOR IS NOT ROTATING. BEFORE CONTACTING ANY INTERNAL PART:

RECTIFIED POWER UNIT — DISCONNECT ALL A-C LINE CONNECTIONS. ROTATING POWER UNIT — DISCONNECT ALL D-C LINE AND FIELD CONNECTIONS.

MAINTENANCE (Continued)

COMMUTATION

Intermittent sparking due to overloads or slight visible sparking does not necessarily indicate poor commutation. Poor commutation exists when there is excessive sparking requiring abnormal maintenance. Every case of excessive sparking should be investigated to determine the cause and correct it. The chart in Table X may help in analyzing commutation problems. (Refer to page 16.) D-C motors and generators are brushed for full load current. If unit or units are consistently operated at less than ½ rated load a condition known as threading will result.

WINDINGS

For long life, keep windings clean and dry. Dirt or dust can be removed by wiping them with clean cloth, by blowing with clean, dry, low pressure air or by vacuum cleaner. Oil or grease can be removed with a cloth moistened with mineral solvent. Be sure not to get any solvent on the commutator.

WARNING

SINCE MINERAL SOLVENTS ARE FLAMMABLE AND MODERATELY TOXIC, PRECAUTIONS MUST BE OBSERVED IN USING AND HANDLING. THESE PRECAUTIONS INCLUDE:

1. USE IN WELL-VENTILATED AREA.
2. AVOID CONTACT WITH SKIN.
3. OBSERVE PROPER HANDLING PRACTICES TO PREVENT FIRE OR EXPLOSION.

FILTERS — CLEANING

When supplied, filters on motors must be kept clean to insure proper air flow and cooling of the D-C motor.

The standard filter is a six-layer woven-steel fabric. The following procedure should be used to clean these filters:

1. For light accumulations of dust, use compressed air to clean.
2. For moderate accumulations, water may be used.
3. For heavy accumulations of dirt and grease, clean the filter using water and detergent.
4. Always completely dry filter after cleaning with water.
5. After heavy cleaning, spray with a very light coat of protective oil to protect against possible loss of plating.

WARNING

DO NOT USE FLAMMABLE SOLVENTS TO CLEAN FILTERS.

CAUTION: Standard washable filters may not be suitable for motors operating in atmospheres with heavy concentrations of oil mist. Oil mist may be drawn into the motor and cause damage to the commutator and windings. Refer to Reliance Electric for motors operating in heavy oil mist atmospheres.

BRAKES

Motor mounted brake, when supplied, must be adjusted and maintained in accordance with the instructions for the specific brake. Refer to separate instructions supplied with the motor or to Reliance Electric.

DISASSEMBLY AND REASSEMBLY INSTRUCTIONS

DISASSEMBLY AND REASSEMBLY INSTRUCTIONS

The RPM III design incorporates many new techniques which are described in this section. It is recommended that these differences be understood thoroughly before any disassembly work is done to avoid any possible damage or harm to either machine and/or maintenance personnel.

AIR GAP AND SHIMMING

(Frames C210ATZ — C360ATZ)

MAIN POLE

Steel or brass shims, when used, are placed between pole and frame. If for any reason the shims are removed they must be replaced under the same poles. Main pole bolts are steel SAE Grade 5 (120,000 psi).

INTERPOLES

Interpoles are an integral part of the frame and do not require nor are they capable of shimming.

DISASSEMBLY AND REASSEMBLY INSTRUCTIONS (Continued)

AXIAL FLOAT

RPM III motors have a wavey spring washer between the drive end bracket and bearing. The commutator end bearing is positioned axially by a float restricting inner cap. Axial float (including bearing internal clearance) should be within the limits listed on the chart below.

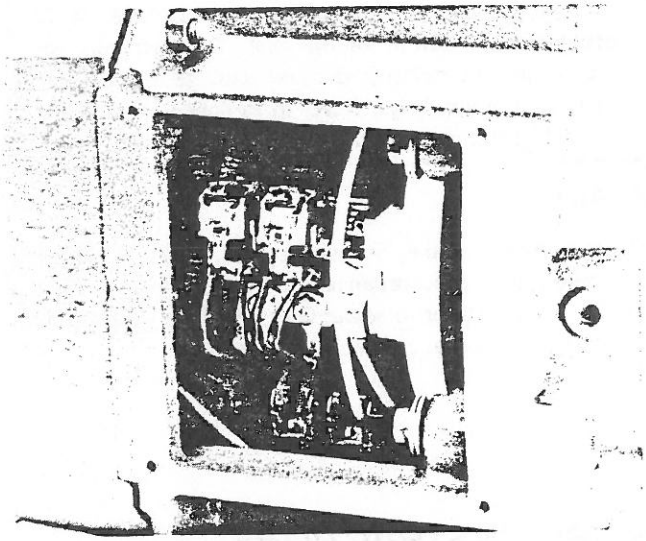
AXIAL FLOAT — IN./MIN.

Frame Size	Maximum		Minimum	
	In.	mm.	In.	mm.
C210ATZ thru C360ATZ	.051	1.29	.013	.33

ANTI-FRICTION BEARING ASSEMBLIES

The bearings are positioned and secured in a machined cavity in the end brackets. Open type ball bearings are used for direct coupled and belt drive applications for frames C210ATZ thru C320ATZ and are protected by inner caps at both ends.

Frame UC360ATZ employs a cylindrical roller bearing on the drive end for belt drives, and a ball bearing for coupled service.



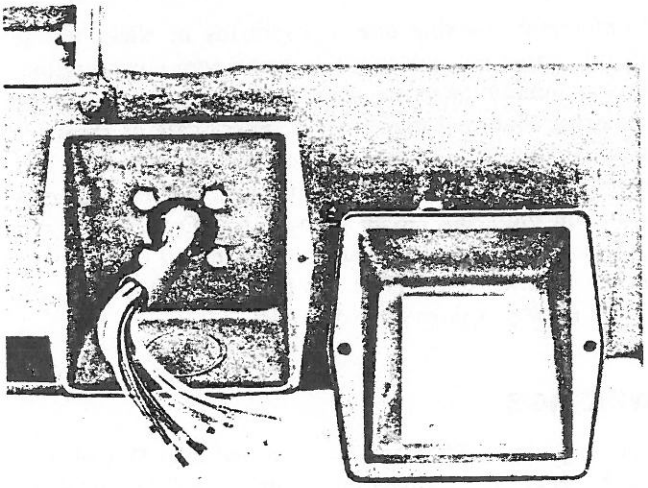
C210ATZ Commutator and brush rigging.

BEARING REPLACEMENT

Remove bearing by means of bearing puller. Clean bearing housing and bearing seat prior to assembly of bearing. Place new bearing in a bake oven for ½ hour @ 250°F. Place bearing onto shaft and push home to bearing shoulder and hold it in place for a minimum of 30 seconds.

After bearing has cooled down for about 1 minute add ½ cu. in. of fresh grease into back of bearing. Once motor becomes assembled grease per instructions found herein.

CONDUIT BOXES



C210ATZ — C360ATZ — Conduit box is located on the frame at the commutator end.

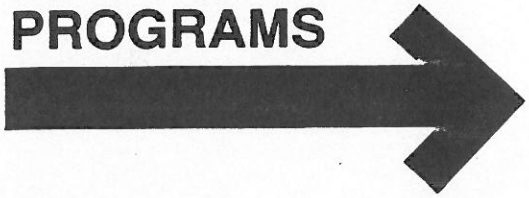
BRUSH RIGGING AND BRUSH HOLDERS

The brush holders in all RPM III motors are of constant pressure design and do not require nor are capable of adjustment over the life of the brushes.

BRACKET RE-ASSEMBLY

To obtain proper planity between the integral mounting feet on the front and back end brackets, a smooth level surface should be used to align the brackets when they are assembled to the frame.

TOTAL MAINTENANCE PROGRAMS



Reliance Electric can provide a wide range of maintenance programs to help you reduce downtime, improve productivity and increase profits. Capabilities include:

- Electrical and Mechanical Start-Up Service
- Electrical Preventive Maintenance
- Mechanical Preventive Maintenance
- Vibration Analysis
- Mobile Van Repair Service
- Balancing and Alignment Service
- Maintenance Schools
- 24-Hour Technical Support
- Modernization Service

For more information contact your local Reliance Electric Sales Office or write:

Reliance Electric Company
Technical Services
24701 Euclid Avenue
Cleveland, Ohio 44117

RENEWAL PARTS

An adequate stock of factory-made renewal parts is an integral part of a sound maintenance program to protect against costly downtime. As a general guide, the following list of spare parts is recommended as minimum protection for one to four duplicate units in operation.

Part	Recommended Stock Quantity
Brushes	1 Set
Bearings	1 Set
Brush holders	½ Set
Field Coils	1 Set
Armature Coils	1 Set
Interpole Coils	1 Set

For large numbers of identical units and for critical applications, it is desirable to stock complete spare armatures or motors. Peak performance of motors and generators require genuine Reliance replacement parts including brushes and bearings. Brushes must have sleeved pigtails.

Parts can be obtained from your nearest Reliance parts distributor, or directly from the Reliance Electric factory. When ordering parts for which a part number is not available, give complete description of part and purchase order number, serial number, model number, etc., of the equipment on which the part is used.

A detailed parts list, which gives Reliance Electric recommendations for spare parts that should be stocked for your equipment, can be ordered from:

1. Nearest Reliance Electric Sales Office
2. Nearest Reliance Electric Distributor
3. Reliance Electric Renewal Parts, Cleveland, Ohio

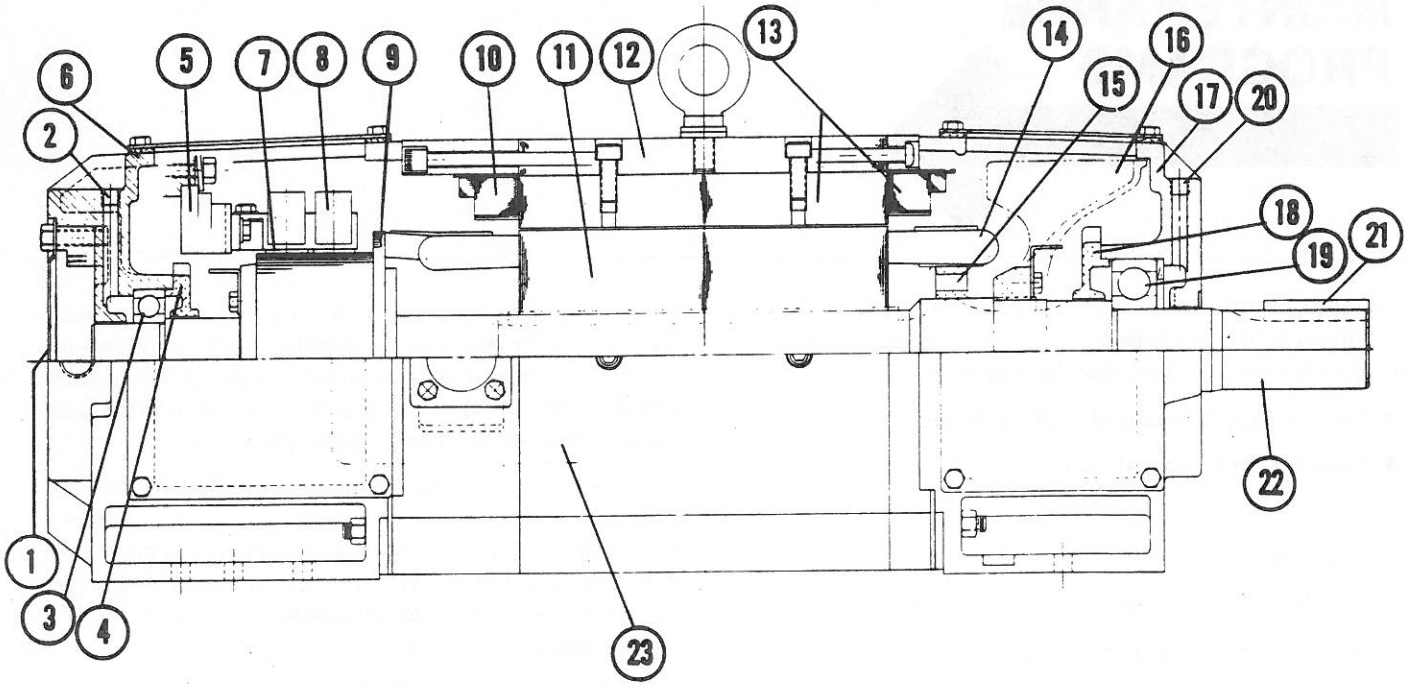
Be sure to include complete nameplate data — purchase order number, serial number, model number, rating, etc. — for your equipment when ordering the spare parts list.

Detailed information on renewal parts including recommendations on spare parts for various numbers of motors in operation is contained in NEMA Standards Publication No. RP1-1981 *Renewal Parts for Motors and Generators (Performance, Selection and Maintenance)*. Copies are available from NEMA, 2101 L Street, N.W., Washington, D.C. 20037.

ADDITIONAL LITERATURE

Additional literature covering D-C machines can be obtained from the Reliance Service Department upon request through your nearest Reliance Electric Sales Office.

PARTS IDENTIFICATION — C210ATZ — C360ATZ



1	Outer Cover	FE
2	Grease Plug	FE
3	Ball Bearing	FE
4	Bearing Cap	FE
5	Rocker	
6	Bracket	FE
7	Brush	
8	Brush Holder	
9	Commutator	
10	Field Coil with Pole	
11	Armature Core	
12	Frame	

13	Field Coil with Pole	
14	Armature Coil	
15	Winding Support	
16	Inner Fan	
17	Bracket	BE
18	Bearing Cap	BE
19	Ball Bearing	BE
20	Grease Plug	BE
21	Shaft Key	
22	Shaft	
23	Conduit Box	

Reliance Electric Company / 24701 Euclid Avenue / Cleveland, Ohio 44117

RELIANCE ELECTRIC

Printed in U.S.A. C-3088-2 68610M

RELIANCE ELECTRIC

DATA TRANSMIT AND CERTIFICAT

CUSTOMER ORDER NO.	DATE	REQ. NO.	S.O. NO.
PO 52386	10/16/87		00VAQ03414

REFER TO THIS NUM IN ALL CORRESPOND

SOLD TO:
PENNWALT CORP
955 MEARNS RD
WARMINSTER PA 18974

SHIP TO:
SAME AS "SOLD TO" UNLESS SHOWN
PENNWALT CORP
955 MEARNS RD
WARMINSTER PA 18974

DATA PROVIDED WITH THIS TRANSMITTAL AND CERTIFICATION IS:

- ☐ FOR CUSTOMER APPROVAL BY DATE: _____
  Return of approval prints by the above date is required to assure scheduled shipment, delay in return and/or revision of approval prints may require shipment reschedule. Return approved D/S to data source.
- ☒ FINAL, APPROVED FOR CONSTRUCTION OR INSTALLATION.
- ☐ PRELIMINARY, ENGINEERING IS COMPLETED.
- ☐ REVISED, SUPERSEDES DATA PREVIOUSLY ISSUED.
- ☐ SEE REMARKS.

DATA SOURCE
TRANSMITTAL AND CERTIFICATION ISSUED BY: M. Colburn DATE 12-12-87 CK BY P Doak DATE 12-12
LARGE MOTOR PLANT
101 RELIANCE ROAD
KINGS MOUNTAIN, NC 28086

DATE PRINTED: 12/08/8

MOTOR OR GEN. DATA

ITEM	USED FOR	USERS PLANT					MOTOR OR GEN. D/S:
A	CENTRIFUGE						608980-559
QTY.	FRAME			SERV. FA	TYPE	R.P.M.	C BOX D/S
3	5010Y	E	200 HP	1.15	P	1800	
PH/HZ/VOLTS-WINDING	DUTY	ENCLOSURE	AMB./INSL.	PWR. CODE			MOTOR OR GEN. C/D:
	CONT	TEFC-XT	40 /F /				
BEARINGS	MOUNTING & METHOD OF DRIVE	RAILS OR BASE	MODEL NUMBER				REDUCER OR AUX D/S:
** ROLL	F1 NEMA						416820-8
ROTAT FROM OPP. DR. END	D-C FIELD EXCITATION	DOUBLE SHAFT EXTEN.					BRAKE OR AUX. D/S
CCW							V54959.211

REDUCER DATA

REDUCER STYLE	CLASS	FRAME	RATIO	OUTPUT RPM	ASSEMBLY	BLOWER MOTOR PH/HZ/VOLTS/HP

BRAKE DATA

BRAKE TYPE	SIZE	RATING FT/LB	DUTY	P.O.

DATA FOR CONTROL

D-C MOTOR ARMATURE CURRENT: _____ AMPS
FIELD CHARACTERISTICS PER CURVE: _____
F_1—F_2, _____ MAX. AMPS _____ _____ RPM
F_{11}—F_{22}, _____ MAX. AMPS _____ _____ RPM
F_3—F_4, _____ MAX. AMPS _____ _____ RPM

A-C MOTOR INFORMATION FOR SELECTION OF STARTER HEATERS:
CODE: J LOCKED AMPS: 1467
F.L. CURRENT: 182 AMPS.

SPCL. INSTALLATION FEAT. AND MISC. DATA

ADDITIONAL MOTOR OR GEN DATA:
PHASE: 3 HERTZ: 60 VOLTS: 575
Lead Location (F1)
Frame Construction - Rigid
WDG PROT QTY 3 DESCRIPTION THERMISTOR, POS TEMP
Grease SRI-2
SPECIAL MARKS:
PART NO. 16-AT-130-CBN
Nema Design - Special
SPECIAL FEATURES:
CLASS B RISE-CSA LABEL--RING TYPE LUGS--6 LEAD WYE DELTA
WR2 LOAD AT MOTOR SHAFT 19,751 LB FT2--WINDAGE & FRICTION
=65 HP--DIR. ROTATION ARROW--WINDING THERMISTORS--PR. CONTR.
SHIP MODEL 135 CONTROL LOOSE .
MOTOR ALWAYS STARTS ON WYE CONN. & ACCEL TO FULL SPEED
BEFORE TRANSITION 85 DBA @ 3 FT-DELY WTD (2) 3/17/88
(1) 4/15/88

* (7) = 2" Pipe Tapped Hole
** Cylindrical Roller Bearing

RE 1805ST2

DUTY MASTER ALTERNATING CURRENT MOTORS

SQUIRREL-CAGE INDUCTION

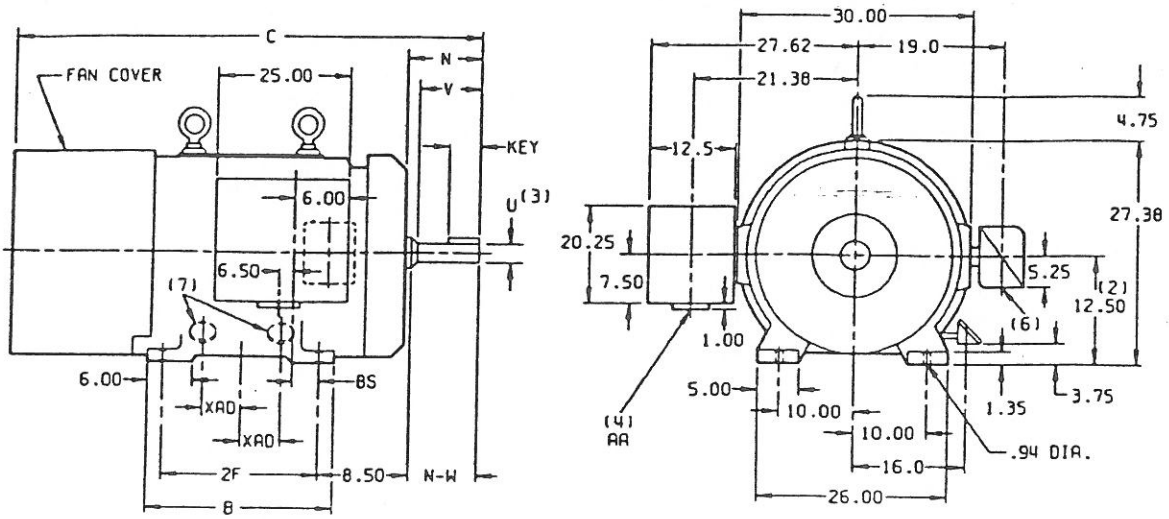
ENCLOSURE: TOTALLY ENCLOSED FAN COOLED AND X/T LOW NOISE

MOUNTING: FOOT

ANTI-FRICTION BEARINGS

OVERSIZE CONDUIT BOX FOR STRESS CONES

FRAME 5010Y THRU 5012Z



DIMENSIONS ARE IN INCHES

FRAME	DUTY	RPM (MAX.)	C	B	2F	BS	XAD	BACK END SHAFT AND KEY						WT. (LBS.)
								N	N-W	U(3)	V	SQ.	LGTH.	
5010Y	BELTED	1800	79.00	37.75	32.00	5.00	8.25	11.18	11.00	3.750	10.75	.875	8.00	4200
5010Z	COUPLED	1800	75.00	37.75	32.00	5.00	8.25	7.18	7.00	4.125	6.75	1.000	5.00	4200
5010S	COUPLED	3600	75.00	37.75	32.00	5.00	8.25	7.18	7.00	2.375	6.75	.625	4.00	4200
5012Z	COUPLED	1800	83.00	45.75	40.00	5.00	12.25	7.18	7.00	4.125	6.75	1.000	5.00	4500
(1)														

MOTOR CONDUIT BOX "AA"		
MAXIMUM FULL LOAD AMPERES	T.E.F.C.	T.E.F.C. X/T
201	4.0 CONDUIT	4.0 N.P.T.
335	5.0 CONDUIT	5.0 N.P.T.
600	6.0 N.P.T.	6.0 N.P.T.

(1) SPECIAL DIMENSIONS ON THIS LINE.
(2) THIS DIMENSION VARIES +.00 -.06
(3) THIS DIMENSION VARIES +.000 -.001
(4) "AA" VARIES WITH F.L. AMPS. SEE TABLE.
(5) WALL OR OBSTRUCTION MUST NOT ENCROACH ON AIR INLET SPACE.
(6) 2" N.P.T. FOR WINDING TEMPERATURE DETECTOR LEADS. WHEN ORDERED.
(7) 3/4 N.P.T. FOR BEARING TEMPERATURE DETECTOR LEADS. WHEN ORDERED.

CONDUIT BOX CAN BE ROTATED 360° IN 90° STEPS. A/F BRGS.. CONDUIT BOX LOCATED ON OPPOSITE SIDE WHEN F-2.W-1.W-4.W-5. W-7 OR C-1 MOUNTING IS SPECIFIED.

IF MOUNTING CLEARANCE DETAILS ARE REQUIRED. CONSULT FACTORY.

MAXIMUM PERMISSIBLE SHAFT RUNOUT WHEN MEASURED AT END OF STD. SHAFT EXTENSION IS .003 T.I.R.

FRAME- _____ TYPE- _____ CERTIFIED FOR- _____

ORDER- _____ ITEM- _____ HP- _____ RPM- _____ PH- _____ HZ- _____ VOLTS _____

RELIANCE SALES ORDER- _____ APPROVED BY- _____ DATE _____

RELIANCE ELECTRIC
CLEVELAND, OHIO 44117 U.S.A.

DR. BY	E.JAMBOR
CK. BY	C.BLALOCK
APP. BY	W.L.SUBLER
DATE	12-8-87

DIMENSION SHEET

608980-559

ISSUE DATE DECEMBER 8, 1987

C/R

ENG. REF. S.O.#VA003414 & 3415

REL. S.O.	FRAME	HP	TYPE	PHASE/ HERTZ	RPM	VOLTS
VA-Q3414	E5010Y	200	P	3/60	1789	575

AMPS	DUTY	AMB°C/ INSUL.	S.F.	NEMA DESIGN	CODE LETTER	ENCL.
182	CONT	40/F	1.15	Special	J	TEFC-XT

E/S	ROTOR	TEST S.O.	TEST DATE	STATOR RES.@25°C OHMS (BETWEEN LINES)
611452-4-R	611413-10-TE	---	---	.0161

PERFORMANCE

LOAD	HP	AMPERES	RPM	% POWER FACTOR	% EFFICIENCY
NO LOAD	0	55.6	1800	8.37	0
1/4	50.0	74.1	1797	57.2	88.5
2/4	100	106	1795	76.1	93.2
3/4	150	142	1792	83.9	94.6
4/4	200	182	1789	86.7	95.1
5/4	250	225	1786	87.5	95.1

SPEED TORQUE

	RPM	TORQUE % FULL LOAD	TORQUE LB.-FT.	AMPERES
LOCKED ROTOR WYE CONNECTION	0	71	401	447
PULL UP WYE CONNECTION	0	77	401	446
BREAKDOWN WYE CONNECTION	1740	81	461	194
FULL LOAD DELTA CONNECTION	1789	100	587	182

AMPERES SHOWN FOR 575. VOLT CONNECTION. IF OTHER VOLTAGE CONNECTIONS ARE AVAILABLE, THE AMPERES WILL VARY INVERSELY WITH THE RATED VOLTAGE

REMARKS: CALCULATED DATA AT DELTA CONNECTION EXCEPT AS NOTED.

RELIANCE ELECTRIC
CLEVELAND, OHIO 44117 U.S.A.

DR. BY P.L.HOWER
CK. BY J.WACHOB
APP. BY F.HEREDOS
DATE 11-21-87

A-C MOTOR PERFORMANCE DATA

V54959.211

ISSUE DATE 11/21/87

REL S.O. VA-Q3414 | RPM 1789 | S.F. 1.15 | ROTOR 611413-10-TE

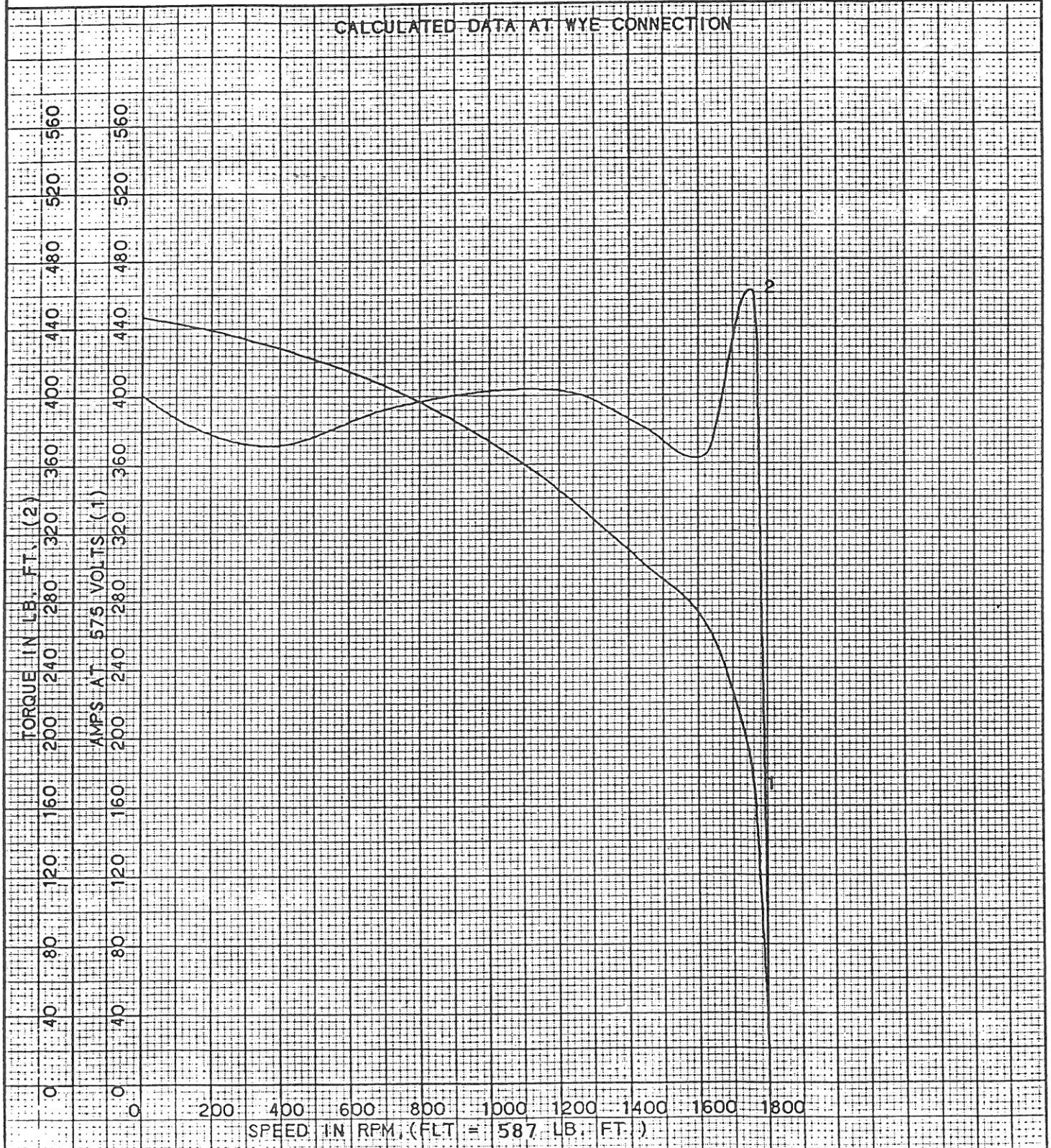
FRAME E5010Y | VOLTS 575 | NEMA DESIGN Special | TEST S.O. ---

HP 200 | AMPS 182 | CODE LETTER J | TEST DATE ---

TYPE P | DUTY CONT | ENCLOSURE TEFC-XT | STATOR RES.@ 25°C .0484 OHMS (BETWEEN LINES)

PHASE/HERTZ 3/60 | AMB°C/INSUL 40/F | E/S 611452-4-R

CALCULATED DATA AT WYE CONNECTION



AMPERES SHOWN FOR 575 VOLT CONNECTION, IF OTHER VOLTAGE CONNECTIONS ARE AVAILABLE, THE AMPERES WILL VARY INVERSELY WITH THE RATED VOLTAGE.

RELIANCE ELECTRIC
CLEVELAND, OHIO 44117 U.S.A.

DR. BY P.L.HOWER
CK. BY J.WACHOB
APP. BY F.HEREDOS
DATE 11-21-87

A-C MOTOR PERFORMANCE CURVES

V54959.211

ISSUE DATE 11/21/87

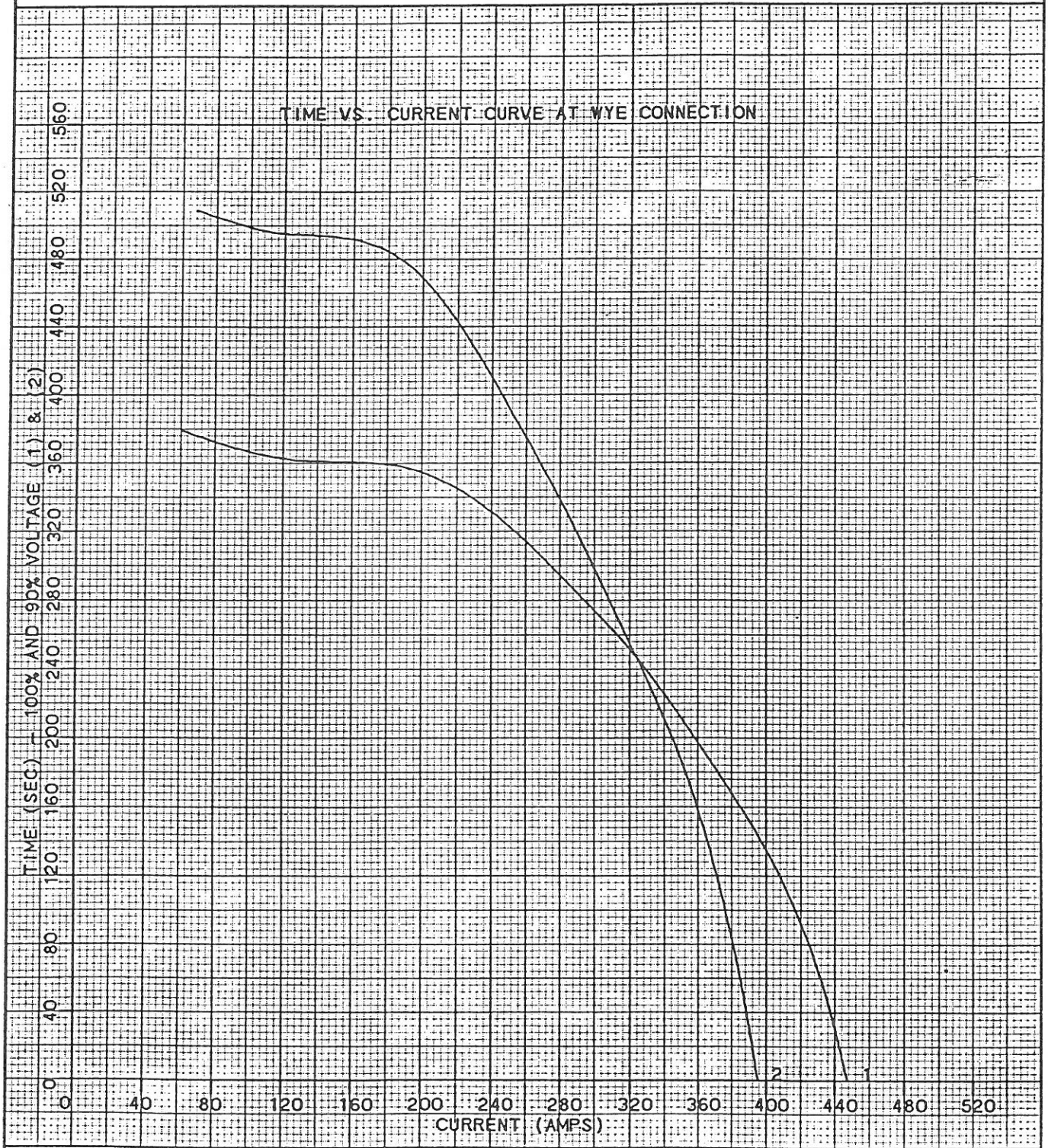
REL S.O. VA-Q3414 | RPM 1789 | S.F. 1.15 | ROTOR 611413-10-TE

FRAME E5010Y | VOLTS 575 | NEMA DESIGN Special | TEST S.O. ---

HP 200 | AMPS 182 | CODE LETTER J | TEST DATE ---

TYPE P | DUTY CONT | ENCLOSURE TEFC-XT | STATOR RES. @ 25°C .0161

PHASE/HERTZ 3/60 | AMB°C/INSUL 40/F | E/S 611452-4-R | OHMS (BETWEEN LINES)



AMPERES SHOWN FOR 575 VOLT CONNECTION. IF OTHER VOLTAGE CONNECTIONS ARE AVAILABLE, THE AMPERES WILL VARY INVERSELY WITH THE RATED VOLTAGE.

RELIANCE ELECTRIC
CLEVELAND, OHIO 44117 U.S.A.

DR. BY P.L.HOWER
CK. BY J.WACHOB
APP. BY F.HEREDOS
DATE 11-21-87

A-C MOTOR PERFORMANCE CURVES

V54959.211

ISSUE DATE 11/21/87

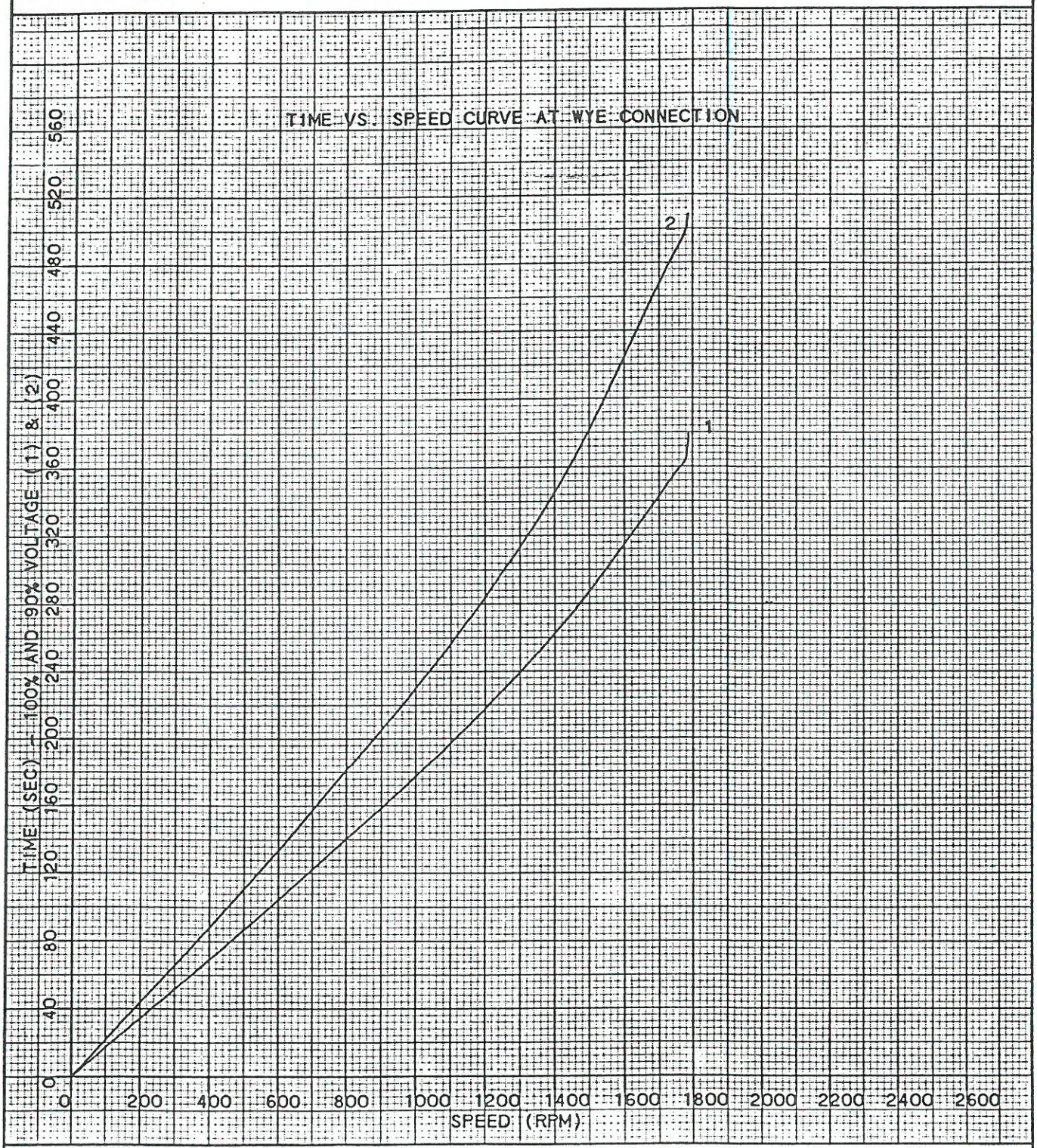
REL S.O. VA-Q3414 | RPM 1789 | S.F. 1.15 | ROTOR 611413-10-TE

FRAME E5010Y | VOLTS 575 | NEMA DESIGN Special | TEST S.O. ---

HP 200 | AMPS 182 | CODE LETTER J | TEST DATE ---

TYPE P | DUTY CONT | ENCLOSURE TEFC-XT | STATOR RES.@ 25°C .0161

PHASE/HERTZ 3/60 | AMB°C/INSUL 40/F | E/S 611452-4-R | OHMS (BETWEEN LINES)



AMPERES SHOWN FOR 575 VOLT CONNECTION, IF OTHER VOLTAGE CONNECTIONS ARE AVAILABLE, THE AMPERES WILL VARY INVERSELY WITH THE RATED VOLTAGE.

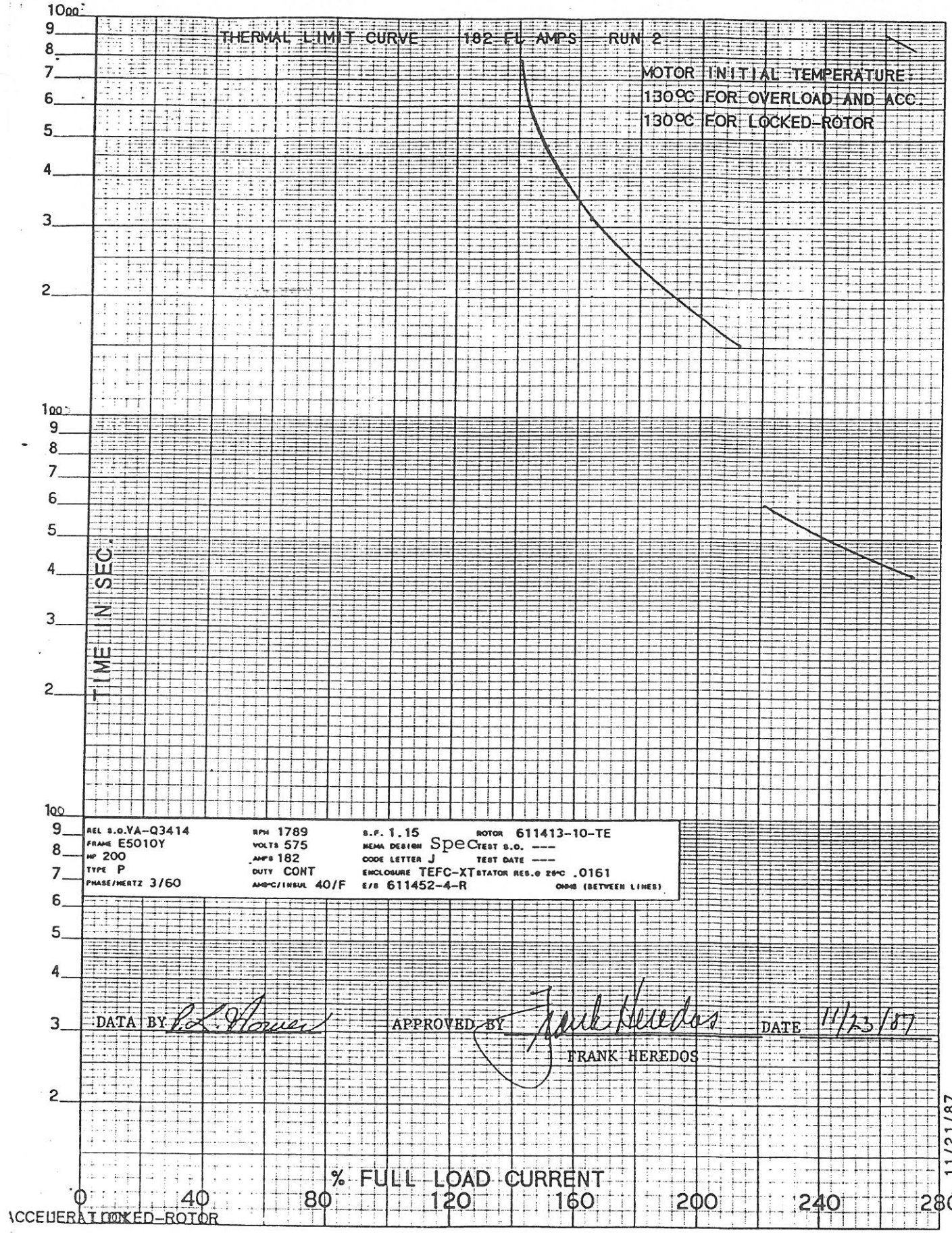
RELIANCE ELECTRIC
CLEVELAND, OHIO 44117 U.S.A.

DR. BY P.L.HOWER
CK. BY J.WACHOB
APP. BY F.HEREDOS
DATE 11-21-87

A-C MOTOR PERFORMANCE CURVES

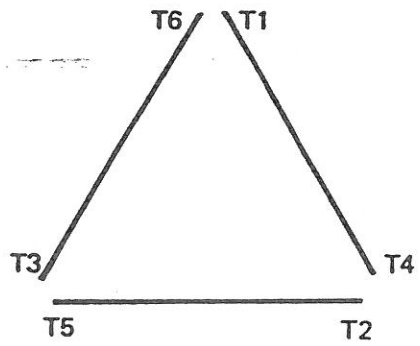
V54959.211

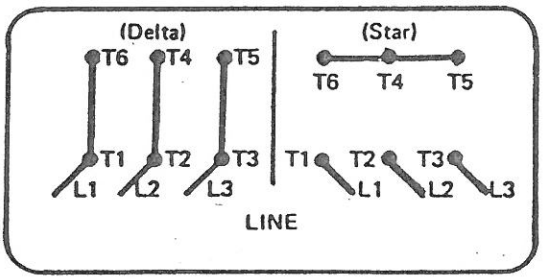
ISSUE DATE 11/21/87


THERMAL LIMIT CURVE 182 FL AMPS RUN 2
MOTOR INITIAL TEMPERATURE:
130°C FOR OVERLOAD AND ACC.
130°C FOR LOCKED-ROTOR
TIME IN SEC.
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
REL S.O. VA-Q3414
FRAME E5010Y
HP 200
TYPE P
PHASE/HERTZ 3/60
RPM 1789
VOLTS 575
AMPS 182
DUTY CONT
AMB°C/INSUL 40/F
S.F. 1.15
NEMA DESIGN Spec
CODE LETTER J
ENCLOSURE TEFC-XT
E/S 611452-4-R
ROTOR 611413-10-TE
TEST S.O. ---
TEST DATE ---
STATOR RES.@ 25°C .0161
OHMS (BETWEEN LINES)
DATA BY P.L. Howell
APPROVED BY Frank Heredos
FRANK HEREDOS
DATE 11/23/87
% FULL LOAD CURRENT
0
40
80
120
160
200
240
280
ACCELERATION
LOCKED-ROTOR
11/21/87

A-C MOTOR
CONNECTION DIAGRAM

STANDARD 6 LEAD **Y START-DELTA RUN**





(N.P. 1767-CD)

CUSTOMER _____ CUSTOMER ORDER NO. _____ RELIANCE S.O. NO. _____

C/R

RELIANCE ELECTRIC COMPANY
CLEVELAND, OHIO 44117 U.S.A.

DR. BY _____
CK. BY DCY
APP. BY _____
DATE 6/15/76

CONNECTION DIAGRAM **416820-8**

ISSUE DATE JUNE 15, 1976

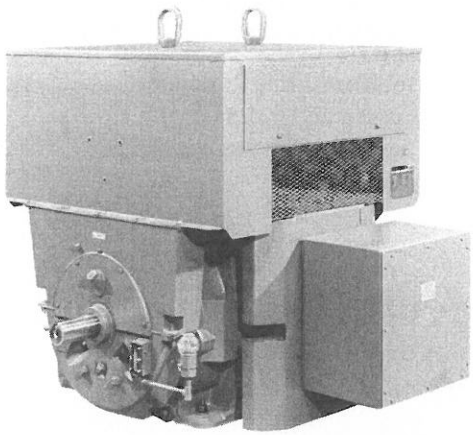
APRIL, 1986

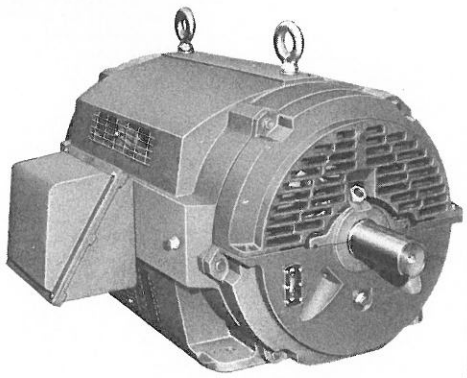
INSTRUCTION MANUAL B-3628-9

INSTALLATION, OPERATION AND MAINTENANCE OF

DUTY MASTER® LARGE A-C MOTORS

Frames E5000 thru E5800
Horizontal Mounting





RELIANCE ELECTRIC

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SECTION 1
GENERAL INFORMATION

INTRODUCTION

WARNING

HIGH VOLTAGE AND ROTATING PARTS CAN CAUSE SERIOUS OR FATAL INJURY. THE USE OF ELECTRIC MACHINERY, LIKE ALL OTHER UTILIZATION OF CONCENTRATED POWER AND ROTATING EQUIPMENT, CAN BE HAZARDOUS. INSTALLATION, OPERATION, AND MAINTENANCE OF ELECTRIC MACHINERY SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. FAMILIARIZATION WITH NEMA MG 2 SAFETY STANDARD FOR CONSTRUCTION AND GUIDE FOR SELECTION, INSTALLATION AND USE OF INTEGRAL HP MOTORS AND GENERATORS, NATIONAL ELECTRICAL CODE AND SOUND LOCAL PRACTICES IS RECOMMENDED.

These instructions do not purport to cover all details or variations in equipment nor to provide every possible contingency or hazard to be met in connection with installation, operation and maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchasers purposes, the matter should be referred to the Reliance Electric Company.

Reliance® Large Duty Master A-C Motors are designed and built to unique systems standards to provide you with a drive power system composed of matched components. Such a system is capable of delivering the horsepower, torque, speed and power efficiency characteristics that you need for your production machinery.

This systems approach was used not only in the design of the motor, but also in the state-of-the-art manufacturing used to produce and test these rugged and dependable machines. And it extends from the major assemblies such as rotors, stators, enclosures and insulation (all systems in themselves), even to the smallest component . . . carefully selected and mated for optimum performance. The result is a product that is, indeed, more than a motor . . . more like a system.

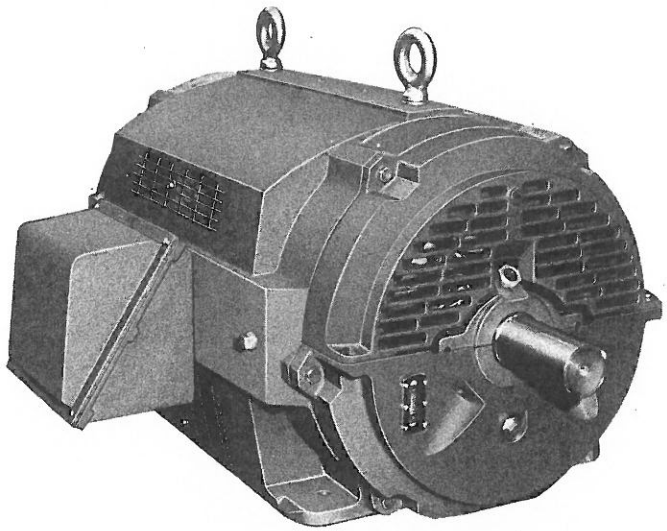
Reliance Large Duty Master A-C Motors are designed for easy disassembly, reassembly, and inspection. They are available with a variety of enclosures such as:

- Drip-proof protected.
- NEMA I weather protected.
- NEMA II weather protected.
- Force ventilated.
- Reduced noise levels.

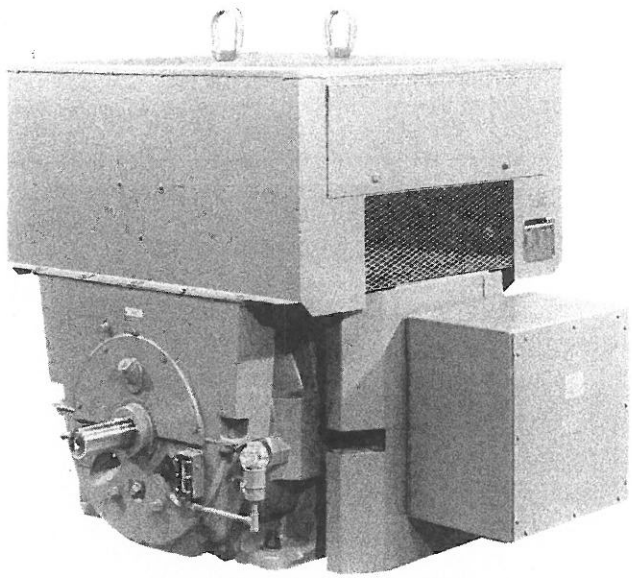
Although characteristics may vary from motor to motor, all major components are essentially identical. In addition, there are a number of available accessories:

- Bearing temperature detectors
- Winding temperature detectors
- Space heaters
- Lightning arresters
- Surge capacitors
- Oil sump heaters
- External oil pump systems (E5800)
- Vibration monitors
- Special conduit boxes

This manual contains the information and instructions that you will need to get the most out of your Reliance Large Duty Master A-C Motor. Please read it carefully and thoroughly before unpacking and installing.



E5000-E5800



E5800

Figure 1
Large Duty Master A-C Motors

RECEIVING AND ACCEPTING

WARNING

EYEBOLT(S) OR LIFTING LUG(S) ARE INTENDED FOR LIFTING THE MOTOR OR GENERATOR ONLY WITH THE STANDARD ACCESSORIES SUCH AS TACHOMETER, BRAKES, ETC., MOUNTED BY RELIANCE ELECTRIC. THE LIFTING MEANS ON THE MOTOR OR GENERATOR MUST NOT BE USED TO LIFT THE UNIT PLUS ADDITIONAL EQUIPMENT SUCH AS GEARS, PUMPS, COMPRESSORS, OR OTHER DRIVEN EQUIPMENT. THE LIFTING MEANS ON THE MOTOR OR GENERATOR CANNOT BE USED TO LIFT ASSEMBLIES OF MOTOR AND GENERATOR OR OTHER EQUIPMENT MOUNTED ON A COMMON BASE. THESE ASSEMBLIES MUST BE LIFTED BY OTHER LIFTING MEANS.

In all cases, care should be taken to assure lifting in the direction intended in the design of the lifting means. Lift using all lugs provided. Likewise, precautions should be taken to prevent hazardous overloads due to deceleration, acceleration or shock forces, Angle of lift with rope or chain never to be less than 45° from horizontal.

Upon receipt, thoroughly inspect the wrapping and crate for any signs of damage. If any damage is evident, do not accept the motor until the freight or express agent makes an appropriate notation on your freight bill or express receipt. If any concealed loss or damage is discovered later, notify your freight or express agent at once and request him to make an inspection.

STORAGE

Do not unpack until ready for use. If your motor is to be stored for any period of time prior to installation, it should be placed in an area which is clean, dry and warm. Severe humidity changes, extreme oil and dirt, fumes or other adverse conditions may, under certain conditions, damage motor insulation or electrical parts.

Whenever the storage area is cold and damp, or severe humidity changes exist, the space heaters (when provided) should be energized. Motors not equipped with space heaters may be kept warm by placing several 100- or 150-watt electric lamps within the motor enclosure and connecting them to a power supply.

Your motor should be inspected periodically and the insulation resistance checked (refer to page 15) and recorded monthly. If you measure a significant change in insulation resistance, it should be investigated and corrective action taken. Consult your local Reliance sales office for additional data.

Reliance grease-lubricated motors are shipped with the proper amount of grease in each bearing.

If the motor is stored for more than one month, the shaft should be rotated (by hand) at least once a month. This distributes the grease, preventing bearing corrosion due to condensation, or to the presence of contaminating gases near the motor.

If the motor is stored and directly exposed to weather conditions, it is important that the motor and grease be inspected for the presence of water. If the grease is contaminated with water, then the housing should be flushed out and new grease added. (See page 14 for recommended grease).

Reliance oil-lubricated motors are tested using an oil containing a rust inhibitor. This additive protects the bearings and associated structural parts from rust and corrosion. Prior to shipment the oil is drained.

As soon as the motor has been received, the bearing oil reservoir should be refilled to the indicated level with the proper lubrication oil. (See page 15).

If your motor is stored for more than one month, the shaft should be rotated by hand every month at least 10 to 15 revolutions to assure that an oil film is on the bearing surfaces.

Motors subjected to extended storage must be handled and treated per the requirements of Reliance Service Bulleting B-8078-3 available from your Reliance Electric District Sales Office.

SECTION 2
INSTALLATION

INSTALLATION

WARNING

INSTALLATION SHOULD BE IN ACCORDANCE WITH THE NATIONAL ELECTRIC CODE AND CONSISTENT WITH ALL LOCAL CODES. COUPLING, BELT, AND CHAIN GUARDS SHOULD BE INSTALLED AS NEEDED TO PROTECT AGAINST ACCIDENTAL CONTACT WITH MOVING PARTS. MACHINES ACCESSIBLE TO THE PUBLIC SHOULD BE FURTHER GUARDED BY SCREENING, GUARD RAILS, ETC. TO PREVENT PERSONNEL FROM COMING IN CONTACT WITH THE EQUIPMENT.

The assurance of a successful startup depends upon the use of good handling, inspection, and installation practices. The motor and driven equipment should be mounted on a rigid and flat surface. The need for closer alignment and heavier bases becomes more critical with higher speed operation and large motors. An experienced Rigger should be employed to handle all large motors.

HANDLING — Motors Without Hoods (Fig. 2 and 3)

Carefully uncrate the motor. Lifting provisions are either eyebolts on the top of the motor or integral lifting ears at the four corners. Place a lifting hook in each of the lifting devices and carefully lift the motor from its packing, using a hoist with adequate capacity.

WARNING

LIFTING MEANS ARE PROVIDED FOR HANDLING THE MOTOR, AND SHOULD NOT BE USED TO LIFT THE MOTOR PLUS ADDITIONAL EQUIPMENT SUCH AS GEARS, PUMPS, COMPRESSORS, OR OTHER DRIVEN EQUIPMENT. IN THE CASE OF ASSEMBLIES ON A COMMON BASE, ANY LIFTING MEANS PROVIDED ON THE MOTOR OR GENERATOR SHOULD NOT BE USED TO LIFT THE ASSEMBLY AND BASE BUT, RATHER, THE ASSEMBLY SHOULD BE LIFTED BY A SLING AROUND THE BASE OR BY OTHER LIFTING MEANS PROVIDED ON THE BASE. IN ALL CASES CARE SHOULD BE TAKEN TO ASSURE LIFTING IN THE DIRECTION INTENDED IN THE DESIGN OF THE LIFTING MEANS. LIKEWISE, PRECAUTIONS SHOULD BE TAKEN TO PREVENT HAZARDOUS OVERLOADS DUE TO DECELERATION, ACCELERATION OR SHOCK FORCES.

HANDLING — Motors with Hoods (Fig. 2 and 3)

Carefully uncrate the motor. Lifting provisions are either eyebolts on the top of the motor or integral lifting ears at the four corners. Place a lifting hook in each of the lifting devices and carefully lift the motor from its packing, using a hoist with adequate capacity.

CAUTION: To prevent damage to the top cover or to special hoods or enclosures, use a spreader bar where necessary.

INSPECTION

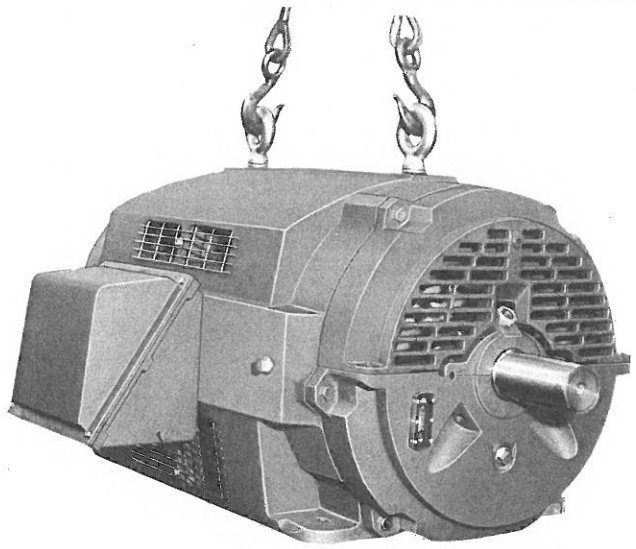
Before installing, make the following checks:

1. Inspect for any damage resulting from shipment. Refer to the paragraph on receiving and storage, page 1 and 2.
2. If the motor has been in storage for an extensive period or has been subjected to adverse moisture conditions, check the insulation resistance of the stator winding (refer to page 15).
3. Examine the motor nameplate data to make sure it agrees with the power circuit to which it will be connected. The motor is guaranteed to operate successfully at line frequency not more than 5%, and line voltage not more than 10%, above or below the nameplate ratings, or a combined variation of voltage and frequency of not more than 10% above or below nameplate ratings. Efficiency, power factor and current may vary from nameplate data.
4. Check to make sure that direction of motor rotation is correct for the intended application.

LOCATION

The motor must be located in an environment that satisfies *local codes* and National Board of Fire and Underwriter's regulations. The following additional considerations should also govern its location.

On open and protected motors, installation and location should be such that the equipment is in a clean area or a room with adequate ventilation for machines which are not equipped with filters. Neighboring equipment should be spaced so that



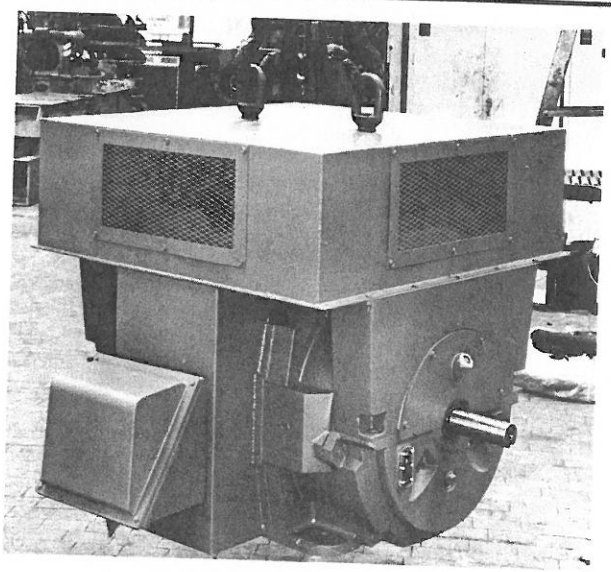


Figure 2

each motor is accessible for inspection, cleaning and repair. It is important for all machines that the external openings for ventilation are not obstructed in any manner that might limit the free passage of air.

Exposure to dirt, dust, stray oil, high ambient temperature and humidity, and atmospheric contamination should be avoided, if possible. Acids, alkalies and gases also have detrimental effects on electrical machinery.

If the room is not large enough to have natural ventilation, some external source of forced and filtered air will be necessary. The room should be such that the heat developed during operation can escape and will not be recirculated through the equipment.

Permanent handling equipment such as chain blocks or other lifting means are desirable to facilitate major service and repair without complete disassembly of the individual units.

CAUTION: On sleeve bearing designs care must be taken when using an external source of forced and filtered air to avoid an air pressure imbalance around the air inlet, air exhaust, and shaft extensions. Failure to maintain atmospheric pressure may result in bearing oil being sucked or blown out of the oil reservoir.

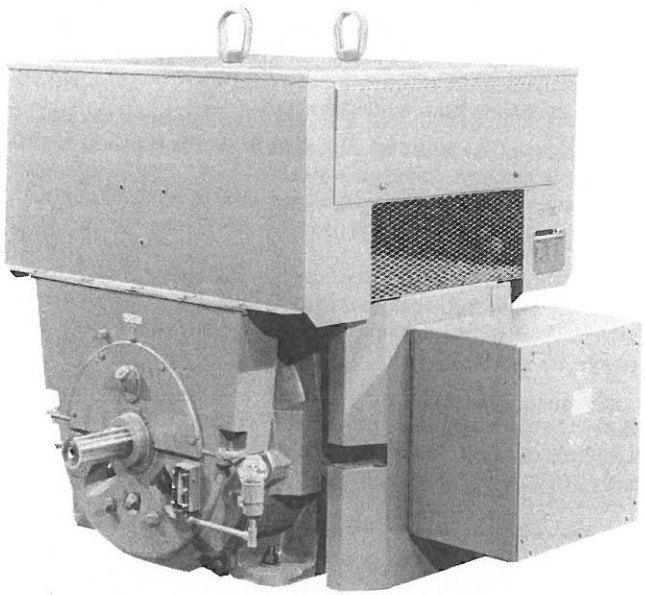


Figure 3

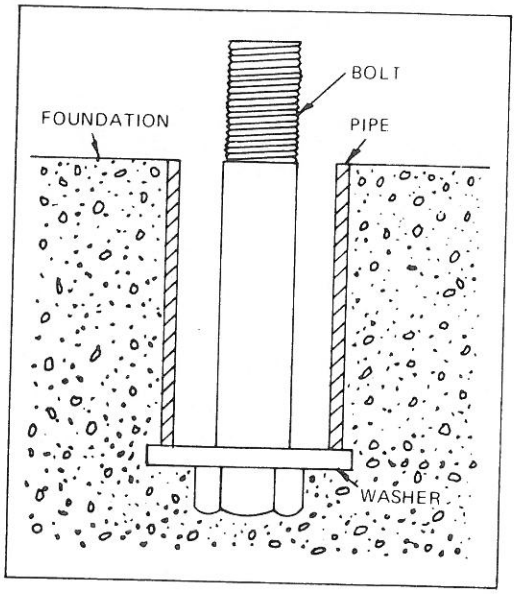


Figure 4
Suggested Foundation Bolt Installation

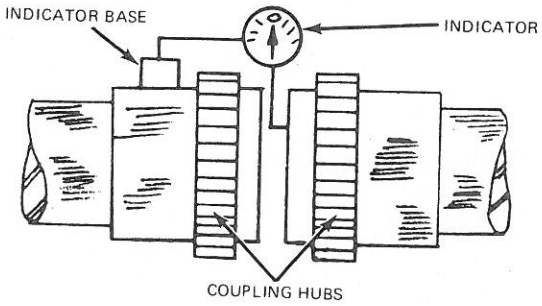


Figure 5
Measuring Angular Misalignment

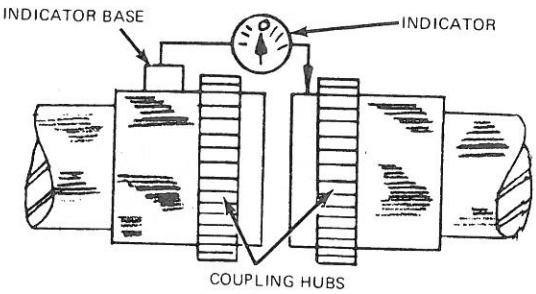


Figure 6
Measuring Shaft Runout

FOUNDATION

The dimensions for mounting are shown on the outline drawing supplied with the motor and should be referred to prior to planning of the foundation.

Large motors require a concrete foundation. The foundation should consist preferably of solid concrete walls or piers and should be carried down far enough to rest on a solid sub-base. This base should be of sufficient stiffness to prevent vibration and to insure long, trouble-free operation. If necessary, a consulting engineer, who is familiar with foundation design, should design and supervise its construction.

If the foundation is to be on steel girders instead of concrete, the girders should be well braced and supported by adequate columns to prevent vibration due to resonance. The natural frequencies of the motor and supporting structure must be at least 20% away from the speed of rotation and twice the speed of rotation.

The size of the foundation is determined by the weight, size and speed of the equipment and by the type and condition of the underlying soil. The width and length of the foundation are usually made to extend at least 6 inches *(150 mm)* beyond the equipment on all sides of the base. Increased width and weight are necessary for operation at higher speeds and for foundations that project about the floor level to give stability against rocking and resonant vibration.

Large motors are not rigid or self-supporting, and should be uniformly supported. Therefore, when set on the foundation or base, adequate support should be provided by leveling plates and shims between the frame and the foundation, particularly at the points of loading; i.e., under the frame feet, and intersection points of the beams, as well as under long, unsupported sections of the base. The number of shims should be kept to a minimum. A few thick ones are preferred over many thin ones.

A 1-inch *(25 mm)* space should be allowed between the base and foundation for grouting. The concrete surface should be roughed to provide a good bonding surface. The lateral clearance for positioning the base can be made by providing a space around the holddown bolts, that are secured headdown to an anchoring washer. (Fig. 4) A sleeve may be used to form the hole when pouring the foundation around the bolt for the length between the anchoring washer and the top surface of the concrete foundation. The size and depth of the hole will depend upon the size of the motor and accuracy of the hole location. A template can be used to locate the holddown bolts. The bolts can be locked in place later, by filling the clearance hole with grouting.

PRE-INSTALLATION CHECKS

Before shipment, every Reliance motor is carefully leveled, end play checked on sleeve-bearing units and given a running test to check operation. The test includes balance and bearing temperatures. Although complete factory tests have been made, motors should be checked for any change resulting from improper handling during shipment or by the customer or by an unsatisfactory foundation. Failure to check or do the necessary work as mentioned above, will cause misalignment resulting in vibration and premature bearing failure.

Before the motor is checked for alignment, all shipping blocks and supports added at the factory, to prevent the rotating element from moving during shipping, should be removed. The shaft should turn over freely. The degree of accuracy required in the alignment depends on the rated speed of the machine. The greater the speed, the grater the care and accuracy necessary in the alignment.

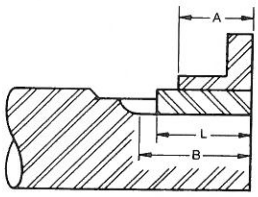
The motor must be level to maintain the proper oil level and free-turning oil rings. Check the driven equipment to make sure that the motor will be coupled to a level shaft. If necessary, level it up before coupling.

COUPLING

1. In preparation for making the coupling alignment, wash off the rust-protective slushing compound on the motor shaft and factory-installed couplings with solvent.

   On sleeve bearing motors, remove the masking tape from the shaft to expose the magnetic center and rotor float scribe lines.

2. The coupling should be heated for proper mounting. Do not press or drive it onto the shaft. The shaft extension key length should be sized per sketch below.



L = Key length
A = Coupling hub length
B = Keyway length

$$L = \frac{A + B}{2}$$

3. Motors supplied with sleeve bearings.

   The drive end shaft extension is scribed with three lines indicating the magnetic center line and rotor end float limits. A single scribe line, magnetic center only, is used in cases where the float extreme scribe lines would interfere with a shaft shoulder or extension keyway.

   The magnetic center scribe line is filled with a light colored paint and covered with masking tape prior to coating with rust protection. The distance from the magnetic center scribe line to the reference surface is indicated on a nameplate attached to the motor frame. The magnetic center is within ± 0.06 in. (± 1.5 mm) of the rotor float mechanical center.

   Rotor end float is 0.50 inch (12.7 mm) minimum. Sleeve bearing motors are not normally designed to withstand external axial thrust. A limited axial float coupling should be used. Total end float of the coupling should not exceed 0.19 inch (4.8 mm).

   The motor axial placement should be established by locating the shaft on its magnetic center and spaced from the driven equipment as recommended by the coupling manufacturer.

4. After the motor is properly positioned for axial end play —and with the hold-down bolts snug but not tightened prepare for the coupling alignment. Mount the coupling hubs, but do not engage the coupling.

COUPLING ALIGNMENT (Fig. 5 and 6)

There are a number of different procedures in aligning the motor to the driven equipment. The end result depends upon the accuracy of the parts in roundness, flatness, runout of the reference surfaces, rigidity of the mounting and the skill of the set-up man. The motor base surfaces must be flat and parallel to the shafts. Make allowance for inserting shims under the motor to make the elevation adjustment. The shims' size should be the full length of the motor-foot-pad, they should be flat, and free from burrs. Insert the shims carefully to maintain the foot plane and to avoid bending or twisting the motor frame. For a poor mounting surface, it may be necessary to machine a shim to compensate for the slope or surface irregularity. To minimize soft stacking, use the thickest shim stock combination with the fewest shims.

A preliminary line-up can be made with feeler gauge by measuring at top, bottom and sides between faces of the hubs. Angular alignment is satisfactory when there is no more than .002 in. *(0.05 mm)* difference between all sides of the hubs. Parallel alignment check can be made with a straight edge, or dial indicator, to determine if both hubs are parallel within 002 in. *(0.05 mm)*. During shimming, use shims that are as thick as possible to avoid a sponginess of an excessive number of layers.

COUPLING ALIGNMENT PROCEDURE

For more accurate alignment use two sets of indicators.

1. For angular alignment, Fig. 5, clamp a dial indicator to the motor coupling, hub and secure the probe against the end of the connecting shaft or face of the coupling.

> ***NOTE:*** *Do not rely on magnetic clamping only. Use additional positive clamping.*

   Check to verify that the support arm or the probe does not deflect under its own weight when the shaft is rotated. Repeat measurements until consistent readings are obtained. Mark the shaft at the point where the probe touches it, *and turn both shafts,* keeping the probe on the reference mark. Shoulder shaft to end of bearing float to maintain axial position.

2. Note the dial indicator reading at 0° (starting point), 90°, 180°, 270°. The total angular misalignment should not exceed one mil (0.001") per inch *(0.001 mm per millmeter)* of coupling hub radius. For checking the coupling face or shaft runout, hold the one shaft stationary and rotate the other shaft, if possible.

MAXIMUM PERMISSIBLE ANGULAR MISALIGNMENT = (Coupling Hub Radius in in. (mm)) x *(0.001 in. (mm))*

3. Check for excessive shaft parallel runout by using the accurately ground or machined diameter provided on most coupling hubs. Set up a dial indicator as shown in Figure 6, with the probe mounted securely on the machined diameter. Mark the shaft at the point where the probe touches it and turn both shafts keeping the probe on the reference mark. To check the shaft or coupling diameter runout, hold one shaft stationary and rotate the other shaft, if possible.

4. Note the dial indicator reading at 0° (starting point), 90°, 180°, 270°. THE MAXIMUM PERMISSIBLE RUNOUT BETWEEN THE TWO COUPLING HUBS IS 0.002 inch *(0.05 mm.)*

5. Tighten the motor and driven equipment hold-down bolts, and recheck alignment. The feet must be tightened down uniformly. Check to make certain that feet are on the same plane by measuring the feet springback when a bolt is loosened. It should not exceed 0.004 inch *(0.1 mm)* at any foot, as the others remain tight. Repeat with two adjacent bolts loose. The shaft springback should not exceed 0.001 inch *(0.025 mm).*

6. In some cases it may be necessary to make a hot alignment check to compensate for thermal expansion. A compensating offset alignment should be made cold. The unit may run rough until the equipment temperatures stabilize.

> **CAUTION:** Do not use the coupling to compensate for poor alignment. This can result in vibration, noise, coupling wear, overloaded bearings and early failure.

If for any reason the alignment of the set does not fall into line, contact the closest Reliance Electric District Office.

LUBRICATION

The lubrication system should be checked in preparation for rotating the shaft during the alignment operation.

ANTI-FRICTION BEARINGS (Grease Lubricated)

Bearing chambers are packed with grease during assembly, and do not normally need additional grease at time of installation, unless the unit has been in prolonged storage. See Repair Section 5 for bearing lubrication.

SLEEVE BEARINGS

Motors with sleeve bearings are shipped from the factory without oil. CAUTION: OIL RESERVOIRS MUST BE FILLED DURING INSTALLATION.

Lubricating oils for sleeve bearing motors should be selected as follows:

1. Viscosity in SUS *(centistokes)* at 100° F. *(37.8° C):*

Ambient Temperature Range**	Speed	
	600 RPM or Less	Over 600 RPM
0° to 120° F* *(-18° C to 50° C*)*	300 SUS *(68 cSt)*	150 SUS *(32 cSt)*
-20° to 50° F *(-30° C to 10° C)*	*150 SUS (32 cSt)*	*90 SUS (18 cSt)*

* For higher temperatures, oil coolers should be used.
** For lower temperatures, heaters should be used to assure adequately high starting temperature.

TABLE I.

2. Pour Point: Below minimum starting temperature.

3. Quality: Use a good grade of turbine type oil, with rust, foam, and oxidation inhibitors. Avoid automotive oils or additives other than those specifically recommended by the oil manufacturer.

   To fill sleeve-bearing motor oil reservoirs on motors not equipped with constant level oilers, be sure that drain plugs are in place and secure, and fill through filler cap until oil level shows at top line marked on oil gauge. Oil level must never be below bottom line marked on oil gauge. For motors with constant level oilers, refer to the instructions. See Accessories Section.

ELECTRICAL CONNECTION

> **IMPORTANT! Motor and control wiring, overload protection, and grounding should be in accordance with the National Electrical Code and consistent with local code requirements.**

A conduit box may be provided for the power lines to the stator and other conduit boxes for all other electrical connections.

Provisions for grounding the frame are provided in the form of tapped holes.

> **WARNING**
>
> **FAILURE TO PROPERLY GROUND THE MOTOR MAY CAUSE SERIOUS INJURY TO PERSONNEL.**

GROUNDING

All large motors should be grounded with the grounding conductor equipped with a brazed copper terminal, or with a suitable solderless terminal fastened to the motor. Solder terminals should not be used. A washer should be used between bolt head and terminal lug. The other end should be fastened with suitable clamps or terminals to rigid metallic conduit or to the nearest available ground. Grounding conductor size should be in accordance with National Electrical Code Table 250-95 reproduced below.

Attachment to the motor should not be made under a foot bolt head.

SIZE of EQUIPMENT GROUNDING CONDUCTORS for GROUNDING INTERIOR RACEWAY and EQUIPMENT

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Size	
	Copper Wire No.	Aluminum or Copper-Clad Aluminum Wire No.*
15	14	12
20	12	10
30	10	8
40	10	8
60	10	8
100	8	6
200	6	4
400	3	1
600	1	2/0
800	0	3/0
1000	2/0	4/0
1200	3/0	250 MCM
1600	4/0	350 MCM
2000	250 MCM	400 MCM
2500	350 MCM	500 MCM
3000	400 MCM	600 MCM
4000	500 MCM	800 MCM
5000	700 MCM	1000 MCM
6000	800 MCM	1200 MCM

*For installation restrictions see Section 250-92 (a).

TABLE 250-95.

GROUTING

Grout should be used, but should not be applied until all alignment and leveling have been completed, and the set is running satisfactorily — from the bearing noise, temperature and vibration standpoint — after the 4-hour run-in test. A good quality commercial non-shrinking type of grouting compound should be used. A cement/sand ratio of 1:1 is recommended.

Grout should be used with a minimum quantity of water to give a stiff mix. The roughened concrete surface should be washed to remove the dust and loose particles. Grouting should be applied to a wet surface but to assure a good bond, there must be no puddles of water or contamination from oil or grease. Prepare only the amount that can be handled within set time and without adding water to the original mix.

The grouting should be done quickly and continuously. Tamp in place and vent the pockets to assure a solid casting. It is suggested that the motor remain idle while the grout is hardening. At least 48 hours curing time is desirable for the grout to develop adequate strength before operating this set, or any nearby large equipment which could create a vibration.

ACCESSORIES

WINDING RTD — RESISTANCE TEMPERATURE DETECTOR

Purpose

To measure or monitor winding temperature during operation.

Principle of Operation

The RTD uses a wire wound in a flat ribbon coil. It is wound so that it is a non-inductive device. Its mode of operation is that of a linear change in resistance with tempearture changes.

Construction

The RTD is a flat strip approximately .030" *(0.76 mm)* thick, width is as wide as stator slot and length as defined by NEMA. The RTD wire coil is sandwiched between two layers of flexible glass and resin. Reliance Electric uses a three wire RTD so it can be used in lead resistance cancellation bridge circuits.

Installation

Reliance Electric installs two (2) RTD's per phase, six (6) in total. Each RTD is located between the top and bottom coils in the slot. The small gauge RTD leads from the detector are terminated at a terminal strip located inside the motor enclosure. From this terminal strip, large gauge leads needed for ruggedness of installation, are brought out to a separate conduit box.

Customer Inter-Connect

RTD leads are supplied in a separate conduit box. Leads are tagged. One side of the customers bridge circuit should be grounded. This can be done either at the motor terminal box or at the instrumentation end of the circuit. Any dangerous voltages that might appear on the circuit due to any type of insulation breakdown will then be passed to ground.

Types Available

Reliance Electric standard is 100 ohms @ 0° C. The wire element is platinum.

Standard optional available are either 120 ohms Nickel @ 0° C, 10 ohms Copper @ 25° C. Dual element RTD's are available on special order.

Remarks

1. Can provide either continuous temperature **measuring** or temperature **monitoring.**
2. Needs a separately mounted control and power source to read temperature or to provide a means for relay operation (for either alarm or motor shut down features.)
3. Temperature can be monitored using an ohm meter or a resistance bridge and converting the resistance (after subtracting lead resistance) to temperature by using the appropriate conversion tables for the element type.

WINDING THERMOSTAT

Purpose

To warn of excessive winding temperature.

Principle of Operation

The thermostat uses a bi-metal snap action disc to operate a set of contacts. The operating temperature is factory selected and non-adjustable. The contacts can be wired directly to a relay to provide either alarm indication or motor shut down features. Means of temperature measuring or monitoring cannot be provided with this device.

Construction

Reliance Electric uses a hermetically sealed switch which is married to a temperature collector strip. The switch has a set of integral contact terminals, leads are connected and brought out to a separate conduit box.

Installation

Reliance Electric installs one thermostat in motor coil head. The temperature collector strip is woven inbetween several coils.

Customer Inter-Connect

Leads terminate in a separate conduit box. Leads are tagged.

Types Available

Reliance Electric's standard is a thermostat with one set of normally closed contacts that open on increased temperature. Operating temperature is factory selected and non-adjustable.

Temperature setting 115° C
Contact Rating A.C., D.C.

Available on special order:

More than one switch
Different temperature settings

Remarks

1. Cannot be used to measure or monitor temperatures.

2. Can be directly wired to motor starter hold in coil relay to provide motor shut down due to excessive temperature.
3. Can be wired directly to an alarm circuit without the use of a separate relay.
4. Can be used for A.C. or D.C. operation.
5. The thermostat provides a thermally automatic reset feature. The snap action automatic reset failure can cause difficulty in troubleshooting unless it is connected to a manual reset relay.

WINDING THERMOCOUPLE (T/C)

Purpose
To measure or monitor winding temperature.

Principle of Operation
The T/C uses a junction of two dis-similar metals to generate a voltage varies linearly with change in junction temperature.

Construction
The T/C is located between two layers of flexible glass and resin. The assembly is normally approximately .050 in. *(1.25 mm)* thick and as wide as the slot.

Installation
Reliance Electric installs two T/C's per phase, six (6) in total. Form wound motors have the bi-metal junction located between the top and bottom coil sides in the slot. The T/C wire is interrupted by a terminal strip located inside the motor enclosure, allowing for replacement of the T/C wire in case of damage.

Customer Inter-Connect
Using same type of T/C wire, connect to leads supplied in separate conduit box. Leads are tagged.

Types Available
Reliance standard is Iron-Constantan

Available upon special order:

1. Copper - Constantan
2. Chromel - Alumel
3. Chromel - Constantan

Remarks

1. Can provide either continuous temperature measuring or temperature monitoring.
2. Can measure temperature by using a potentiometer and converting from voltage to temperature by using proper conversion tables.
3. Needs separately mounted control and power source to read temperature or to provide a means of relay operation for either alarm or motor shut down features.

WINDING THERMISTORS

Purpose
To warn of excessive winding temperature.

Principle of Operation
Device is a semiconductor that changes its resistance abruptly at a certain temperature. The change is used to trigger a switching action in an associated circuit which provides an alarm or shutdown signal.

Installation
Thermistors can be installed in either the coil head or slot between top and bottom coil sides. Reliance Electric standard is to install six: in the slot on form wound stators and in the coil heads on random wound stators. A controller, included in thermistor package is mounted in an accessory conduit box.

Customer Inter-Connect
Thermistor leads are brought to a terminal strip located inside the motor enclosure. Separate leads continue to the controller, located in the accessory conduit box, where customer connections are made.

Types Available
Reliance standard is 155° C switching temperature thermistors for use in coil heads of random wound stators. Other switching temperatures are available by special order. Types for installation in form wound stator slots, between top and bottom coil sides, also available on special order.

Remarks
Cannot be used to measure or monitor winding temperature.

BEARING RTD — RESISTANCE TEMPERATURE DETECTOR

Purpose
To measure or monitor bearing temperature during operation.

Principle of Operation
The RTD uses a wire wound in a coil. It is wound so that it is a non-inductive device. Its mode of operation is that of a linear change in resistance with temperature.

Construction
The RTD coil is located inside of a 3/16 inch *(4.76 mm)* diameter stainless steel tube. Reliance Electric's standard is a tip-sensitive RTD. A special fitting is used which provides both oil sealing features and a quick disconnect spring loading to assure the RTD is always in contact with the bearing.

Installation
Reliance Electric installs one RTD per bearing. The tip of the RTD is in actual contact with the bearing. The small gauge RTD leads are protected with a metal armored sheath and are terminated in a terminal strip inside a separate conduit box.

Customer Inter-Connect
A terminal strip is supplied inside the conduit box. Leads are tagged.

Types Available
Reliance Electric standard is 100 ohms @ 0° C, tip-sensitive. The wire element is platinum. Also available are either 120 ohms @ 0° C, 10 ohms @ 25° C.

Also available upon **special order:**

1. Insulated tip-sensitive.
2. Dual elements within one tube.
3. On sleeve bearing motors the tip can be located in close proximity of bearing babbit, (within approximately 1/8 inch) *(3 mm).*

Remarks
1. Can provide either continuous temperature measuring or temperature monitoring.
2. Needs a separately mounted control and power source to read temperatures or to provide a means of relay operation for either alarm or motor shut down features.
3. Temperature can be monitored using an ohm meter or a resistance bridge and converting the resistance (after subtracting lead resistance) to temperature by using the appropriate conversion tables for the element.

BEARING THERMOCOUPLE — T/C

Purpose
To measure or monitor bearing temperature during operation.

Principle of Operation
The T/C uses a junction of two dis-similar metals to generate a voltage which varies linearly with change in junction temperature.

Construction

The bi-metal junction is located inside a 3/16 *(4.76 mm)* diameter tube. Reliance Electric's standard is a tip-sensitive T/C. A special fitting is used which provides both oil sealing features and a quick disconnect, spring loaded to assure the T/C is always in contact with the bearing.

Installation

Reliance Electric installs one T/C per bearing. The tip (bi-metal junction) is in actual contact with the bearing. The small gauge T/C wires are protected with metal armored sheath and are terminated at a terminal strip inside their separate conduit box. Each bearing T/C has its own conduit box.

Customer Inter-Connect

Using the same type of T/C wire, connect to terminal strip posts in separate conduit box. Leads are tagged.

Types Available

Reliance Electric standard is Iron-Constantan

Available on special order:

1. Copper - Constantan, Chromel - Alumel, Chromel - Constantan
2. Tip grounded (copper wire) in any type above with uninsulated bearings
3. Insulated tip-sensitive

Remarks

1. Can only provide continuous temperature measuring or temperature monitoring.
2. Can also measure temperature by using a potentiometer and converting voltage to temperature by use of the proper conversion tables.
3. Needs separately mounted control and power source to read temperature or to provide a means of relay operation for either alarm or motor shut down features.

BEARING THERMOSTAT

(Also called Bearing Temperature Relay or Gas Bulb Switch)

Purpose

To warn of excessive bearing (anti-friction) or oil (sleeve) temperatures.

Principle of Operation

The device operates due to the expansion of gases sealed within a sealed gas bulb element which is placed in contact with the bearing housing (anti-friction) or in the oil contained in the oil sump (sleeve bearing). As the temperature of the bearing or oil increases, the gas in the element expands and deflects a diaphram in the switch. The movement of the diaphram activates the switch contacts. The contacts can be wired directly to a relay to provide either alarm indication or motor shutdown.

Construction

The thermostat consists of a set of normally closed or normally open contacts operated by a diaphram which is connected to a gas bulb through a capillary tube.

Installation

The gas bulb must be mounted horizontally or vertically pointing downward. The gas bulb must be in contact with the bearing housing (anti-friction bearing) or submersed in the oil (sleeve bearing) for proper operation.

Type Available

Reliance Electric standard has normally closed contacts. Contacts operate on increasing temperature. Available upon special order:

1. Thermostat with normally open contacts
2. Various trip temperature settings

Remarks

1. The thermostat cannot be used to provide a read out of the bearing temperature.
2. The thermostat is equipped with a manual reset.
3. The thermostat contacts are rated for AC and DC.
4. The thermostat trip temperature is preset.
5. The thermostat is not an adequate device for continuous monitoring of bearing temperatures and therefore is not recommended by Reliance Electric as a reliable protective device.

BEARING THERMOMETER

Purpose

To measure directly the temperature of the oil in the bearing sump (sleeve bearing) or of the bearing outer race (anti-friction bearing).

Principle of Operation

The device operates due to the expansion of liquid in a sealed bulb and capillary tube system. Heat applied to the bulb, which is filled with expansible liquid, causes the liquid to expand through the capillary tube and actuate a bellows assembly. The bellows motion, in turn, actuates the control switch mechanism by means of a push rod. The motion of the push rod also actuates the temperature indicating system. The temperature indicator provides a continuous display of the temperature in question.

Construction

The control housing and cover assembly is of die cast aluminum. The unit is splash and dust resistant. Adequate space is available in the controller so that special switching may be installed for various circuit applications.

Installation

The liquid bulb is mounted horizontally or vertically pointing downward. The liquid bulb must be submersed in the oil (sleeve bearing) or in contact with the bearing housing for proper operation.

Available

A standard thermometer is not stocked by Reliance Electric and is not recommended as a reliable protective device.

Remarks

1. A standard thermometer is not stocked by Reliance Electric.
2. The bearing thermometer measures average oil sump temperature (sleeve bearing) or average bearing temperature (anti-friction bearings) and not hot spot temperature.

OIL CIRCULATION SYSTEM

Purpose

To provide a source of cool, clean oil to the bearings. (E5800)

Description

The oil lubrication system consists of provisions for introducing oil to the bearing and drains which will permit removal of excess oil in the sump without flooding or without letting the sump level become too low for the oil rings to pick up oil in the event the source of oil is lost.

It consists of modifications to the bearing to introduce oil into the journal area. A metering device which controls the amount of oil introduced to the bearing, and a modified sump which will provide adequate drain without total evacuation of the oil in the sump.

Requirement

The need for a lubrication system exists on some ratings due to the journal size and speed of the shaft. In those cases the unit would be supplied with inlet and outlet provisions as standard for connection to a customer provided source of oil.

Available options are:

1. Separately mounted pump and sump
2. Motor shaft mounted and driven pump and sump
3. Oil coolers for above sumps
4. Oil heaters and thermostats above sumps
5. Sump thermometers for above sumps
6. Oil filters for removing foreign material from the oil

The details of ratings requiring a lubrication system are shown on the rating and bearing data sheets.

SPACE HEATERS

Purpose

Space heaters are used to prevent condensation of moisture within the motor enclosure during shutdown or storage periods.

Construction

High quality, coiled nickel-chrome resistance wire is located with uniform spacing over the width and length, then embedded in high-grade refractory material which both insulates the wire and transfers heat rapidly to the sheath. Refractory is then compressed to rock hardness and maximum density under tremendous hydraulic pressure. The elements are oven-baked at high temperatures to semi-vitrify and mature the refractory.

Mounting

Space heaters are normally in the form of a flat or annular strip and are mechanically fastened to the inside surfaces of the frame.

Selections

Space heaters are selected using the following parameters.

1. Sheath temperature [350° F (200° C)] nominal maximum
2. Temperature rise inside of motor raised approximately 10° F *(6° C)* above ambient
3. Assume ambient maximum of 40° C

From the above, space heaters are sized, mounted and terminated at an accessory conduit box. Leads are tagged.

Explosion proof enclosures are available as a special option.

Approximate Space Heater Watts by Frame Size

E5000 — 400 Watts
E5800 — 500 Watts

WARNING

DISCONNECT POWER TO SPACE HEATERS BEFORE PERFORMING MAINTENANCE WORK ON MOTOR.

DIFFERENTIAL AIR PRESSURE SWITCH

Purpose

Differential Air Pressure Switch is used to indicate dirty or clogged air filters.

Principle of Operation

The switch is connected, through tubing or hoses, to static pressure probes located on the inlet and exhaust sides of the air filters. As the air filters become clogged during operation the static pressure drop across the filters will increase and the air flow through the motor will be reduced. The static pressure probes sense the change in static pressure drop across the filter and, as a result of this pressue imbalance, a diaphram in the switch body is deflected. The switch diaphram deflection will actuate the switch contacts.

Construction

The differential air pressure switch consists of a switch body that encloses a diaphram and contact switch connected to static pressure probes on either side of the filter through tubing and/or hose.

Features

The device is an indicator of reduced air flow (increased static air pressure drop) through the air filters. It cannot be used to measure actual air flow rates. Its primary function is as a maintenance aid to alert the user of the filter condition.

Availability

The standard device features an enclosed switch which is mounted on the outside of the motor.

An explosion-proof enclosure is optional.

Remarks

The switch contacts are preset to actuate at a static pressure differential of 0.5″ W.G. (This value indicates clogged filters).

The switch can be utilized to activate an alarm or shut down the motor.

DIFFERENTIAL AIR PRESSURE INDICATOR (MANOMETER)

Purpose

Differential Air Pressure Indicator (Manometer) is used to measure the static air pressure drop across the air filters which is an indication of the degree of blockage of the filter.

Principle of Operation

The Differential Air Pressure Indicator is an inclined-vertical manometer connected to static pressure probes, through tubing and/or hose, located on the inlet and exhaust sides of the air filters. As the air filters become clogged during operation, the static air pressure drop across the filters will increase and the liquid column level in the manometer tube will change. This change in liquid column level in the manometer is calibrated to indicate the static pressure drop in inches of water.

Construction

The differential air pressure indicator or gauge consists of an inclined-vertical manometer with a red oil liquid column connected to static pressure probes on either side of the air filter by means of tubing and/or hoses.

Features

The device is a continuous indicator of static air pressure drop across the air filters (i.e., reduced air flow volume). It cannot be used to measure actual air flow rates. Its primary function is as a maintenance aid to alert the user of the filter condition.

Availability

The standard device is a molded plastic manometer with an epoxy coated aluminum face plate and brass static pressure probes.

Remarks

The manometer scale is marked at the factory: green pointer at the clean filter pressure differential, red pointer at the dirt filter pressure differential level.

PRESSURE SWITCHES

Purpose

To warn of pressure below a set limit. This can be applied to oil pumps/oil systems or water coolers. (heat exchangers)

Description

The device consists of an adjustable sensor and contacts.

Installation

The device is connected into the system close to the pressure source using tubing and fittings as required.

The conduit box is provided for connections.

The device has a set of contacts and must be wired into an appropriate circuit to provide protection.

The device is set at the factory for safe operation. Adjustments can be made in the field to suit special conditions.

Standard
Square "D" model
Option — explosion-proof enclosure

INSULATED BEARINGS

Insulated bearings are used when the design of the motor dictates it or the application warrants the need of an insulated bearing.

Purpose
The purpose of an insulated bearings is to prevent damaging current flow across the oil or grease film which may damage the bearings and/or shaft.

Sources
The sources of bearing voltage or currents can be varied. Typical causes could be lack of symmetry in the stator configuration, segmental laminations, unequal winding sections or excessive rotor eccentricity (unequal air gaps). From the field application the sources could be from the driven equipment, including D.C. generators, control systems, etc.

Reliance Electric Standard
Insulated bearings are provided whenever test dictates the need. Sleeve bearing motors are insulated at the bearing. Anti-friction bearing motors are fitted with insulated sleeves in the bearing bracket.

Insulating Materials
Plasma sprayed alumina is used on sleeve bearings. B stage glass tape is used on sleeved anti-friction bearing brackets.

A nameplate notifies the customer of insulated bearings in the unit. This is to alert the customer so he can ground his driven equipment if necessary.

***NOTE:** If insulated bearings are required, insulated bearing temperature detectors will also be required.*

The following procedure is used to determine whether insulated bearings are required:

The motor is run at no load, uncoupled, at rated voltage. Using any standard volt meter with 1000 ohms per volt or greater the following levels should not be exceeded.

SLEEVE BEARINGS
100 Milli volts — Bearing to Bearing journal
300 Milli volts — Shaft end to Shaft end

ANTI-FRICTION BEARINGS
75 Milli volts — Bearing to Bearing journal
100 Milli volts — Shaft end to Shaft end

If the above levels are exceeded insulated bearings are required.

CONSTANT LEVEL OILER

Description
Constant level oilers are used as small supplementary oil sumps which provide an additional source of oil to replenish small amounts of oil lost by long term leakage. They provide this feature without changing the oil level in the sump.

Operation
The device is mounted on the side of a unit and is interconnected to the bearing housing. As oil in the bearing sump is lowered (due to leakage) the constant level device adds oil to a pre-determined level. The level is set at the factory and does not require any additional adjustments.

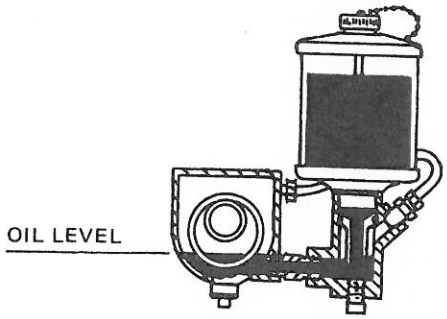


Figure 7
Constant Level Oiler Installation

Features
The device has the following features:

1. Auxiliary source of oil for make-up of oil due to leakage.
2. Provides an indication of rate of oil leakage by the change in oil level in the constant level oiler.
3. Gives a "quick look" assurance that oil is in the bearing without the need to get close to the housing or shaft.

Reliance Standard
Mfg. — *Oil rite* — Capacity 5 oz. *(148 ml.)*
Mounting — F1 or F2

CURRENT TRANSFORMERS

Description
Current transformers are a means of measuring or sensing current flow through the input leads of A.C. motors.

Construction
Current transformers consist of a laminated iron core with windings of a predetermined ratio for use with specific metering or relaying devices.

Application
Applications involve use of current transformers either for differential protection or metering line phase current.

Installation
The current transformers can be supplied and mounted in an oversize main motor conduit box.

The current transformers will be identified by ratio on the current transformers nameplate and will include screw type terminals on the secondary terminals.

Selection
The selection of the current transformers is based upon the ratio that the user requires for matching his meters or related instrumentation.

Availability
Due to the wide variety of ratios that can be specified, no standard stock can be provided.

Specification
If current transformers are required by the user the sales order should show the ratio required and intended application.

LIGHTNING ARRESTORS AND SURGE CAPACITORS

Description
Lightning arrestors serve to limit the crest value of incoming voltage surges. Surge capacitors tend to lengthen the rise time of the surge wave front reducing its effects on the stator winding.

Installation

Arrestors and/or capacitors can be mounted in an oversize main connection box. They are connected from line leads to ground, generally as near as possible to the motor.

Selection

Reliance Electric standard capacitance value for surge capacitors is 0.5 mtd. They are suitable for 25, 40, 50, or 60 Hz systems. Arrestors are selected according to the maximum RMS line to ground voltage.

AIR FILTERS

Filters will handle high-velocity air speeds up to 600 FPM *(3 ms)* net face-velocity. Resistance to air flow of a clean filter should not exceed 0.15″ W.G. *(37 N/m^2 gauge).*

Reliance Electric recommends that the filters be cleaned or replaced when the static air pressure drop across the filters reaches .50″ W.G. *(123.3 N/m^2* gauge).

Reliance Electric furnishes permanent, cleanable all metal filters as standard. Disposable filters can be furnished by special order.

SECTION III
OPERATION

PRE-OPERATION CHECK

Before starting the motor for the first time, the following checks must be made:

1. Check that the hold-down and bearing bracket bolts are tight.
2. If the motor has been idle for a long period of time after installation, check insulation resistance. Check sleeve bearings for shaft corrosion.
3. Check the incoming power to be sure that line voltage, frequency, and phase are correct for the motor (refer to the motor nameplate).

WARNING

DISCONNECT POWER BEFORE TOUCHING ANY INTERNAL PART. HIGH VOLTAGE MAY BE PRESENT EVEN WHEN THE MACHINE IS NOT ROTATING.

4. Inspect all electrical connections for correct termination, clearance, mechanical strength, and electrical continuity.
5. Check to be sure that the shipping brace (when provided) has been removed from the motor shaft.
6. On machines supplied with oil lubricated bearings inspect lubrication system to insure that oil reservoirs have been filled to the proper level with correct oil. Do not overfill oil reservoirs.
7. If possible, manually turn the shaft to make sure that it rotates freely.
8. Check direction of rotation by momentarily applying power to the motor. IMPORTANT: When the driven machine is likely to be damaged by the wrong direction of rotation, it is best to uncouple the motor from its load during the check for rotation and/or during the initial start.

   Some motors are designed for a single direction of rotation. Running those units in the wrong direction will deter air flow causing overheating. Check to see that both the motor and driven equipment are operating in the correct direction of rotation. If it is necessary to change rotation, remove all input power and interchange any two input power leads.
9. Replace all panels and covers.
10. Check to see that coupling guards and other protective enclosures are not blocking the ventilating air into the motor and exhaust openings.

INITIAL START

CAUTION: Check direction of motor rotation before coupling motor to load.

Read each of the steps in the following procedure over thoroughly, so that each is fully understood, before attempting to start the motor.

1. When alignment is correct and motor is properly lubricated, prepare for no load run uncoupled startup. The coupling should be uncoupled and a safety clamp should be on the sleeve away from the shaft hub.
2. Inspect the motor carefully. Make the initial start by following the regular sequence of starting operations in the control instructions.
3. After starting, check that the motor is running smoothly. If the motor shows excessive vibration, shut down immediately and investigate. Check for coupling and key unbalance, rusty bearing, lack of lubrication, foot planity, structural resonance.
4. Check that the oil rings, when supplied, are operating properly and that oil is being fed to the shaft. Check bearing temperatures frequently. They should not exceed 185° F. *(85° C).* Likewise the rate of temperature rise should not be excessive. At initial start, the bearing temperature rate-of-rise is more indicative of trouble than overall temperature for a minimum of two hours. If at any time the rate of rise curve appears too steep, stop the motor immediately and re-check its alignment.
5. Check to make sure that the protective controls are functioning properly before any prolonged operation.
6. Run the motor for at least two hours.

COUPLED START

After the initial start, assemble the coupling and lubricate with the manufacturer's recommended lubricant. Check to see that the coupling is not binding, the motor shaft is on its magnetic center and coupling axial movement is within the bearing float limit.

Try no load coupled startup, repeating procedures as outlined in the initial startup. Check to see that the driven equipment is not transmitting vibration back to the motor through the coupling or the base. Run unit for 4 hours and determine if the motor operates within the vibration and bearing temperature limits.

VIBRATION LIMITS

RPM	Maximum Amplitude* (Peak-To-Peak)	
3000-4000 Incl.	.001 in.	.025 mm
1500-2999 Incl.	.0015 in.	.038 mm
1000-1499 Incl.	.002 in.	.050 mm
999 and below	.0025 in.	.063 mm

*(Bearing Housing)

TABLE III.

Vibration severity and conversion of the above limits to velocity or acceleration can be determined by using the vibration nomographs in the back of this manual.

STARTING DUTY (Jogging and Repeated Starts)

CAUTION: Repeated starts and/or jogs can greatly reduce the life of an induction motor. If it is necessary to repeatedly start or jog a motor, check the application with your local Reliance Electric sales office.

At ambient temperature, the motor is normally capable of making two starts in succession and coasting to rest between starts.

The motor is also capable of making one start at its rated-load operation temperature. For cooling times required before additional starts can be made consult your local Reliance Electric Sales Office or the motor starting nameplate if one is provided.

If more starts than defined above are attempted in shorter periods of time, severe damage to the motor electrical windings and rotor may result.

The starting conditions listed above apply only if the inertia of the connected load, the load torque during acceleration, the applied voltage, and the starting method are those for which the motor was designed. For starting situations not covered here, consult your local Reliance Electric sales office before proceeding. Refer also to the nameplate on the motor listing starting conditions.

NOTE: *Maximum allowable time for operation under stalled or locked rotor condition is given on the motor's thermal limit curve.*

OPERATIONAL RUN

WARNING

REPLACE COVERS AND PROTECTIVE DEVICES BEFORE OPERATING.

Make final check out as required. Prepare for grouting the base. Realign, if necessary.

SECTION IV
ROUTINE MAINTENANCE

SCHEDULED MAINTENANCE

There are two inspection periods which are important to the proper operation and maintenance of your Reliance motor. These occur every 3 months (or 500 operating hours — whichever comes first) and every six months, respectively. In addition, the following should always be observed.

- Provide adequate ventilation
- Keep air and exhaust openings clean and free of obstructions.
- Avoid sharp blows and excessive axial thrust loads on the output shaft (particularly on sleeve bearing motors).
- Maintain proper lubricant level (check weekly on oil-lubricated units).

Reliance Large Duty Master A-C Motors when properly applied, are very easy to maintain. Since clearances and fits are precisely machined, there are no periodic mechanical adjustments to make. Like any precision machine, periodic inspection and simple routine maintenance will prolong your motor's life and help spot potentially damaging conditions before they assume the proportions of a disaster. The minimal time spent performing the simple procedures below cannot begin to compare with the cost of lost productivity and time consuming major repairs incurred through neglect of routine inspection and maintenance.

PERIODIC INSPECTION

Every 3 months (or 500 operating hours, whichever comes first).

1. Listen for any abnormal noises and check cause immediately.
2. Check for excessive vibration.
3. Check to see that air filters, when used, are in place and clean, and that air passages are not blocked or clogged.
4. Check to see that all covers are in place and secure.
5. Check for proper lubrication.
6. Check bearing temperature rise.
7. Check voltage and frequency variations. Unbalanced voltage of single-phase operation of polyphase motors will cause excessive heating and ultimately failure. Only a slight unbalance of voltage applied to a polyphase motor will cause large unbalance currents and resultant overheating. Periodic checks of phase, voltage, frequency, and power consumption of an operating motor are recommended. These checks can also provide an excellent indication of the load from the driven equipment. Comparisons of this data with previous no-load and full load power demands will given an indication of the performance of the driven machine.

WARNING

HIGH VOLTAGE. ELECTRIC SHOCK MAY CAUSE SERIOUS OR FATAL INJURY. DISCONNECT POWER BEFORE TOUCHING ANY INTERNAL PART. HIGH VOLTAGE MAY BE PRESENT EVEN WHEN THE MACHINE IS NOT ROTATING.

8. TURN OFF INPUT POWER and check to see that all electrical connections are tight.
9. Check for frayed points on interconnecting wiring, especially at points where it contacts the motor frame.

SEMI-ANNUAL MAINTENANCE

1. Inspect and clean rotor ends, windings and fan blades.
2. Check electrical connections for tightness and absence of corrosion.

BEARING LUBRICATION

Depending upon the application and ratings, your motor is equipped with either anti-friction or sleeve type bearings. When properly cared for (i.e., inspection and lubrication) bearings will provide years of uninterrupted service. Use one of the following lubrication procedures, depending on the type of bearings with which your motor is equipped.

Anti-Friction Bearings (Grease Lubricated)

Lubrication should be carried out on schedules outlined on the unit nameplate. If nameplate data is not available, use the following:

SPEED rpm.	SERVICE CONDITIONS*		
	Standard (Hrs.)	Severe (Hrs.)	Extreme (Hrs.)
1800 1200	4000	2000	1000
900 600	6000	3000	1500
3600	2000	500	350

Standard Conditions

Normal or light loading, clean 0° F *(-18° C)* to 104° F *(40° C)* ambient air temperature.

Severe Conditions

Medium shock, vibration dirt dust, -20° F *(-30° C)* to 120° F *(50° C)* ambient air temperature.

Extreme Conditions

Heavy shock, vibration greater than .44 in/sec., heavy dust, dirt, abrasives, corrosives and/or extreme ambient air temperatures.

Low: -65° F *(-54° C)* to 0° F *(-18° C)*
High: +120° F *(50° C)* and higher

Recommended Lubricant

Chevron SRI No. 2 — Standard Oil of California, or equivalent.

CAUTION: Some greases are not chemically compatible and should be checked with Reliance sales office.

Lubricate anti-friction bearings in accordance with the following procedure:

1. De-energize the motor, preferably by opening manual disconnect switches.
2. Remove relief plug. If grease is caked around the plug, clean with a wooden stick or suitable tool. If severe caking appears at the plug, run the motor until the bearing housing is warm, permitting a freer flow of grease through the housing.
3. Add grease with a low pressure grease gun — a hand operated gun is recommended.
4. Add a maximum of one cubic inch of grease or until fresh grease appears around the shaft or grease relief. Then start the motor and run with the relief plug open for several minutes until all excess grease is relieved.
5. Replace plugs and wipe off any excess grease.

Sleeve Bearings

Oil should be changed periodically (at least 6 months), or immediately if discolored or contaminated. Follow the schedule on the motor nameplate, or if not shown, use the following schedule:

LUBRICATION SCHEDULE

SPEED rpm.	SERVICE CONDITIONS*	CHANGE OIL
3600	Standard Severe	Every 6 mos. 2000 Hrs.
1800 & Lower	Standard Severe	Every 6 mos. 2000 Hrs.

TABLE V.

Service Conditions:

Standard Conditions:

Normal or light loading, clean 0° F *(-18° C)* to 104° F *(40° C)* ambient air temperature.

Severe Conditions

Medium shock, vibration, dirt dust, -20° F *(-30° C)* to 120° F *(50° C)* ambient air temperature.

Lubricating oils for sleeve bearing motors should be selected as follows:

1. Viscosity in SUS *(centistokes)* @ 100° F: *(37.8° C)*:

Ambient Temperature Range	Speed	
	600 RPM or Less	Over 600 RPM
0° F to 120° F *(-18° C** to 50° C*)*	300 SUS *(68 cSt)*	150 SUS *(32 cSt)*
-20° F to 50° F *(-30° C** to 10° C)*	150 SUS *(32 cSt)*	90 SUS *(18 cSt)*

TABLE VI.

* For higher temperatures, oil coolers should be used.

** For lower temperatures, heaters should be used to assure adequately high starting temperature.

2. Pour Point: Below minimum starting temperature.
3. Quality: Use a good grade turbine type oil, rust, foam, and oxidation inhibited. Avoid automotive oils or additives other than those specifically recommended by the oil manufacturer.

The procedure for changing oil is as follows:

1. De-energize the motor, preferably by opening the manual disconnect switches.
2. Remove drain plug and drain oil.
3. If oil appears to be contaminated, the housing can be flushed out by filling with fresh oil and draining again.
4. Replace plug and fill through filler cap until oil level indicated on oil sight gauge
5. Tighten caps and plugs, fill constant level oiler if provided.
6. Start unit and observe to be assured of no oil leakage.

Winding Maintenance

De-energize motor preferably by opening manual disconnect. To inspect the ends and outside surface of the windings, remove the endcover from the motor. Inspection of these portions of the windings will provide a good indication of their general condition. To thoroughly inspect and clean the windings it may be necessary to remove the rotor.

There are numerous methods for cleaning windings. The following methods are most commonly used, in order of preference. NOTE: Before cleaning the windings, check for loose blocking, evidence of damage to insulation, distortion or movement of coils, etc. If any of these conditions exist, contact your local Reliance Electric service engineer for recommendations.

Dry Wiping

This method is satisfactory when the surfaces to be cleaned are accessible and when only dry dirt is to be removed. Use a clean dry, lintless cloth. Do not use "waste" since the lint will adhere to the insulation and increase dirt collection. Lint is particularly objectionable on high voltage insulation systems as it tends to concentrate corona discharge.

Brushing and Suction Cleaning

Remove the dry dust and dirt by brushing with a bristle brush, followed by a vacuum suction cleaning. DO NOT USE WIRE BRUSHES.

Blowing

Dry dirt and dust can be removed from inaccessible crevices by using a jet of low pressure compressed air.

CAUTION: Do not use air pressures greater than 30 psi (200 kPa). Avoid directing the air in such a way that the dirt will be blown into inner crevices.

1. Avoid inhaling fumes
2. Protect eyes
3. Protect skin
4. Avoid flamible solvents

Solvent Cleaning

CAUTION: Do not use solvents to clean windings with Class H (silicone) insulation (See nameplate for type of insulation). Refer to "Cleaning With Water and Detergents" for proper method of cleaning silicone insulation.

Oil, grease, tar and wax can be removed by cloth wetted with solvent, followed by wiping with a dry cloth. Typical solvents which can be used are:

- Atlantic Safety Solvent
- Graymills Solvent
- De-Greaseall
- Zep
- Stoddard Solvent

WARNING

BE SURE TO ADHERE TO THE SOLVENT MANUFACTURER'S PRECAUTIONS.

Cleaning with Water and Detergent

Windings can be cleaned by hose washing or by a pressure spray from a low pressure steam generator or shop steam line.

CAUTION: Jet pressure and temperature should not exceed 30 psi (200 kPa) and 90° C respectively. Oil, grease, tar and wax can be removed by adding a NON-CONDUCTIVE DETERGENT to the wash water. After washing, it is advisable to dry the windings in an oven.

Reconditioning (Revarnishing) Windings

If after cleaning with solvent or water and detergent, the insulation shows signs of dryness, etc., it may be necessary to revarnish the windings. Consult your local Reliance service engineer for type and proper method of revarnishing.

Checking Insulation Resistance

If the motor has been in storage for an extensive period or has been subjected to adverse moisture conditions, check the insulation resistance of the stator winding with a megger or an insulation resistance meter. The minimum insulation resistance (Rm) can be determined from the following formula:

$$Rm = KV + 1$$

Where

Rm = Minimum insulation resistance in megohms at 40° C of the entire machine winding.

KV = Rated machine potential, in kilovolts.

For machines in good condition, insulation and resistance readings of 10 to 100 times Rm are not uncommon. If the insulation resistance is lower than that calculated from the formula, the winding should be dried out in one of these two ways:

1. Bake in an oven (preferably a circulating air oven) at a temperature not over 90° C until insulation resistance remains constant.
2. With the rotor locked, apply low voltage and gradually increase current through winding (do not exceed 50% full load amps) until winding temperature, measured with thermometer, reaches 90° C. Do not exceed this temperature.

SECTION V
TROUBLESHOOTING

TROUBLE	CAUSE	SOLUTION
Motor won't start	Motor improperly connected.	Check motor connection and control connections.
	Incorrect line voltage.	Check nameplate for required voltage. Measure voltage at motor terminals.
	Overload relay tripped.	Correct and reset.
	Fuses blown or defective.	Replace fuses.
	Open circuit in stator or rotor.	Check for open circuit.
	Short circuit in stator.	Check for short circuit.
	Grounded winding.	Check for ground.
Motor noisy.	Winding single-phased.	If winding is single-phased, unit will not start. Stop unit and try to restart.
	Loose mounting.	Check and correct.
	Noisy bearing.	Check and correct.
	Coupling halves loose.	Inspect alignment and tighten.
	Vibration.	Check alignment with driver disconnected. Check feet plane. Correct balance of motor rotor if necessary. Check key unbalance on coupling.
	Loose covers or pipe.	Tighten down.
	Uneven air gap.	Check gap.
Excessive bearing temperature (anti-friction bearing)	Excessive lubrication.	Clean out grease reservoir.
	Inadequate lubrication.	Add lubricant per nameplate instructions.
	Bent shaft.	Replace shaft.
	Coupling misalignment.	Realign unit.
	Inadequate internal clearance.	Incorrect replacement bearing – consult factory.
	Inadequate ventilation.	Clean filters. Check to see if louvers are blocked.
Excessive bearing temperature (sleeve bearing)	Inadequate oil supply.	Refer to nameplate requirements and correct. Check for proper fill, oil, leaks, gage level.
	Excessive end thrust.	Locate cause and eliminate. Check coupling float, shaft level, air baffle balance.
	Contaminated oil.	Draw and refill. If filters are provided, replace with new ones. Determine source of contamination and correct.
	Tight clearance.	Check bore and O.D. clearance.
	Bent shaft.	Straighten and refinish.
	Oil rings not functioning.	Check for damage or reason for binding – roundness, burrs, shaft level – and correct.

TROUBLE	CAUSE	SOLUTIONS
Excessive bearing temperature (sleeve bearing) Con't.	Bearing material torn.	Dress down, scrape, and refit.
	Rough shaft or corrosion.	Dress and polish shaft.
	Bearing misalignment.	Realign bearing or reseat bearing. Check feet flatness and reshim.
	Coupling misalignment.	Relign motor.
	Shaft current.	Insulate bearing and isolate shaft from ground.
Excessive temperature.	Overload.	Reduce load to nameplate rating or replace with larger unit.
	Restricted ventilation.	Check openings and duct work for obstructions and correct.
	Electrical	Check for grounded or shorted coils and unbalanced voltages between phases.
Oil leak. (sleeve-bearing units)	Overfilled.	Drain to proper level or adjust oiler elevation.
	Sealing surface of bearing cap not flat.	Stone or file flat, remove burrs.
	Screws loose.	Tighten down.
	Pipe fittings loose.	Retighten or replace worn threaded parts.
	Bearing air pressure equalizer vent passage clogged.	Clear out passage.
	Wrong sealing compound used on bearing cap surface.	Use Permatex Aviation type No. 3 or other non-hardening gasket sealer.
Oil leak. (pressure lube systems)	Too much oil flow in pressure lube system.	Reduce flow. (change oriface)
	Drain line too small.	Use larger lines.
	Air pressure unbalance.	Clear venting pipes.
Excessive vibration.	Coupling misalignment.	Realign to operating condition.
	Coupling unbalance.	Rebalance.
	Coupling key unbalance.	Rebalance.
	Foundation structure improperly designed.	Correct foundation or mounting base under motor. (See Foundation p. 5)
	Rotor unbalance.	Rebalance rotor.
	Worn bearing.	Replace bearing if bore oversized.
	Coupled equipment.	Check uncoupled, and if necessary, rebalance equipment.
	Shaft straightness.	Straighten without residual stress to avoid springback, or, replace shaft.

STATOR CORE REMOVAL — E5000, E5800 Frame

The stator core is located by a machined bore in the frame. The air gap is accurately maintained by this bore and the bearing bracket fits machined into the frame ends. The axial location of the stator core is set at the factory to align with the rotor core. The frame and stator core are then drilled, pinned and the pins are tack welded in place.

To remove the stator core, it is necessary to drill out the locking pins located on the top center rib and bottom center of the frame. Use caution in drilling to avoid drill penetration beyond the pin length. Damage to the core and coils can result if drill depth is excessive.

After the locking pins have been removed, the stator core and frame should be supported in a vertical position, suspended from a crane by the stator core lifting straps. Heat should then be applied to the frame to expand it and allow it to drop away from the stator core.

Heat the frame in an oven to allow sufficient expansion for reassembly at the stator core. Locate the core in the same axial position as originally set at the factory. Support the core until the frame is cooled, install new locking pins and tack weld them in place.

ROTOR REMOVAL

1. Follow same procedure as under bearing removal, pick proper bearing type, i.e., sleeve or anti-friction. Remove top cover; remove bearing housing.
2. Protect shaft journals by wrapping with heavy kraft paper or equivalent.
3. Fit a steel pipe or tube (proper inside diameter, length, and strength) over end of the rotor shaft opposite coupling end of shaft. Do not place pipe over journal, but locate it instead over portion of shaft adjacent to rotor core.
4. Attach rope slings (fastened to hoisting crane or chain hoist) to steel pipe and portion of shaft adjacent to coupling location.
5. Slowly and carefully move rotor through stator assembly until end of steel pipe extends beyond coupling end of stator assembly. Move hoist horizontally and vertically — in such a way that rotor does not slide against stator winding.
6. Wrap kraft paper around the shaft adjacent to end of steel pipe. Secure a rope sling to this wrapped-portion of shaft, and attach sling to an additional hoist (or to same hoist if a turnbuckle or other means of vertical adjustment can be used with this third rope sling).
7. Lift third rope sling until it supports weight of rotor end to which pipe is fitted.
8. Remove steel pipe (and its associated sling) from shaft.
9. Carefully lower rotor onto a large sheet of thick cardboard (or other suitable material) placed on floor. Block rotor in place.
10. The rotor and the interior of the stator assembly may be inspected or cleaned as desired.
11. Assemble in reverse order of removal. If stator core was moved the air gap alignment must be checked and reset if necessary.

Bracket Removal (Anti-friction bearing in bracket) Fig. 9

1. Remove covers or accessories that are mounted to the bearing housing.
2. Remove bolts holding bracket to frame and bearing inner cap bolts.
3. Take bracket off by prying between bracket mounting bolt lugs and frame bosses. Pry evenly to avoid cocking bracket on bearing. Do not try to remove bracket when bearing is hot. Bracket will be free of the frame fit when moved 3/8" *(10 mm)* The bracket will be free of the bearing when moved approximately 2" *(50 mm)*. When removing the bracket from the the unit use suitable lifting means to support the bracket and to avoid injury.
4. The bearing can now be removed. (Refer to bearing replacement.)
5. Reassembly parts in reverse order of removal.

On totally enclosed fan cooled (TEFC) motors the inboard surface of the bracket and bearing inner cap are covered with a metal thermal barrier. Prior to reassembly of the motor, a check should be made to assure that these thermal barriers are in place, as the motor bearings may overheat without them.

Repairs on TEFC-XP motors must be performed by an approved Service Center in order to maintain the Underwriters' Laboratory (UL) integrity of its label.

Bracket Removal (Sleeve bearing bracket with rabbet fit) Fig. 9

1. Remove covers or accessories that are mounted to the bracket.
2. Remove bearing (Refer to bearing replacement).
3. Lift shaft off the bracket seal fits using a rope or non-metallic sling. Block shaft in this position.
4. Remove bolts holding bracket to frame.
5. Take bracket off by prying between bracket mounting bolt lugs and frame bosses. Pry evenly to avoid cocking bracket. Bracket will be free of frame fit when moved 3/8" *(10 mm)*. When removing the bracket from the unit, use suitable lifting means to support bracket and to avoid injury.
6. Reassemble parts in reverse order.

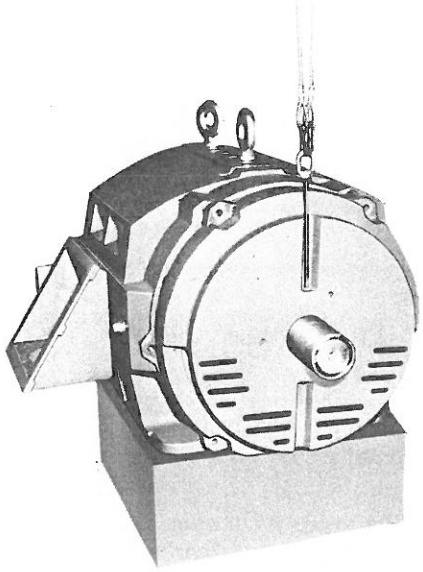


Figure 8

Bracket Removal E5000, E5800 Frame Anti-Friction Bearing

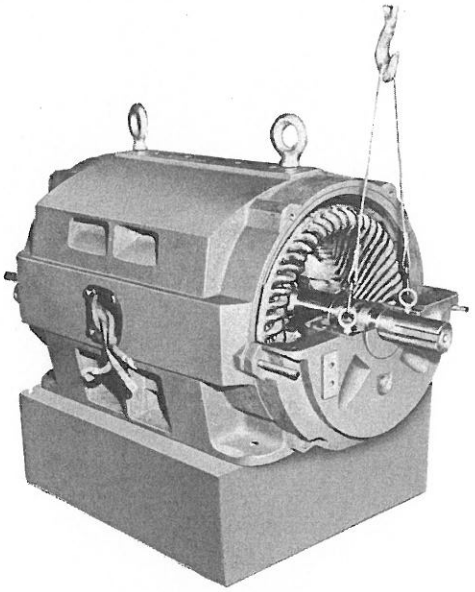


Figure 9

Bracket Removal E5000, E5800
Frame Sleeve Bearing

Anti-Friction Bearing Replacement

1. Remove bracket and/or cartridge.
2. The bearing can now be removed by using a conventional bearing puller with the puller arms located behind the bearing race. Protect the shaft center by using a spacer block of brass or some other soft material between the shaft and bearing puller.
3. Clean and inspect all parts.

   On totally enclosed fan cooled (TEFC) motors equipped with space heaters, it will be necessary to disconnect the leads from the space heater terminals prior to removing the bearing inner cap.
4. All shaft shoulders should be dressed to assure square shoulders for bearing replacement.
5. Heat bearing in oil to 250° F-275° F *(120° C-135° C)*. Hold at this temperature for at least 20 minutes to permit thorough absorption of heat and adequate expansion. The bearing can be assembled without force if properly heated.

   Alternate Method — Heat bearing in electric oven or home type electric roaster. Wrap bearing to keep dirt out. Heat to 250° F-275° F *(120° C-135° C)*. Hold at this temperature for at least 30 minutes after oven reaches this temperature to permit thorough absorption of heat and adequate expansion. Check bearing with thermometer if possible to assure temperature.
6. Place bearing on shaft making sure that it is contacting locating shoulder on the shaft.
7. Reassemble parts in reverse order of removal. Make sure dowels are engaged in both bracket and motor frame.
8. Lubricate bearings as indicated under Lubrication (page 13).

Sleeve Bearing Replacement (Cylindrical Seated)

1. Remove top cover or grille as required.
2. Remove bearing temperature detectors (if used).
3. Remove screws used to hold top half of bearing housing to bottom half.
4. Back-off top half of housing using jack screws in tapped holes if so equipped. Otherwise use two pry bars in vent holes to lift cap evenly. (Housing halves are dowelled together, Fig. 10).
5. Using a small pry and nominal hand pressure, separate the bearing halves. (Bearings halves are dowelled together, Fig. 11). NOTE: Some models are equipped with socket head screws in addition to the dowels. These screws must be removed before attempting to pry bearing top off.
6. Remove top half of bearing and bearing anti-rotation keying devices from bearing housing, (Fig. 11 and 12).
7. Using a rope or sling (non-metal) around the shaft, raise it just high enough to be able to spin-out the bottom half of the bearing.
8. Tap bearing gently to unseat and spin bearing half up and out of housing.

   NOTE: Shims used to limit axial float are located on the outboard end of the bearing in the housing. Remove and note the quantity used at each end, (Fig. 13).
9. Remove bottom half of bearing and gently lower shaft.
10. Check to see that bearing journal and shoulders are free of nicks and burrs; dress with rubber stone or replace as necessary.
11. Using a clean, lint-free cloth, wipe bearing journal and bearing clean and dry.
12. Apply a light, even coat of "Prussian Bluing" to the shaft bearing journal.
13. As in step 7, raise the shaft as required to reassemble bearing. Do not allow the shaft to touch the bearing and smear the bluing.
14. Gently lower the shaft until it is in its final position.
15. Assemble top half of bearing.
16. Reassemble parts in reverse order of removal. Make sure dowel pins are engaged in top and bottom halves of housing.
17. By hand (or suitable wrench) slowly rotate the shaft 1/2 turn in one direction to transfer bluing to bearing high spots.
18. Remove screws used to hold top half of bearing housing to bottom half.
19. Back-off top half of housing using jack screws in tapped holes if so equipped. Otherwise use two pry bars in vent holes to lift cap evenly. (Housing halves are dowelled together).
20. Using a small pry and nominal hand pressure, separate the bearing halves. (Bearing halves are dowelled together).

    NOTE: Some models are equipped with socket head screws in addition to the dowels. These screws must be removed before attempting to pry bearing top off.
21. Raise the shaft as in step 7, free bearing from shaft and remove. Use caution to prevent smearing the bluing.
22. Using proper tools, scrape all high spots. Clean bearing and bearing journal and re-blue.
23. Repeat steps 12-22 until inspection shows at least 75% contact on center of bottom half.
24. Wipe bearing and journal free of bluing and pour fresh, clean oil on bearing journal and over bearing. Be sure to cover both inside and outside diameters. Replace bottom half of bearing. Use caution to prevent damage to bearing and to prevent dirt from contaminating bearing surface.
25. Replace anti-rotation keys. If keys are equipped with a tab to prevent axial bearing movement the keys should be

installed with tabs pointing toward the bearing.

26. Assemble top half of bearing.
27. Reassemble parts in reverse order of removal. Make sure dowel pins are engaged in top and bottom halves of housing. Apply non-hardening aviation type Permatex #3 to faces of lower bearing housing.
28. When restarting a motor which has had bearings replaced the sequence of steps used during the "initial start" portion of this manual should be followed.

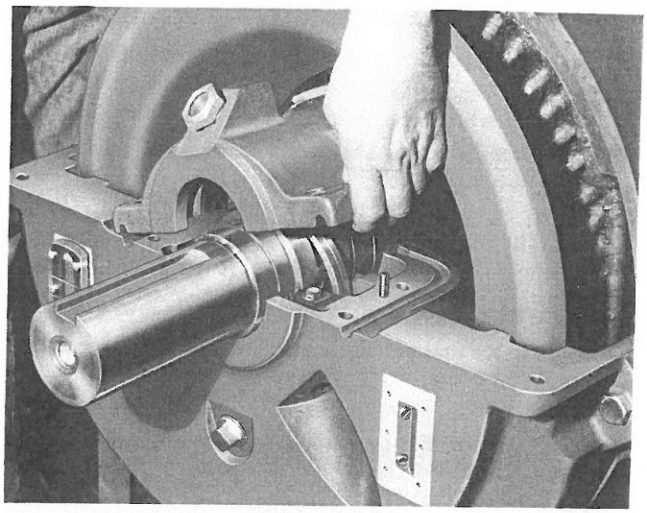


Figure 10

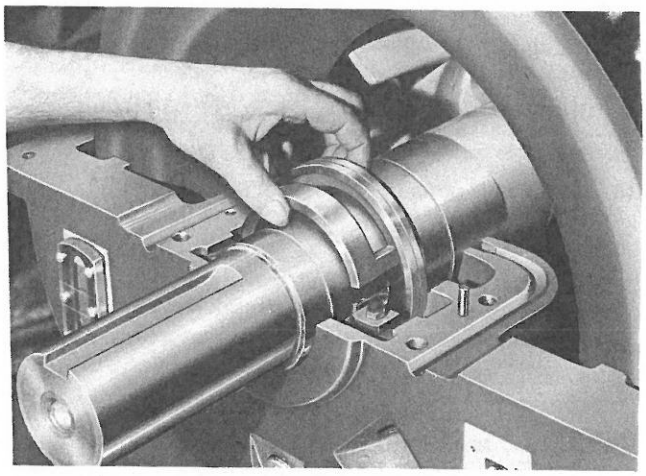


Figure 11

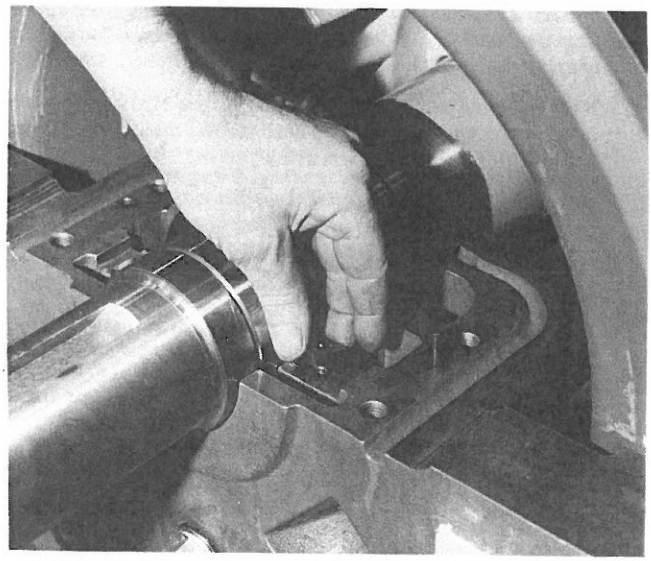


Figure 12

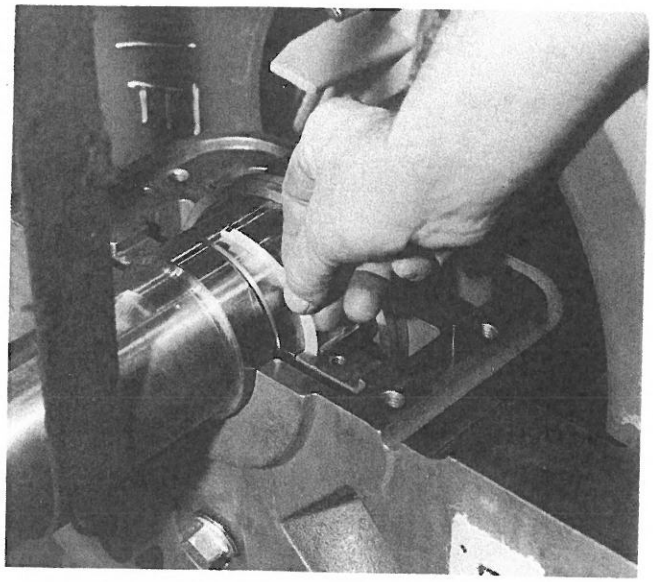


Figure 13

RENEWAL PARTS

The high productivity which industry seeks to maintain, demands a well planned maintenance program — the success of which often can depend on the number and type of spare parts on hand. Serious consideration should be given to having all vital replacement components on hand to protect the units against costly down time.

A detailed parts list, which gives Reliance Electric's recommendations for spare parts that should be stocked for your equipment, can be ordered from:

1. Nearest Reliance Electric sales office.
2. Nearest Reliance Electric distributor.
3. Reliance Renewal Parts, Cleveland, Ohio.

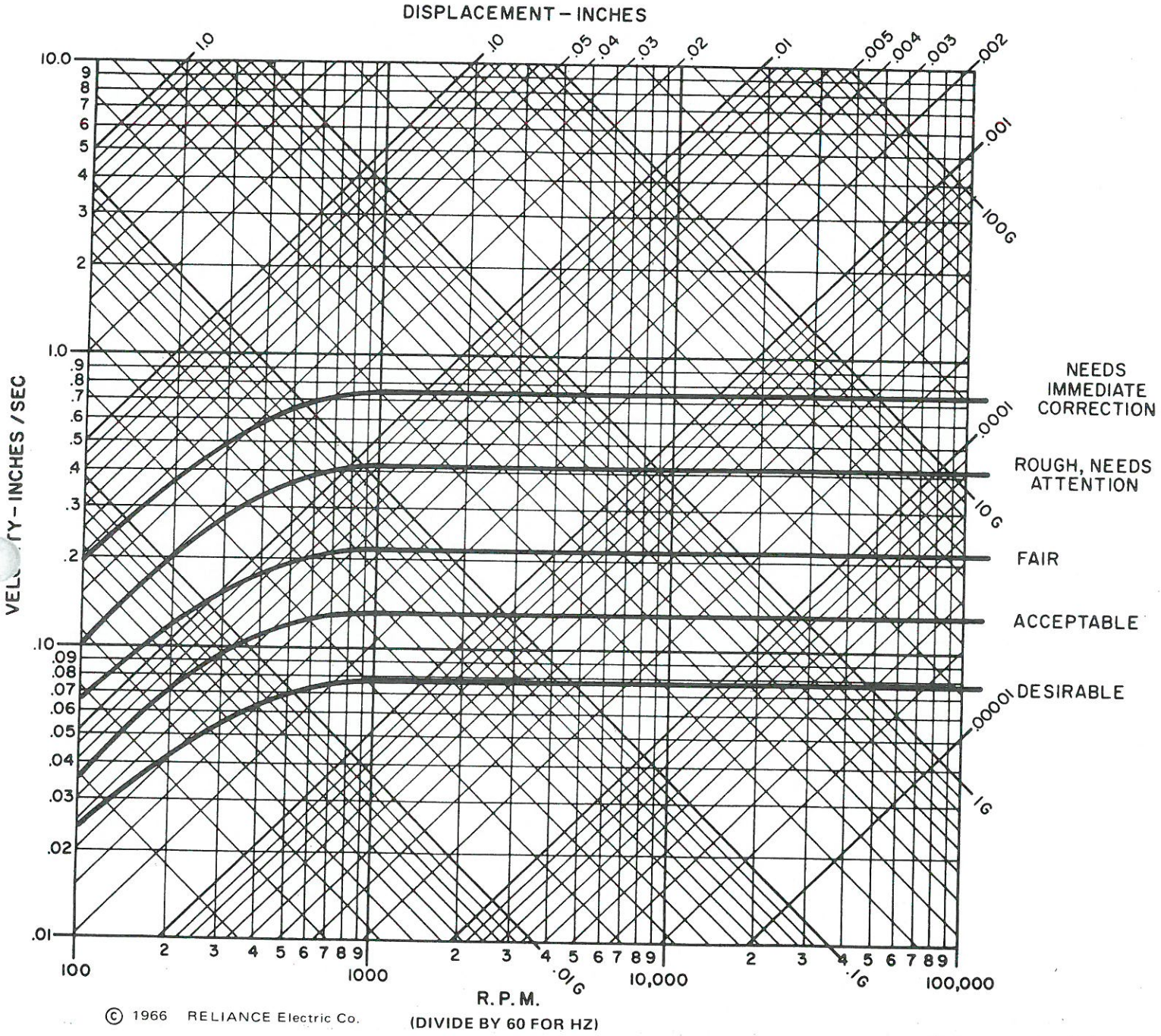
Be sure to include complete nameplate data — purchase order number, serial number, model number, rating, etc., — for your equipment when ordering the spare parts list.

Parts can be obtained from your nearest Reliance parts distributor, or directly from our factory. When ordering parts for which a part number is not available, give complete description of part and purchase order number, serial number, model number, etc., of the equipment on which the part is used.

New Parts Guarantee

The Company guarantees that the parts to be delivered in the event of an order will be the kind of quality described in the specifications, and no other warranty, except of title, shall be implied. The conditions of any tests shall be mutually agreed upon, and the Company shall be notified of, and may be represented at, all tests which may be made. If any failure to comply with the specifications appears within one (1) year from the date of shipment, the purchaser shall notify the Company thereof immediately, and the Company shall thereupon correct the defect, or defects, by repairing the defective part or parts or by supplying a replacement therefor. The liability of the Company (except as to title) arising out of the supplying of said parts or their use, whether on warranties or otherwise, shall not in any case exceed the cost of correcting defects in the parts, and, upon the expiration of said one (1) year, all such liability shall terminate.

VIBRATION NOMOGRAPH



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Reliance Electric Company / 24701 Euclid Avenue / Cleveland, Ohio 44117

RELIANCE ELECTRIC

Printed in U.S.A.

B-3628-9

4865M

SDC PRE-STARTUP CHECK SHEET

CUSTOMER_____

48#_____SERIAL #_____

DRIVE MOTOR MFG_____S/N_____HP____

B/D MOTOR MFG_____S/N_____HP____

B/D MFG. (ECB_____) (DC_____) (OTHER_____)

B/D CONTROL S/N_____

SERVICE ENGINEER_____DATE_____

____ IS THERE SUFFICIENT ROM TO REMOVE THE FEED TUBE?

____ IS THERE A MONORAIL AND IS IT POSITIONED TO ALLOW EASY REMOVAL OF THE VARIOUS COMPONENTS?

____ IS THERE SUFFICIENT HEAD ROOM TO HOIST COMPONENTS CLEAR OF OTHER COMPONENTS?

____ IS THE MACHINE LEVEL?
I/4" MINIMUM CLEARANCE BETWEEN (CAST) VIBRATION ISOLATORS.
3/8" MINIMUM CLEARANCE BETWEEN (STEEL) VIBRATION ISOLATORS.

____ TIGHTEN ISOLATORS TO 20 FT/LBS on P5000'S OR LARGER:

____ IS THE FEED TUBE SEAL PROPERLY ADJUSTED?

____ ARE ALL THE JACKSHAFT SET SCREWS TIGHT?

____ IS THE HOIST PROPERLY SIZED FOR LIFTING THE ROTATING ASSEMBLY?
(2 TON P3400) (5 TON P5000/PM75000) (10 TON PM95000)

____ ARE THE PULLEYS ALIGNED AND THE BELTS PROPERLY TENSIONED?

____ IS THE MOTOR SUPPORT LEVEL AND CLEAR OF THE FLOOR?

____ ARE ALL THE PLATE DAMS SET ON THE SAME NUMBER?
WHAT IS THE NUMBER? [_____]

____ DOES THE SYSTEM HAVE AN AUTOMATIC FEED SHUTOFF?

____ IF SUPPLIED, IS THE HYDRAULIC PRESSURE TRANSMITTER PROPERLY FILLED AND ADJUSTED, TO A GAP OF 5/16"?

____ CHECK THE BACKDRIVE ALIGNMENT:
ANGULAR_____[0.044 MAX]
PARALLEL 13" span. .026 [0.002/INCH OF SPAN] ~~+ Stbd~~

____ IS THE FLUID COUPLING ALIGNED? [AFTER BELT TENSIONING]
FACE_____[0.005 MAX]
O.D._____ [0.005 MAX]

PIPING

____ IS THE WATER DRAIN LINE FROM THE ECB OPEN AT THE BRAKE?

____ IS THE FEED TUBE SECURELY FASTENED AND DOES IT HAVE A FLEXIBLE CONNECTOR INSTALLED?

____ BE SURE NOTHING RIGID IS CONNECT TO THE MACHINE?

____ IS A WATER LINE CONNECTED TO THE FEED LINE FOR FLUSHING THE MACHINE?

____ DO ALL THE RINSE LINES TO THE MACHINE HAVE FLEX CONNECTIONS?

____ IS THERE A STEADY FLOW OF POTABLE WATER TO THE ECB?

____ ARE THE CUSTOMERS DISCHARGE CHUTES INDEPENDENTLY SUPPORTED?

____ ARE FLEX CONNECTIONS INSTALLED BETWEEN THE CENTRIFUGE CASING AND THE CUSTOMER'S CHUTES?

____ IS THERE A STEADY FLOW OF WATER TO THE LUBE SYSTEM HEAT EXCHANGER?

____ IS THE SARCO VALVE SET TO MAINTAIN A 90 DEG. F. INLET OIL TEMP?

___ ARE THE VENT PIPES PROPERLY SIZED AND LOCATED?
WHAT SIZE_____?

___ IS THERE A VENT ON THE SOLIDS CHUTE?

ELECTRICALS

___ IS FLEXIBLE CONDUIT USED ON THE DRIVE MOTOR?

___ WHAT IS THE TIME ON THE ACCELERATION TIMER?
_____MINUTES_____SECONDS

___ IS THE MOTOR ROTATION CORRECT IN BOTH THE START AND RUN MODE? [BOWL ROTATES CLOCKWISE FROM THE FEED TUBE END]

___ IF SUPPLIED IS THE FAULT DETECTOR OPERATIONAL?

___ IS THE LUBE PUMP MOTOR DIRECTION CORRECT?

___ ARE THE OIL FLOW INDICATORS PROPERLY ADJUSTED?
OLD STYLE [OPEN AT 50% FALLING FLOW]
NEW STYLE [OPEN AT .2 GPM FALLING FLOW]

___ IS THE TORQUE CONTROL SWITCH WIRED TO SHUTDOWN THE MACHINE? [CHECK BY TRIPPING THE TORQUE CONTROL TO BE SURE IT SHUTS THE MACHINE DOWN].

___ IS THE AMMETER SHUNTED OUT DURING ACCELERATION?

___ IS THE WATER PRESSURE SWITCH OF THE ECB SET? [OPEN BELOW 35PSI]

WHAT ARE THE B/D SETTINGS?
MIN. SPEED_____MAX. SPEED_____

WHAT ARE THE DC BACKDRIVE CONTROL SETTINGS?
ARMATURE VOLTS_____
HOT FIELD AMPS_____
MAX. TORQUE_____

___ IS THE RPM METER CALIBRATED?

___ IS THE VIBRATION SWITCH SET?

___ ARE THE % EXITATION METER SET POINTS INTERLOCKED TO SHUT THE MACHINE DOWN?

____ WHAT IS THE SETTING OF THE INSTANTANEOUS TRIP RELAY IF SUPPLIED?

____ CHECK THE AUTO RESET ON THE D.C. BREAKER TO BE SURE IT OPERATES.

LUBRICATION

____ ARE THE GREASE AND OILS TO BE USED OF THE RECOMMENDED TYPE?

____ CHECK THE GEARBOX LEVEL:

____ GREASE THE CONVEYOR BEARINGS:

____ GREASE THE PILLOW BLOCK BEARINGS OR CHECK THE OIL LEVEL:

____ GREASE ALL THE REMAINING FITTINGS:
[JACKSHAFT, CENTRIC CLUTCH, MOTOR HINGE PINS]

____ CHECK THE JACKSHAFT OIL LEVEL:

____ CHECK THE FLUID COUPLING OIL LEVEL:

____ DEMONSTRATE GREASING TO THE CUSTOMER:

MOTORS

____ PRIOR TO TESTING GREASE MOTORS:

TEST RUN MINIMUM 4 HOURS
ACCELERATION TIME_____MIN. TO_____RPM

RETURN OIL TEMPERATURE AFTER 4 HOURS:
FRONT_____DEG. F
REAR_____DEG. F

TEMPERATURE OF OIL TO BEARINGS AFTER 4 HOURS:
_____DEG. F

PILLOW BLOCK TEMPERATURE AFTER 4 HOURS:

FRONT_____COOL_____WARM_____HOT
REAR_____COOL_____WARM_____HOT

VIBRATION LEVEL: [ADD READINGS IF AVAILABLE]

OFF STREAM_____
ON STREAM_____

____ UNLESS RETENSIONING IS NECESSARY, ADVISE CUSTOMER TO RETENSION BELTS AFTER 72 HOURS OF RUNNING:

ARE ALL THE SUPPLIED SPARES ACCOUNTED FOR?
YES_____NO_____

PROCESS

IS THE FEED MATERIAL THE CENTRIFUGE IS OPERATING ON, THE ORIGINALLY SPECIFIED MATERIAL? YES_____NO_____

IF THE ANSWER TO THE ABOVE QUESTION IS NO:
WHAT IS THE MATERIAL?_____

CONTACT OUR ENGINEERING:

REVISION 5/91
FILE:STARTCHK.SHT

INSTALLATION AND MAINTENANCE INSTRUCTIONS

2-WAY INTERNAL PILOT OPERATED SOLENOID VALVES DIAPHRAGM TYPE – 1, 1 1/4 AND 1 1/2 N.P.T. NORMALLY CLOSED OPERATION

BULLETINS
8210
8211

ASCO

Form No. V-5436R2

DESCRIPTION

Bulletin 8210's are 2-way, normally closed internal pilot operated solenoid valves. Valve body and bonnet are of brass construction. Standard valves have a General Purpose, NEMA Type 1 Solenoid Enclosure.

Bulletin 8211's are the same as Bulletin 8210's except the solenoids are equipped with an enclosure which is designed to meet NEMA Type 4 - Watertight, NEMA Type 7 (C or D) Hazardous Locations - Class I, Group C or D, and NEMA Type 9 (E, F or G) Hazardous Locations - Class II, Groups E, F or G. The Explosion-Proof/Watertight Solenoid Enclosures are shown on separate sheets of Installation and Maintenance Instructions, Form Nos. V-5380 and V-5391.

OPERATION

Normally Closed: Valve is closed when the solenoid is de-energized and open when solenoid is energized.

MANUAL OPERATOR (OPTIONAL) (Refer to Figure 1)

Valves with Suffix "MO" in catalog number are provided with a manual operator which allows manual operation when desired or during an interruption of electrical power.

MANUAL OPERATOR OPERATION (Refer to Figure 1)

To operate valve manually, rotate manual operator stem clockwise 180°. Disengage manual operator by rotating stem counterclockwise 180° before operating electrically.

INSTALLATION

Check nameplate for correct catalog number, pressure, voltage and service.

TEMPERATURE LIMITATIONS

For maximum valve ambient and fluid temperatures, refer to chart below. The temperature limitations listed are for U.L. applications. For non U.L. applications, higher ambient and fluid temperature limitations are available. Consult factory. Check catalog number on nameplate to determine maximum temperatures.

Construction	Coil Class	Catalog Number Prefix	Maximum Ambient Temp. ° F.	Maximum Fluid Temp. ° F.
A–C Construction (Alternating Current)	A	None or DA	77	180
	F	DF or FT	120	180
	H	HT	140	180
D–C Construction (Direct Current)	A, F or H	None, FT or HT	77	150

POSITIONING/MOUNTING

This valve is designed to perform properly when mounted in any position. However, for optimum life and performance, the solenoid should be mounted vertical and upright so as to reduce the possibility of foreign matter accumulating in the core tube area.

PIPING

Connect piping to valve according to markings on valve body. Apply pipe compound sparingly to male pipe threads only; if applied to valve threads, it may enter the valve and cause operational difficulties. Pipe strain should be avoided by proper support and alignment of piping. When tightening the pipe, do not use valve as a lever. Wrenches applied to valve body or piping are to be located as close as possible to connection point.

IMPORTANT: For the protection of the solenoid valve, install a strainer or filter suitable for the service involved in the inlet side as close to the valve as possible. Periodic cleaning is required depending on the service conditions. See Bulletins 8600, 8601 and 8602 for strainers.

WIRING

Wiring must comply with Local and National Electrical Codes. Housings for all solenoids are provided with connections for 1/2 inch conduit. The General Purpose Solenoid Enclosure may be rotated to facilitate wiring by removing the retaining cap or clip. **CAUTION: When metal retaining clip disengages, it will spring upward.** Rotate to desired position. Replace retaining cap or clip before operating.

SOLENOID TEMPERATURE

Standard catalog valves are supplied with coils designed for continuous duty service. When the solenoid is energized for a long period, the solenoid enclosure becomes hot and can be touched with the hand only for an instant. This is a safe operating temperature. Any excessive heating will be indicated by the smoke and odor of burniing coil insulation.

MAINTENANCE

WARNING: Turn off electrical power supply and depressurize valve before making repairs. It is not necessary to remove valve from pipe line for repairs.

CLEANING

A periodic cleaning of all solenoid valves is desirable. The time between cleanings will vary depending on media and service conditions. In general, if the voltage to the coil is correct, sluggish valve operation, excessive leakage or noise will indicate that cleaning is required. Be sure to clean valve strainer or filter when cleaning solenoid valve.

PREVENTIVE MAINTENANCE

1. Keep the medium flowing through the valve as free from dirt and foreign material as possible.
2. While in service, operate the valve at least once a month to insure proper opening and closing.
3. Periodic inspection (depending on media and service conditions) of internal valve parts for damage or excessive wear is recommended. Thoroughly clean all parts. Replace any parts that are worn or damaged.

IMPROPER OPERATION

1. **Faulty Control Circuit:** Check the electrical system by energizing the solenoid. A metallic click signifies the solenoid is operating. Absence of the click indicates loss of power supply. Check for loose or blown-out fuses, open circuited or grounded coils, broken lead wires or splice connections.
2. **Burned-Out Coil:** Check for open circuited coil. Replace coil, if necessary.
3. **Low Voltage:** Check voltage across coil leads. Voltage must be at least 85% of nameplate rating.
4. **Incorrect Pressure:** Check valve pressure. Pressure to valve must be within range specified on nameplate.
5. **Excessive Leakage:** Disassemble valve and clean all parts. Replace worn or damaged parts with a complete Spare Parts Kit for best results.

Form No. V-5436R2 PRINTED IN U.S.A. 1976 Automatic Switch Co.

ASCO Valves
FLORHAM PARK, NEW JERSEY 07932

ASCO

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COIL REPLACEMENT

Turn off electrical power supply and disconnect coil lead wires. Proceed in the following manner:

A-C CONSTRUCTION (Refer to Figure 2)

1. Remove retaining cap or clip, nameplate and cover. **CAUTION: When metal retaining clip disengages, it will spring upward.**
2. Slip yoke containing coil, sleeves and insulating washers off the solenoid base sub-assembly. Insulating washers are omitted when a molded coil is used.
3. Reassemble in reverse order of disassembly paying careful attention to exploded view provided for identification and placement of parts.

D-C CONSTRUCTION (Refer to Figure 3)

1. Remove retaining cap or clip, nameplate and housing. **CAUTION: When metal retaining clip disengages, it will spring upward.**
2. Remove spring washer, coil and insulating washers. Insulating washers are omitted when a molded coil is used.
3. Reassemble in reverse order of disassembly paying careful attention to exploded view provided for identification and placement of parts.

CAUTION: Solenoid must be fully reassembled as the housing and internal parts are part of and complete the magnetic circuit. Place insulating washers at each end of coil, if required.

MANUAL OPERATOR DISASSEMBLY AND REASSEMBLY

(Refer to Figure 1)

Depressurize valve and turn off electrical power supply. Proceed in the following manner:

1. Remove retaining cap or clip and slip entire solenoid enclosure off solenoid base sub-assembly. **CAUTION: When metal retaining clip disengages, it will spring upward.** Unscrew solenoid base sub-assembly and remove manual operator body gasket.
2. Unscrew the manual operator body. Remove the body, stem retainer, core assembly, core spring and bonnet gasket.
3. Slip stem/spacer sub-assembly and stem gasket from manual operator body.
4. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete Spare Parts Kit for best results.
5. Reassemble in reverse order of disassembly paying careful attention to exploded views provided for identification and placement of parts. Be sure the spacer on the stem/spacer sub-assembly is located properly when reassembling.
6. Torque solenoid base sub-assembly and manual operator body to 175 ± 25 inch pounds.

VALVE DISASSEMBLY AND REASSEMBLY (Refer to Figures 2 & 3)

Depressurize valve and turn off electrical power supply. Proceed in the following manner:

1. Remove retaining cap or clip and slip the entire solenoid enclosure off the solenoid base sub-assembly. **CAUTION: When the metal retaining clip disengages, it will spring upward.**
2. Unscrew solenoid base sub-assembly and remove bonnet gasket, core assembly and core spring. Unscrew valve seat.
3. Remove bonnet screws and bonnet.
4. Remove diaphragm spring, diaphragm assembly, body gasket and body passage gasket.
5. All parts are now accessible for cleaning or replacement. Replace worn or damaged parts with a complete Spare Parts Kit for best results.
6. Reassemble in reverse order of disassembly paying careful attention to exploded views provided for identification and placement of parts.
7. Torque valve seat to 65 ± 10 inch pounds.
8. Torque solenoid base sub-assembly to 175 ± 25 pounds.
9. Torque bonnet screws to 144 ± 15 inch pounds.
10. After maintenance, operate valve a few times to be sure of proper opening and closing.

SPARE PARTS KITS

Spare Parts Kits and Coils are available for ASCO valves. Parts marked with an asterisk (*) are supplied in Spare Parts Kits.

ORDERING INFORMATION FOR SPARE PARTS KITS

When Ordering Spare Parts or Coils Specify Valve Catalog Number, Serial Number and Voltage.

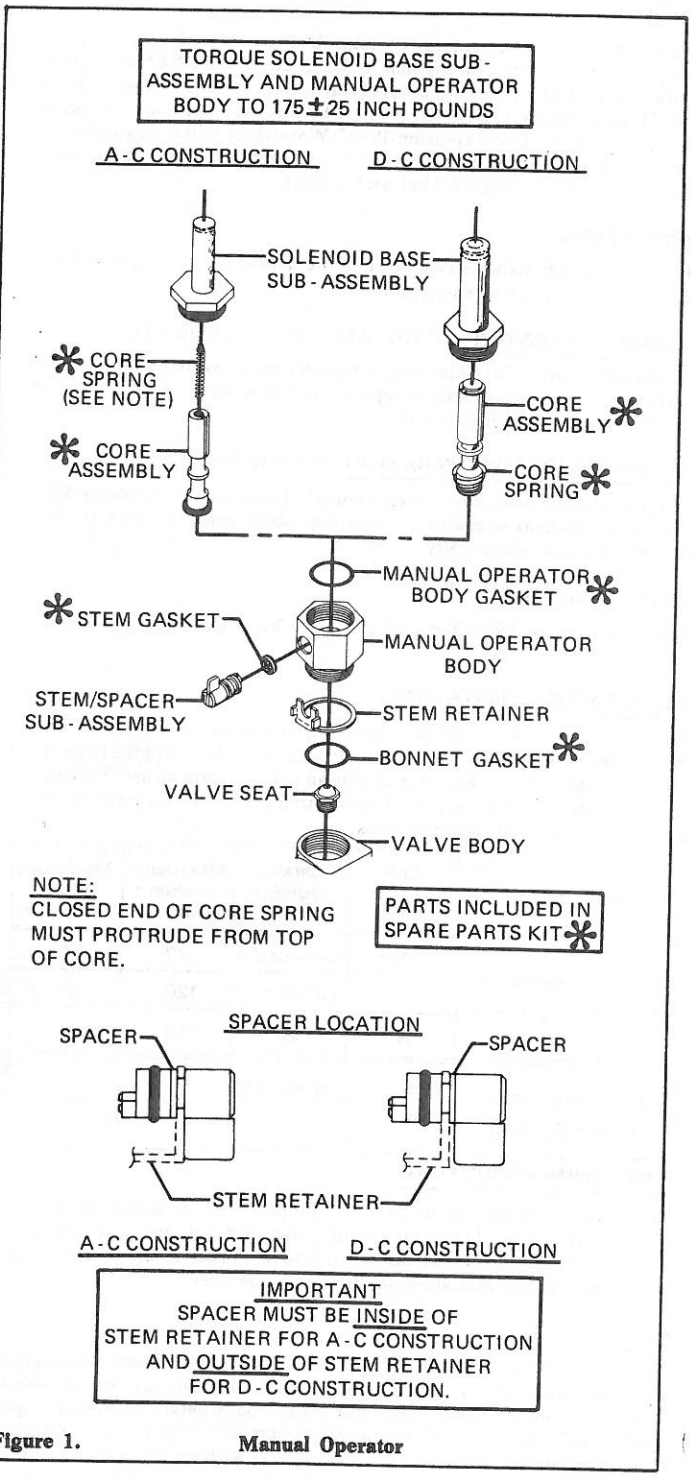


Figure 1. Manual Operator

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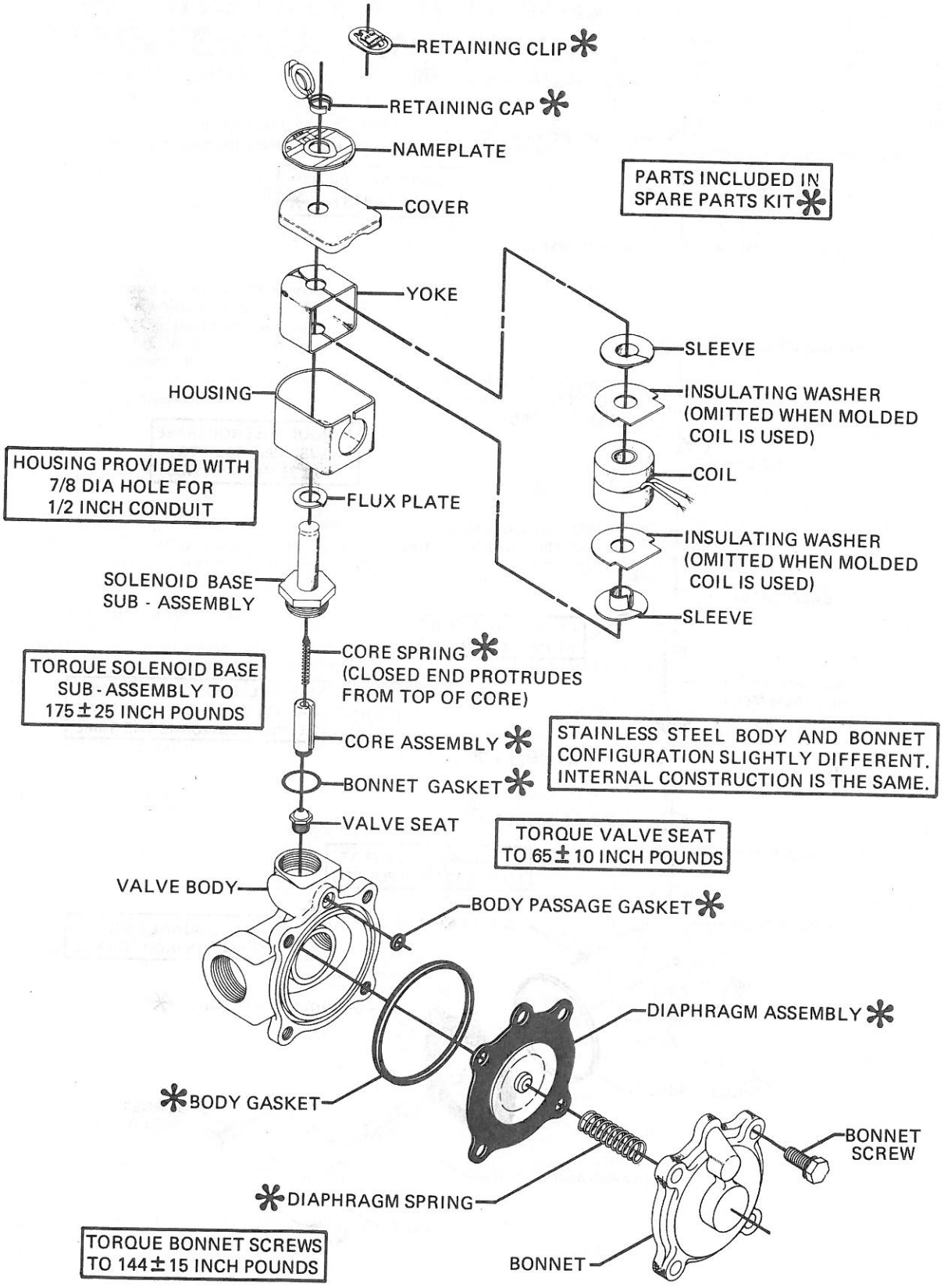


Figure 2. **Bulletin 8210 - A-C Construction**
General Purpose Solenoid Enclosure Shown
For Explosion-Proof/Watertight Solenoid Enclosure used on Bulletin 8211, see Form No. V-5391

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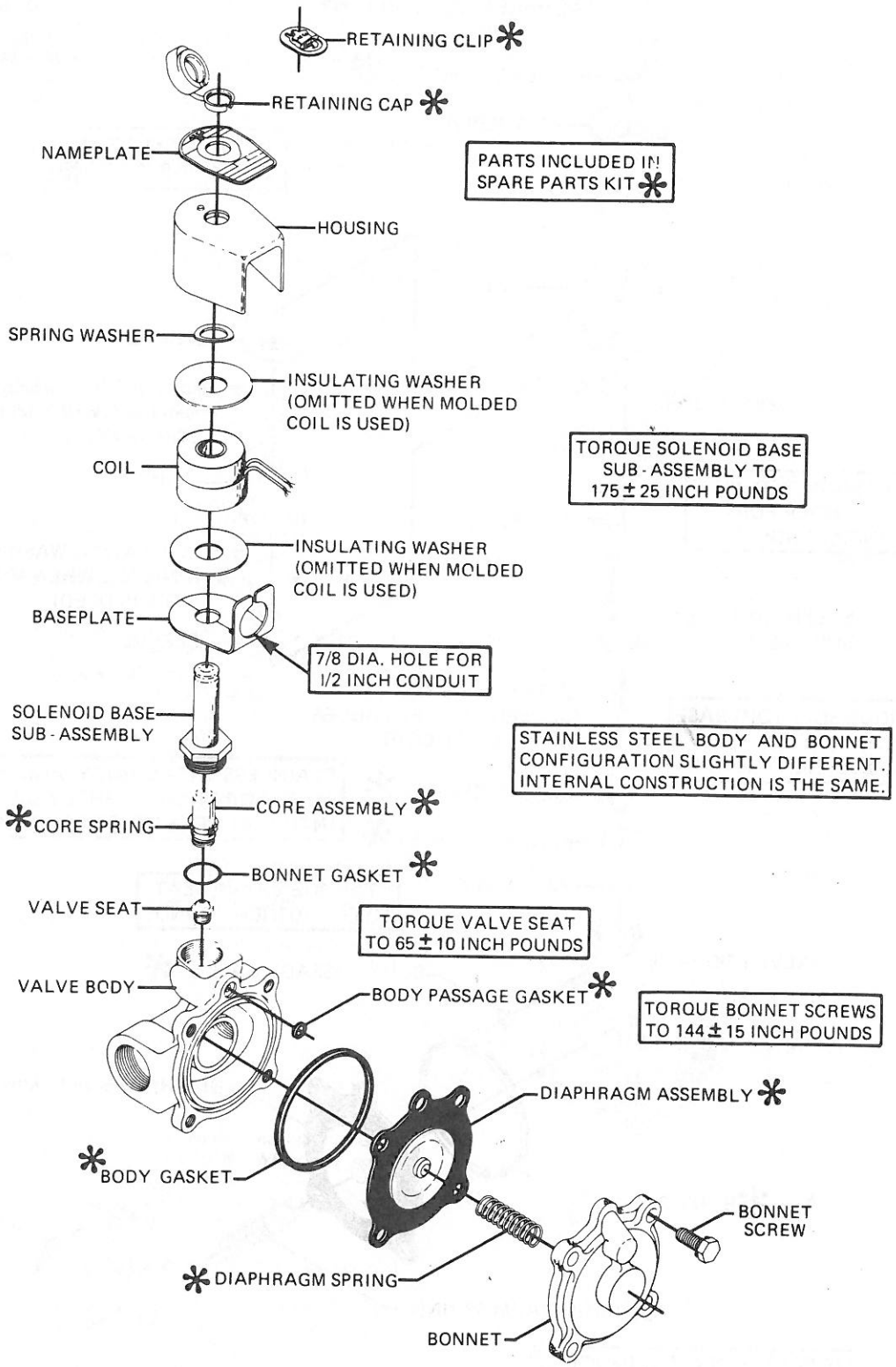
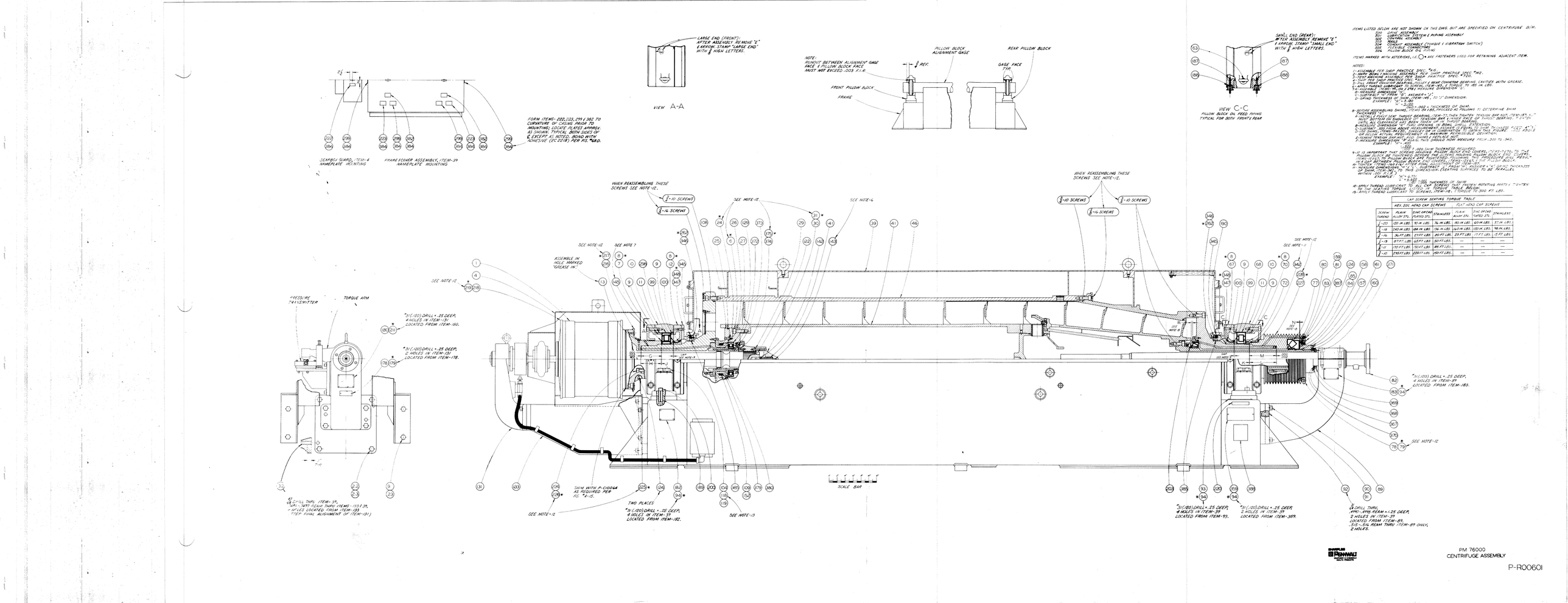


Figure 3.

Bulletin 8210 - D-C Construction
General Purpose Solenoid Enclosure Shown
For Explosion-Proof/Watertight Solenoid Enclosure used on Bulletin 8211, see Form No. V-5380

ASCO Valves
Automatic Switch Co. FLORHAM PARK, NEW JERSEY 07932 Form No. V-5436R2 PRINTED IN U.S.A. 1976
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PM 76000
CENTRIFUGE ASSEMBLY

P-R00601

INSTRUCTION MANUAL

SHARPLES-STOKES
FUSELESS PANEL DRIVE



SPINDLEMATE™

CMC CLEVELAND MACHINE CONTROLS

CLEVELAND MACHINE CONTROLS, INC.
WESTERN OPERATIONS
ONE KELLY COURT, MENLO PARK, CALIFORNIA 94025
PHONE (415) 328-2640 • TELEX 34 5521

WARNING

This equipment is at line potential any time the incoming line power disconnect is closed even if the motor is not rotating. AC power must be disconnected (all phases) before it is safe to touch any internal parts of this equipment.

CORPORATE HEADQUARTERS
7550 HUB PARKWAY, CLEVELAND, OH 44125
PHONE: (216) 524-8800 TELEX: 98-5613

SS-00-781C

RECEIVING, HANDLING & STORAGE

Receiving

The equipment must be placed under adequate cover immediately upon receipt as packing cases are not suitable for outdoor or unprotected storage.

Examine the shipment carefully upon arrival and check items with the Packing List. Any shortage or damage should be reported promptly to the carrier and to the nearest CMC sales office.

Storage

If equipment is not being installed immediately, it should be stored in a clean, dry location. Precautions should be taken to prevent moisture from accumulating in the equipment. Moisture, dust or dirt is detrimental to the equipment operation.

WARNING: THIS EQUIPMENT SHOULD BE INSTALLED, ADJUSTED AND SERVICED BY QUALIFIED PERSONNEL FAMILIAR WITH ELECTRICAL EQUIPMENT AND THE CONTENTS OF THIS MANUAL.

DO NOT SERVICE MOTOR UNLESS ALL POWER IS OFF. VOLTAGE MAY BE PRESENT EVEN THOUGH MOTOR SHAFT IS NOT ROTATING.

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2.0	INSTALLATION
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4.0	THEORY OF OPERATION
5.0	MAINTENANCE & TROUBLESHOOTING
6.0	DRAWINGS
7.0	DATA SHEET

1.0 GENERAL DESCRIPTION

1.1 MEET THE SPINDLEMATE™

The CMC SPINDLEMATE Controller is designed specifically for use with standard shunt-wound DC motors in machine tool spindle drive applications. It provides a system which combines the high torque characteristics of a DC motor at low speed with operation well above base speed at constant horsepower. A three-phase full-wave (6 pulse) regenerative SCR (silicon controlled rectifier) power bridge is utilized in the armature power circuit for fast response, controlled stops and excellent current form factor. This type of configuration allows direct line operation without the need for an isolation power transformer or output "overlap" inductor.

Available in four sizes, the SPINDLEMATE is MTD (machine tool duty) rated for optimum match to the machine application. The regenerative feature of the controller provides four-quadrant power flow in response to low-level analog commands from the CNC or operator controls. A built-in field regulator automatically weakens the motor shunt field in the constant horsepower range of operation and is used for field economizing at idle periods. Speed feedback is from a motor-mounted DC tachometer. Comparator circuits with optically coupled transistor outputs are provided for low-speed and set speed detection. These outputs can be directly connected back to the CNC or relay interfaced for interlock functions such as controlled stop, feed enable, gear shift speed, etc. A third (AUX) comparator can be tailored to a specific machine function via circuit board jumper matrix.

The SPINDLEMATE's compact design requires a minimum of panel space while its modular construction provides straightforward maintainability. Power and control circuit subassemblies are easily replaceable. Control circuitry is incorporated onto two main plug-in printed wiring boards to minimize spares requirements and simplify adjustment. Diagnostic aids include status and latching fault LED's and a connector is provided for an optional tester.

Each SPINDLEMATE incorporates the following standard features:

- 3Ø, Full-Wave (6 pulse) Regenerative SCR Bridge
- Machine Tool Rated (MTD)
  150% Torque - 15 min.
  200% Torque - 1 min.
- Phase Sequence insensitive
- 50/60 Hz operation - jumper connectable.
- Integral shunt field regulator for wide speed range.
- Motor shunt field economizing to minimize heating at idle periods.
- Full time inner current loop.
- Low level control circuitry - no high voltage on main control circuit boards.
- Optoisolated speed comparator output signals
- Motor armature current and voltage output signals
- Controlled acceleration/deceleration
- Single-ended or differential inputs
- Tachometer feedback (or BEMF feedback without field range)
- Status and Fault LED indicators
- Small size/modular construction
- Plug-in circuit boards
- Provision for plug-in tester
- Serviceability - circuit boards hinged to provide access to SCRs and other chassis components.
- SCR snubbers and ferrite line reactors for dv/dt and di/dt protection
- Easily removable SCR subassemblies

1.2 SPECIFICATIONS, SPINDLEMATE CONTROLLER

240V MODELS					
Horsepower		Spindlemate Model	Cont. Rated Line Amps	Cont. Rated Arm. Amps	Unit Size
MTD*	Cont.				
7-1/2	5	SP 1240-5A	18	17.7	A ⊛
10	7-1/2	SP 1240-7.5A	27	28.1	A ⊛
15	10	SP 1240-10A	34	36.6	A ⊛
22-1/2	15	SP 1240-25A	49	55.1	A ⊛
30	20	SP 1240-20B	62	70.5	B
37-1/2	25	SP 1240-25B	79	91.1	B
45	30	SP 1240-30C	89	107	C
60	40	SP 1240-40C	114	138	C
75	50	SP 1240-50C	145	175	C
90	60	SP 1240-60C	170	205	C
100	75	SP 1240-75C	211	256	C
125	100	SP 1240-100D	284	345	D
150	125	SP 1240-125D	349	425	D
500V MODELS					
7-1/2	5	SP 1500-5A	11	8.4	A ⊛
10	7-1/2	SP 1500-7.5A	15	13.2	A ⊛
15	10	SP 1500-10A	18	17.2	A ⊛
22-1/2	15	SP 1500-15A	25	25.2	A ⊛
30	20	SP 1500-20A	33	35.1	A ⊛
37-1/2	25	SP 1500-25A	39	42.7	A ⊛
45	30	SP 1500-30A	45	50.4	A ⊛
60	40	SP 1500-40B	58	65.4	B
75	50	SP 1500-50B	73	83.7	B
90	60	SP 1500-60C	80	97.4	C
100	75	SP 1500-75C	105	123	C
125	100	SP 1500-100C	135	161	C
150	125	SP 1500-125C	170	202	C
180	150	SP 1500-150C	200	240	C
300	200	SP 1500-200D	270	323	D
375	250	SP 1500-250D	332	399	D

* MTD indicates "Machine Tool Duty"
⊛ Indicates Size B with optional integral tester

1.2 SPECIFICATIONS (Cont'd)

		240V Models	500 V Models
1.	AC Input Power 3Ø, 50/60 Hz	230 VAC ±10%	460 VAC ±10%
2.	Armature Output Voltage	0 to ±240 VDC	0 to ±500 VDC
3.	Field Voltage	150 VDC Nominal	300 VDC Nominal
4.	Armature Current Rating (See table, P. 1-3)	100% Rated Continuous 150% Rated 15 Min. 200% Rated 1 Min.	
5.	Field Current Rating	10 Amp., Max.	
6.	Field Control Range	4 : 1	
7.	Ambient Temperature Operating Storage	 55°C 85°C	
8.	Altitude	3300 Feet max. without derating	
9.	Cooling Size A * Sizes B, C & D	 Convection Fan-Cooled	
10.	Input Command Scale Factor	0 to ±10 VDC Nominal (Can be ± 5 or ±7.5)	
11.	Tachometer Scale Factor	±7 VDC per 1000 RPM min. ±200 VDC max. at full speed without special scaling.	
12.	Input Impedance	10K, Min.	
13.	Reference Voltages Avail. (50 ma max. each)	±12V Regulated ±24V Unregulated	

14. Module Size

A	10-1/2X x 11-1/2H x 9-1/4D
B	10-1/2W x 18-1/8H x 9-1/4D
C	13W x 20-1/2H x 11-1/4D
D	22-1/2W x 32H x 15D

15. Output Signals

Armature Current	+10V @ 150% Rated Current
Armature Voltage	±8V @ Rated Voltage
Fault Interlock Relay	Form C Contacts
Speed Comparators	Set Speed
(Opto-Isolated Transistors)	Low Speed
	Aux. Speed

16. Terminals

Control and Signal	Tubular Screw type terminal blocks
Power, Sizes A & B	Tubular screw type terminals
Power, Size C & D	Bus bars

17. Adjustments

Stability	10:1 range	Acceleration	0.5 to 5 sec.
Torque	0 to 200%	Set Speed	1/2% of Max Speed
IR Comp	With BEMF FB	Low Speed	1/2% of Max Speed
Max Speed		Aux.	

1.3 PROTECTIVE FEATURES

Reference voltage and field power fusing	Overvoltage (armature)
Phase Loss	Tachometer Loss
Overtemperature	Field Current Loss
Overspeed (Tachometer)	Static Overcurrent
	Stall Current Limit

1.4 DIAGNOSTIC FEATURES

Status LEDs

AC Power On
±12 VDC Reference Voltages
Ready (No Fault)
Drive On (Enable circuit closed)

Fault LEDs

- Phase Loss
- Overtemperature
- Overspeed (Tachometer)
- Overvoltage (Armature)
- Tachometer Loss
- Field Current Loss
- Static Overcurrent
- Stall Current

All except Stall Current Limit latch the controller off with the LED on until reset. Reset is accomplished by momentarily connecting TB1-17 +24V or by removing and re-applying power.

Optional Plug-In Tester Functions

An optional plug-in tester is available. The tester plugs into one of the connectors on the main PC board assembly. A selector switch on the tester accesses twelve circuit points on the SPINDLEMATE and indicates the relative signal level on a bar-graph LED display with a full scale of 150%.

OPTIONAL PLUG-IN TESTER FUNCTIONS

SWITCH POSITION	CIRCUIT CHECK	SWITCH POSITION	CIRCUIT CHECK
1	Line Voltage, L1 to L2	7	Speed Command
2	Line Voltage, L2 to L3	8	Tachometer Voltage
3	Line Voltage, L1 to L3	9	+12 Volt Ref. Voltage
4	Shunt Field Current	10	-12 Volt Ref. Voltage
5	Armature Voltage	11	Current Command
6	Armature Current	12	Torque Limit Setting

1.5 CONTROLLER COMPONENT DESCRIPTION

The following is a brief functional description of the major SPINDLEMATE assembly components.

Refer to Figures 1-1 through 1-4 for component location and Figure 1-5 for circuit interconnection.

a) Main Circuit Board Assemblies, A1 and A2

The two main circuit board assemblies contain most of the electronic components and circuitry necessary to operate the controller.

The boards are mounted back-to-back and interconnect at connector J7.

Major functions of the Control Board, A1, are:

1) Speed and current regulator circuits

2) User adjustments

3) Interlock circuitry to prevent controller turn-on unless operating parameters are correct and to turn off the controller if an abnormal condition develops.

4) Status and Fault LED indicators

5) Speed comparator circuits with opto-isolated outputs.

Major functions of the Logic and Firing Board, A2, are:

1) Line synchronization circuits

2) SCR firing pulse generation, distribution and amplifier circuits

3) Output current polarity steering logic

4) Field current regulator and adjustments

5) ±12 volts and ±24 volt power supplies

b) Field Isolator & Interlock Circuit Board, A3

Since there is no high voltage on the two main circuit board assemblies (these circuits are referenced to signal common), isolation is required between the high voltage field regulator power circuit and the control circuitry located on assembly A2. This isolation function is accomplished on the Field Isolator & Interlock Assembly, A3. It is located at the inside bottom part of the chassis on Size A and B controllers; inside top of Size C & D controllers. It transformer couples shunt field current as measured across a series resistor and SCR gate firing signals to the field power module. A3 also functions as a mounting location for the fault interlock relay, CR1.

c) Reference Transformer Assembly, A4

The Reference Transformer Assembly, A4, provides the necessary isolated low voltage for the ±12 volt and ±24 volt power supplies. The AC secondary voltage is also used for pulse generator synchronization. The primary windings of these transformers are jumper connectable for 230 VAC or 460 VAC power line operation as required.

d) Field Power Circuit Module, REC 1

The Field Power Circuit Module, REC 1, is a molded assembly which contains three diodes and an SCR which are connected to form a 2/3 wave rectifier circuit with integral flyback diode. The assembly is directly mounted to the chassis but is electrically isolated internally.

e) Reference and Field Power Fuses, F1-F6

Fuses F1, F2 and F3 provide short circuit protection for the reference transformer assembly. Fuses F4, F5 and F6 protect shunt field supply wiring.

f) Armature SCR Power Bridge

The armature power bridge consists of twelve SCRs and associated gate pulse transformers and snubber networks. The SCRs are connected back-to-back in two three-phase, full-wave bridge circuits - - one for forward direction of operation, the other for reverse. Size A and B controllers utilize heatsink (chassis) mounted "slim-line" modules. Each contains two SCRs which are electrically isolated from the chassis. Size C & D controllers utilize larger "hockey-puk" SCRs which are mounted in pairs in sandwiched heatsink assemblies. Each assembly is easily removable as a unit.

g) Line Inductors, L1 - L6

A ferrite reactor is connected in series with each leg of the SCR power bridge. The reactors limit the rate of change of current (di/dt) through the SCRs and also function with snubber components to limit the rate of change of voltage (dv/dt) across them.

h) Thermal Switch, TS1

An internal thermal switch is provided to shut down the controller in case of overheating due to prolonged excessive output current or loss of fan cooling.

i) Current Transformer Assembly, TB4

AC line current is sensed at power terminal assembly, TB4, by current transformers CT1, CT2 and CT3. These transformers provide an isolated current feedback signal for the main control circuit boards.

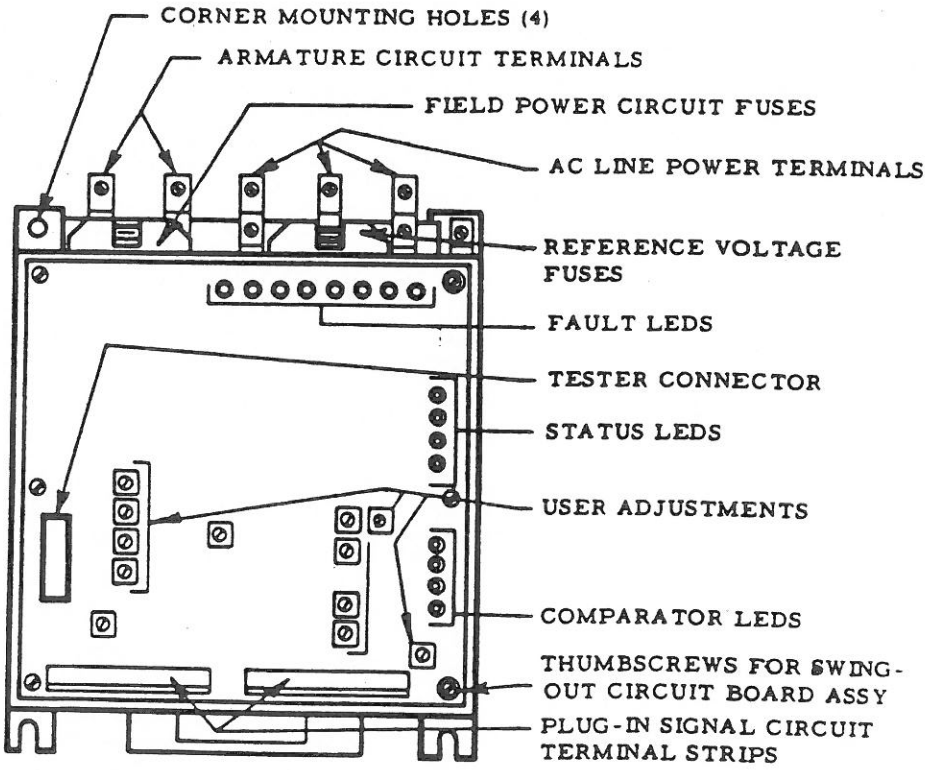


FIGURE 1-1. COMPONENT LAYOUT, SIZE "A" & "B" SPINDLEMATE

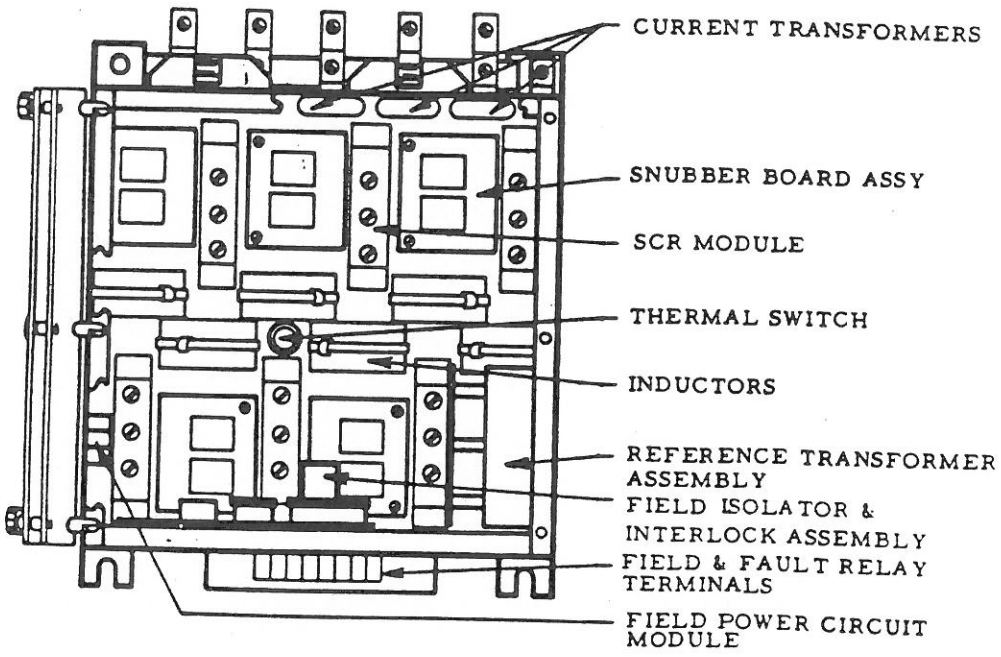


FIGURE 1-2. COMPONENT LAYOUT, SIZE "A"& "B" SPINDLEMATE SWING-OUT CIRCUIT BOARD ASSY OPEN

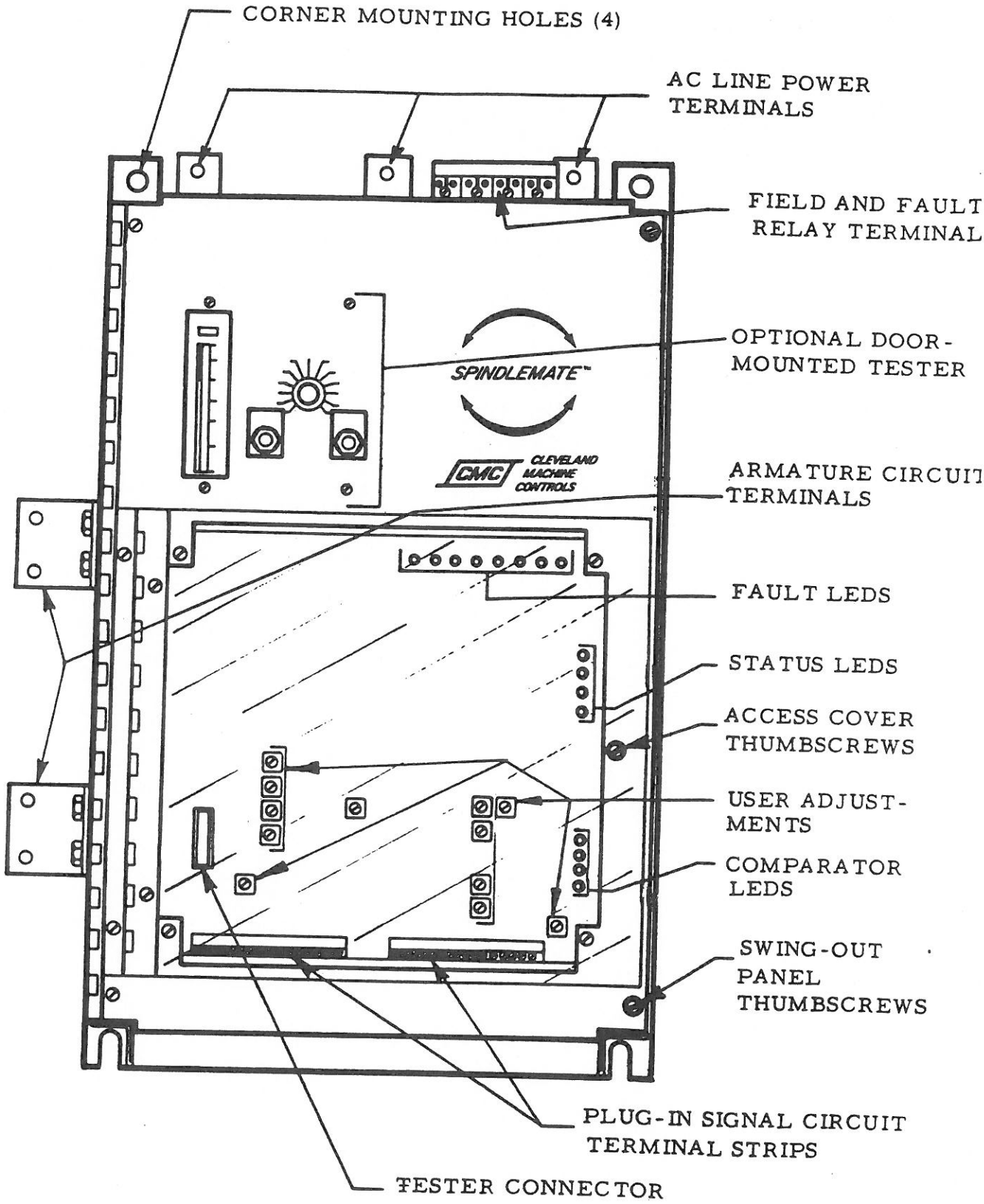


FIGURE 1-3. COMPONENT LAYOUT, SIZE "C" & "D" SPINDLEMATE

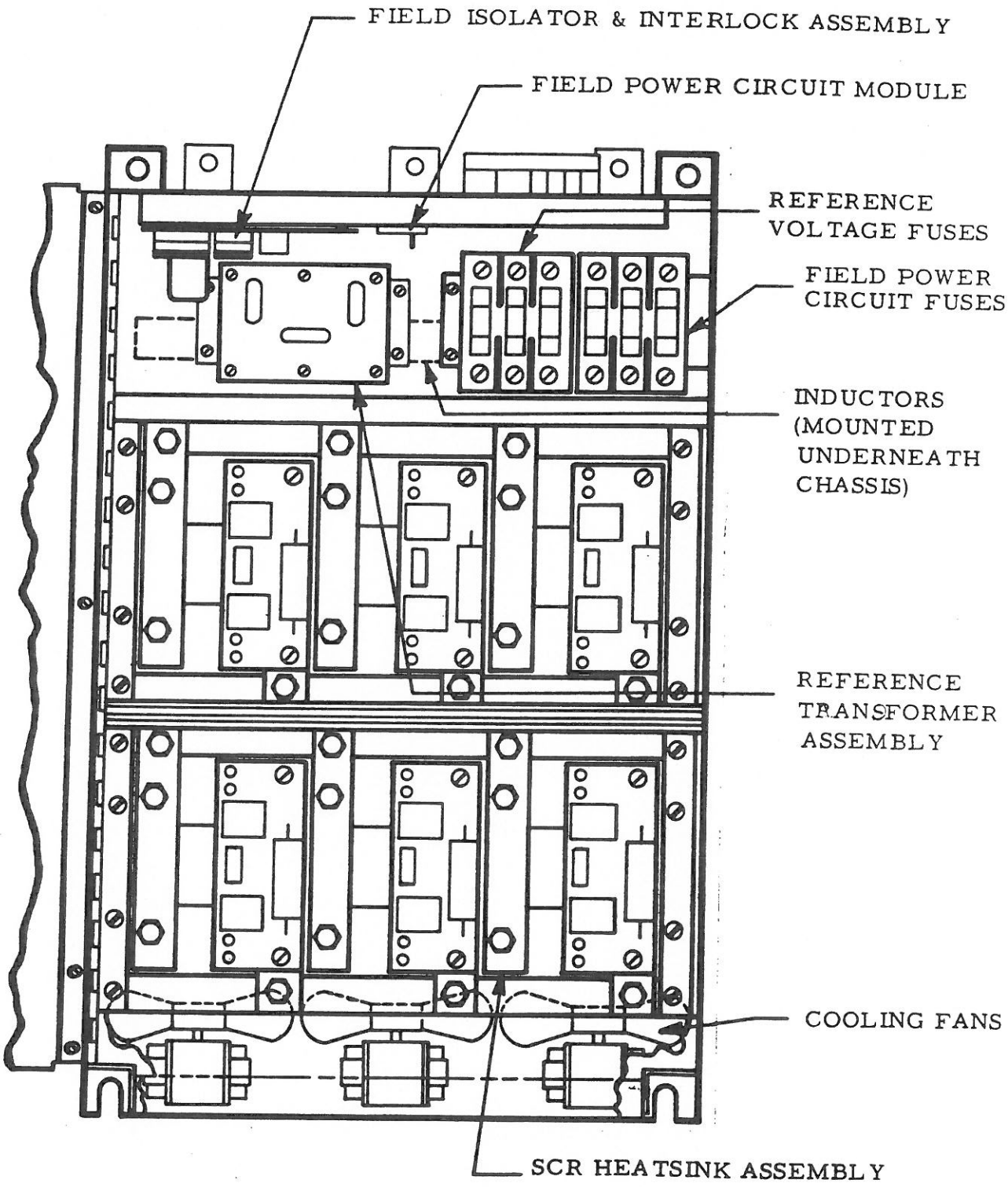


FIGURE 1-4. COMPONENT LAYOUT, SIZE C & D SPINDLEMATE, SWING-OUT PANEL OPEN

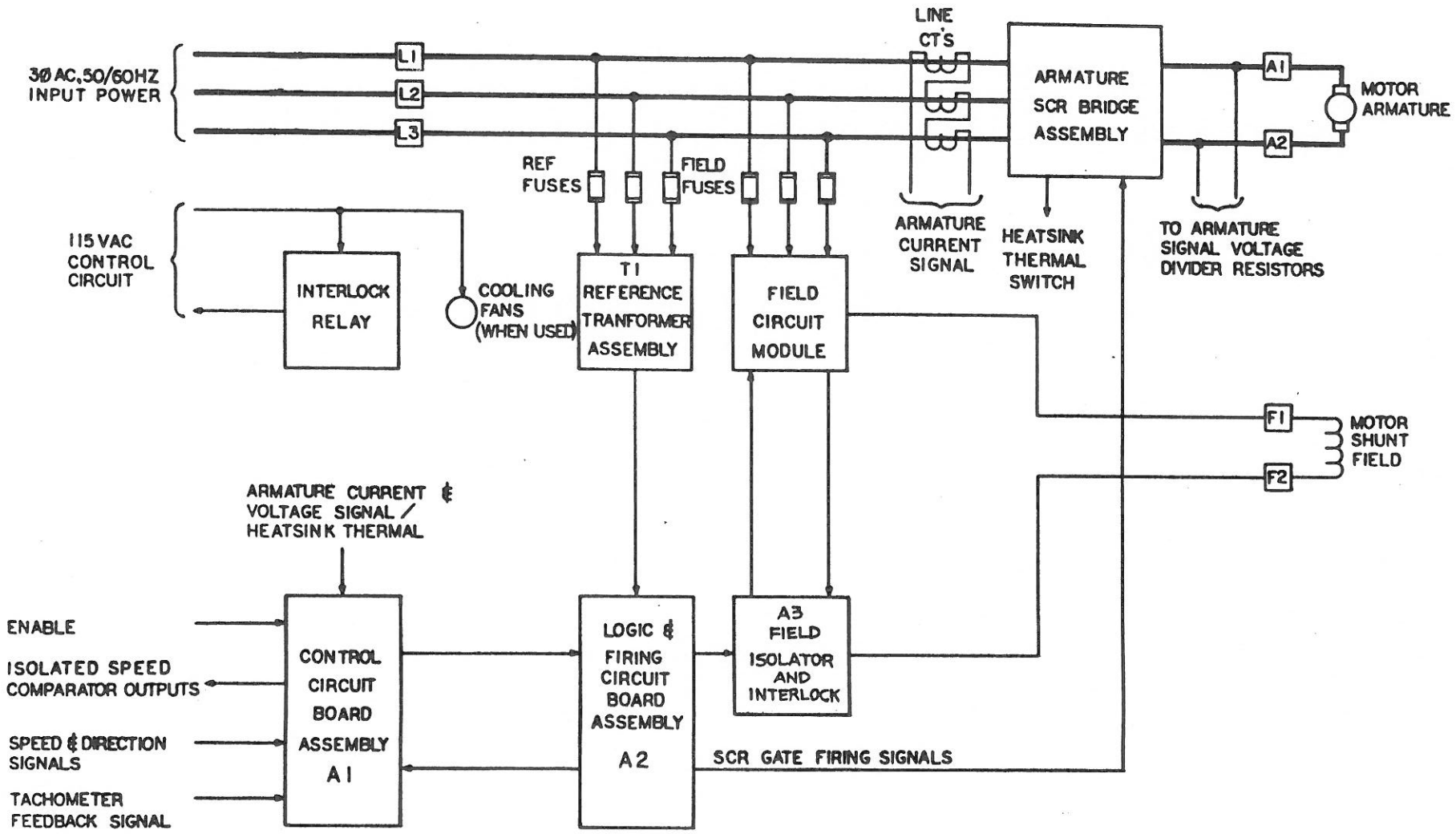


FIGURE 1-5. SPINDLEMATE BLOCK DIAGRAM

1.6 PANEL COMPONENT DESCRIPTION

Refer to drawing section 7.0 for panel layout and circuit connections.

a) AC Circuit Breaker CB1

A three-pole special semiconductor protection type no-fuse circuit breaker is provided to protect the SCR's in case of a fault.

b) DC Circuit Breaker CB2

A three-pole special semiconductor protection type no-fuse circuit breaker is provided to protect the motor in case of a fault. The circuit breaker includes an auxiliary switch connected in the 115 VAC control circuit and an alarm switch which actuates when the circuit breaker trips.

c) DC Circuit Breaker Motor Operator (Part of CB2)

Operation as follows:

1) ON Control

Operating the "ON" switch energizes the motor, which turns ON the breaker. When the breaker is turned ON, the limit switch operates to de-energize the motor.

2) OFF Control

Operating the "OFF/RESET" switch energizes the motor, which turns OFF the breaker. When the breaker is turned off, the limit switch operates to de-energize the motor.

3) ON-OFF Indicator on Motor

When breaker that is ON is tripped, ON-OFF indicator will be showing ON until breaker is reset.

4) RESET Control

Operate the "OFF/RESET" switch to reset the tripped breaker. Circuit operation is the same as in OFF control. Always remove the cause of breaker tripping before resetting it.

Allow five to ten minutes to cool when the breaker was tripped by thermal overload trip, then reset the breaker.

5) Manual Operation

Pump the bottom manual handle right and left to turn ON-OFF the breaker. The indicator on motor operator shows breaker ON and OFF positions.

About 20 cycles of handle pumping completes one breaker ON-OFF cycle.

d) Line Contactor M1

An electrically operated contactor connects the line power to the motor controller.

e) Control Transformer T1

This transformer transforms the line power to 115 VAC. It provides power for the line contactor, the control relay and the motor controller fans.

f) Fuses F1, F2 & F3

These fuses protect the control transformer.

g) Control Relay CR2

The control relay is used to energize the line contactor.

h) RC Surge Suppression Networks R1-C1, R2-C2 & R3-C3

These networks are connected in a delta configuration across the AC power line for the protection of large voltage spikes.

2.0 CONTROLLER INSTALLATION AND WIRING

NOTE: MAKE CERTAIN THE CONTROLLER NAMEPLATE MATCHES THE MOTOR HORSEPOWER, THE MOTOR VOLTAGE AND AVAILABLE AC LINE VOLTAGE.

THIS EQUIPMENT SHOULD BE INSTALLED, ADJUSTED AND SERVICED BY QUALIFIED PERSONNEL FAMILIAR WITH ELECTRICAL EQUIPMENT AND THE CONTENTS OF THIS MANUAL.

IF THE CONTROLLER HAS BEEN FURNISHED WITHOUT A LINE CIRCUIT BREAKER, THE USER MUST INSTALL A CIRCUIT BREAKER OR FUSED DISCONNECT IN ORDER TO MEET REQUIREMENTS OF THE NATIONAL ELECTRICAL CODE.

2.1 GENERAL REQUIREMENTS AND MOUNTING

The SPINDLEMATE controller is supplied as a panel-mounted subassembly. Refer to drawing section 7.0 for installation, panel wiring and system connections.

Mount the SPINDLEMATE controller in a clean, dry equipment enclosure where free air flow is allowed through heatsinks. Maximum ambient temperature should not exceed 55°C. Do not mount directly above components which radiate heat. Avoid areas where moisture, dirt or dust prevail. Never install the controller where combustible vapors are present. Provide accessibility to board-mounted screwdriver adjustments and make certain the swing-out panel can be fully opened for service to internal components.

2.2 POWER WIRING

Wire in accordance with the requirements of the National Electrical Code (NEC) and any local requirements. Size line and armature wiring per the current shown in the Specification Table, Page 1-3. For motor shunt field and contactor control circuits, use 16 AWG minimum. Run signal wiring (including tachometer) in separate conduits from power wiring.

IMPORTANT: Always install a controller ground wire the same size as the AC input power wiring.

2.3 SIGNAL WIRING

Small gauge wire (18 to 22 AWG) can be used in the signal and monitor circuits. Command and tachometer wire should be twisted-shielded pairs with the shield terminated at only one end. Take care to run signal and tachometer wires in separate conduits from armature, field and AC power wires to avoid noise pickups which can cause speed regulation errors.

2.3.1 Reset

Reset of all fault detection circuits is automatic when the fault reset button is actuated or when power is applied to the controller (assuming fault is corrected).

2.3.2 Armature Current/Voltage Signal

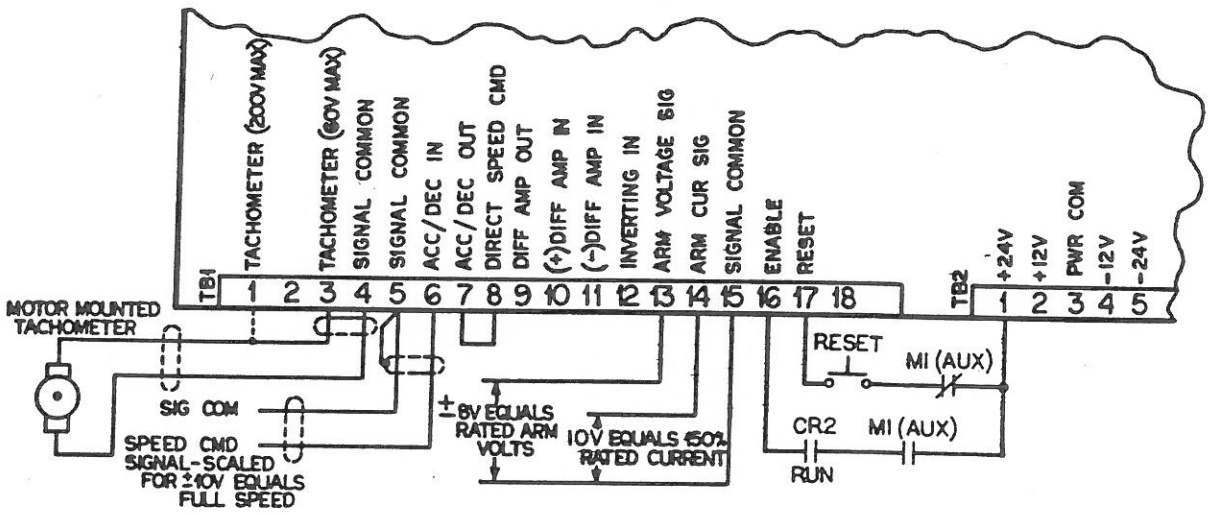
Motor armature voltage and current signals are available at TB2-16 and TB2-15 respectively. Each is referenced to signal common at TB2-14. The controller is normally shipped with the current signal connected for uni-polar output (i.e., positive output regardless of armature current polarity).

2.3.3 Input Signal Connections

The SPINDLEMATE is configured to operate as follows:

1) Single Ended Input with Controlled Acceleration

Bi-polar command signal ranges from 0 to ±10 volts and is referenced to controller common. Output of the controlled acceleration circuit, TB1-7, is jumpered to the direct speed command input of TB1-8.



2.4 SPEED COMPARATOR OUTPUTS

Standard speed comparator output signals on the SPINDLEMATE are Low Speed, Set Speed and Signal Present (AUX). They are commonly interfaced with the CNC for interlock functions such as zero speed, gear shift speed, axis feed permission (up to speed, down to speed), etc. They can also be used to signal operator station status lamps. Outputs are optically coupled transistors which give total isolation from controller signal common. Each has a rating of 30 volts, 30 ma and each has a separate on-board LED status indicator. The outputs can be used directly or as relay drivers in a 115 VAC control circuit.

Comparator output status is as follows:

FUNCTION	TRANSISTOR SWITCH STATUS
Low Speed	
Below Trip Point	OFF
Above Trip Point	ON
Set Speed	
Below/Above Trip Point	OFF
Within Set Speed Range	ON
Aux (Signal Present)	
Below Trip Point	OFF
Above Trip Point	ON

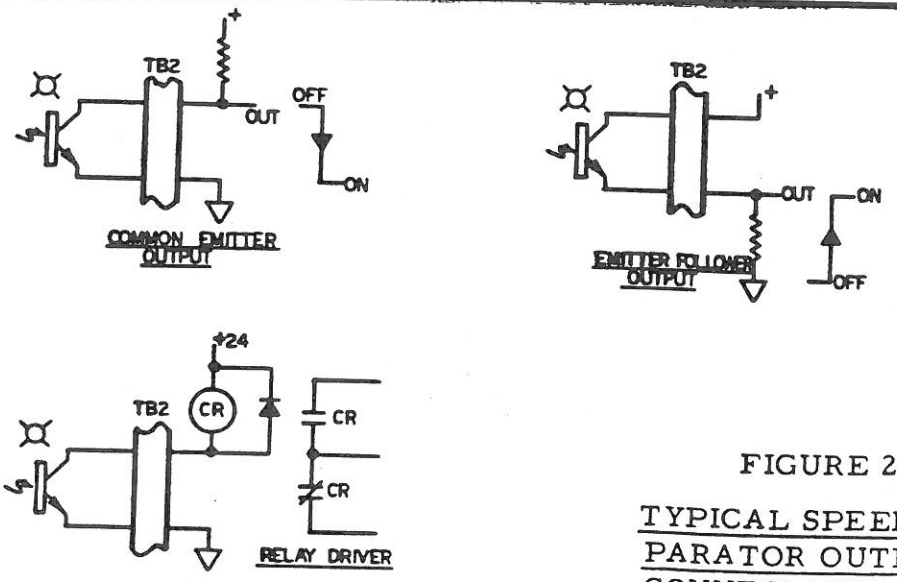


FIGURE 2-10

TYPICAL SPEED COMPARATOR OUTPUT CONNECTIONS

3.0 START AND ADJUSTMENT

SAFETY NOTICE: This equipment should be installed, adjusted and serviced by qualified personnel familiar with electrical equipment and the contents of this manual. High voltage (240 or 480 VAC) is present when the power is on. Use appropriate high voltage troubleshooting techniques.

Accidental short circuits can result in high currents, equipment damage and personnel injury. Check for short circuits and loose connections before applying power. Use ground isolated instruments for all measurements.

FOLLOW THESE SAFETY PRECAUTIONS!

- Check all power and signal wiring. Check heatsinks and circuit boards for loose wire strands or debris which may have accidentally fallen into the controller during installation.
- Verify that motor and drive mechanism is clear of obstruction. Remove any loose parts or shaft keys which could fly off and cause injury.
- Be prepared to immediately stop the drive and turn off power. When starting a system for the first time, the motor may accelerate to a high speed or run in the wrong direction due to improper or missing connections.
- Make certain controller chassis is properly grounded.

TEST EQUIPMENT

1) Digital Multimeter (DMM) or Volt-Ohmmeter (VOM) such as Simpson Model 260.

2) CMC's SPINDLEMATE Tester
The tester is supplied as an option with the controller -- either as a hand-held version or built into the unit (Size B, C & D) Though not required for startup, the tester provides a convenient means of checking system operation. It is calibrated in percent so that it can be utilized to check

controllers of various horsepower and at different locations. It s use will be referenced throughout this section, along with actual voltage and current measurements.

3.1 PRELIMINARY CHECKS, POWER OFF

1) If the optional SPINDLEMATE tester is available, plug it into connector J7 on Control Circuit Board Assembly A1.

2) Turn to TORQUE adjustment CCW until it is about 1/4 turn from its fully CCW position.

NOTE: 50 HZ POWER LINE OPERATION

Controllers are factory-tested on 60 Hz line power. If input power to the controller is 50 Hz, the jumper wire soldered across the two terminals labelled "50 Hz" on Logic and Firing Circuit Board Assembly, A2, must be removed.*

3.2 PRELIMINARY CHECKS, POWER ON

1) Close the AC line power disconnect to apply power to the SPINDLEMATE controller. (Do not yet close the motor contactor.)

Carefully measure the three-phase voltage applied to the controller:

240V Systems - 230 VAC ±10% Line-Line
500V Systems- 460 VAC ±10% Line-Line

2) Check for the following LED indicators:

AC POWER
±12 V
READY

If any of these indicators do not come on, recheck wiring and fuses.

---

* With this jumper, the motor armature bias current at zero speed will be excessive when operated at 50 Hz.

3) Sizes B, C & D Controllers - check cooling fan operation

SPINDLEMATE Tester Checks

SWITCH POSITION	NOMINAL METER READINGS
Line Voltage, L1-L2	100%
Line Voltage, L2-L3	100%
Line Voltage, L1-L3	100%
Field Current	20 to 40% (Economized)
Armature Voltage	
Armature Current	
Speed Command	0
Tach Voltage	
+12V	100%
-12V	100%
Current Command	10 to 20%
Torque Limit	10 to 20%

3.3 MOTOR OPERATING CHECKS

CAUTION: If any problem is encountered during startup, DO NOT JUMPER OUT ANY SAFETY INTERLOCK CIRCUITRY. Refer to troubleshooting guide lines in Section 5 of this manual.

1) With a zero speed command signal, energize the motor contactor, M1, with the Spindle Start control circuit. The motor should remain at near zero speed. Check the Spindle Stop control circuit to be certain its motor contactor drops out.

IF THE MOTOR STARTS TO ACCELERATE TO A HIGH SPEED, the tachometer feedback polarity is reversed. Interchange the tachometer wires.

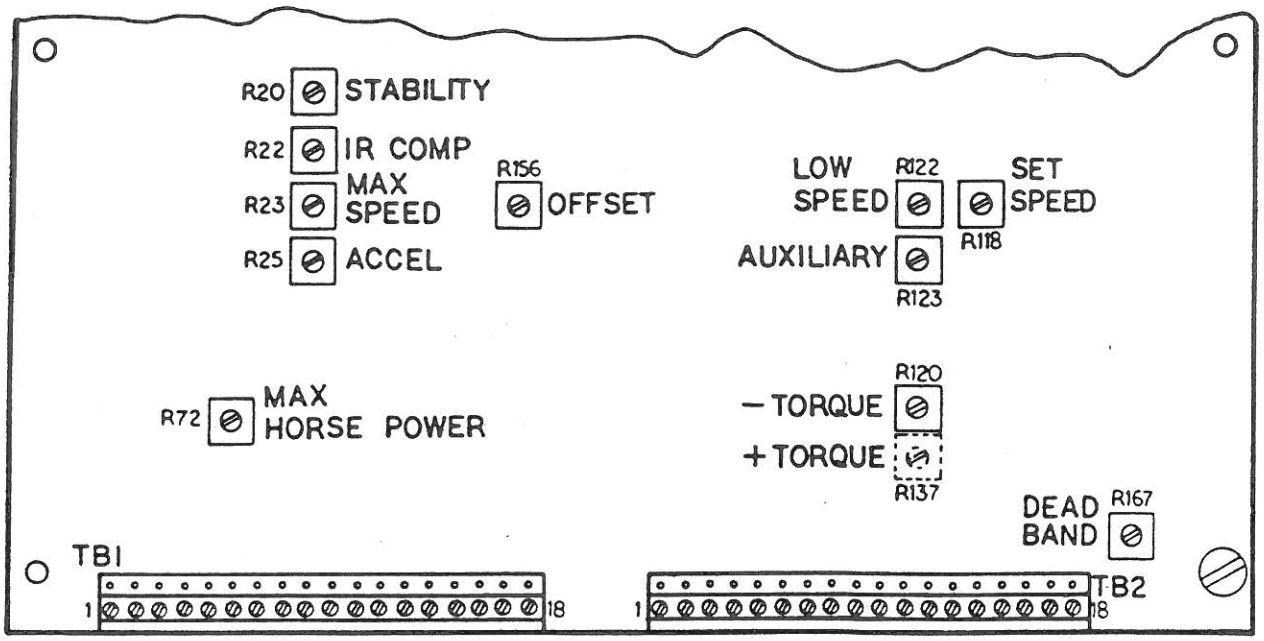
2) Restart the drive and apply a small forward speed command signal. The motor should accelerate and stabilize at the commanded speed. If motor rotation is reversed from that required for the speed command polarity, reverse both the motor shunt field and the tachometer wires.

3) When the speed command signal is removed, the motor should regenerate to zero speed. If the motor runs at a very low speed without a speed command signal present, adjust the OFFSET trimmer potentiometer, R156 on Control Circuit Board A1, for zero speed.

4) Check reverse operation by applying a small reverse speed command signal. When proper speed control is established, turn the TORQUE adjustment to mid-position.

SPINDLEMATE Tester Checks	
SWITCH POSITION	NOMINAL METER READING
Field Current	100% (Full Field)

3.4 CONTROLLER ADJUSTMENT



A1 CONTROL CIRCUIT BOARD ASSEMBLY

NOTE: User adjustments are clearly labelled and easily identified on the main circuit board assemblies. The small DP trimmer adjustments are factory set and should not be altered. The procedure for setting these trimmers is listed for reference in the back of the manual.

1) TORQUE

The TORQUE control is used to set the amount of torque the motor can provide up to base operating speed by determining its level of armature current. Full CCW rotation will reduce the current to zero while with full CW rotation, the controller can provide 200% rated current. Most applications require a setting of about 150% in order to meet low speed load and acceleration requirements. The adjustment is most easily made using the SPINDLEMATE tester but alternate methods are listed below. Be certain to keep motor speed low (below base speed) until the other controls are properly adjusted. Apply step command signals (abruptly apply and remove the signal) with the ACCEL control fully CW to check the setting.

NOTE: It is not recommended that the motor shaft be locked for this test. If it is, be aware that the output current will reduce to 10% of nominal as set by the TORQUE control after 1 second of operation by the Stall Current Limit detector circuit.

a) SPINDLEMATE Tester Checks - A special feature of the tester is the ability to set maximum output current without the motor operating. Simply switch the tester to the TORQUE LIMIT position and depress the pushbutton. This displays the TORQUE adjustment setting and simultaneously opens the interlock circuit to prevent motor operation. Output current can be then checked on the ARMATURE CURRENT position.

b) Current Test Output Signal - A signal proportional to the absolute value of armature current is available at TB1-14. It is referenced to signal common and has a scale factor of +10 volts equals 15% rated current.

c) Armature Circuit Shunt - A shunt can be placed in series with one of the armature leads and the current can be measured with a ground-isolated DMM. If done this way, connect test leads directly to sense screws on shunt - not power terminals which can give a faulty indication due to voltage drop of terminal connections.

CAUTION: HI VOLTS

2) STABILITY

The STABILITY control provides response time adjustment of the controller within limitations imposed by system mechanican characteristics and the torque limit. Turning the adjustment CW will increase system response and correct overshoot or low frequency oscillation. Too high a setting may, however, cause high frequency oscillation. For most applications, a 50% setting is a good compromise. The adjustment is most easily made by applying step command input signals.

3) Field Control CROSSOVER Check

NOTE: If the SPINDLEMATE is connected for BEMF feedback (no tachometer) turn the CROSSOVER control fully CW.

Monitor the armature voltage with the SPINDLEMATE tester or a DMM and apply a low level (non-reversing) speed command signal. Slowly increase the signal to a level where the motor shaft is rotating at, or slightly above, base speed. At this point, the motor armature voltage should have stopped increasing with shaft speed and the field regulator should have taken over. Verify this by noting that the armature voltage is:

215 to 230 VDC, 240 volt motors
450 to 480 VDC, 500 volt motors

If the armature voltage continues to rise above the levels indicated, the CROSSOVER adjustment in the field regulator is incorrectly set. This will cause overvoltage trip-out. Proceed to Field Regulator Adjustments, Para. 3.6, before going to the MAX SPEED adjustment.

SPINDLEMATE Tester Checks	
SWITCH POSITION	NOMINAL METER READING
Armature Voltage	85% to 95%
Field Current	Starting to decrease from the 100% position

4) MAX SPEED

With the CROSSOVER adjustment correctly set, continue to increase the speed command signal to its maximum value while monitoring motor shaft speed. Do this by measuring tachometer voltage or by checking with a hand-held tachometer or equivalent. Adjust the MAX SPEED control for the desired motor speed.

CAUTION: DO NOT OVER SPEED MOTOR

If the motor armature voltage starts to increase at high speeds, the MIN FIELD adjustment in the field regulator is incorrectly set. See Para. 3.6.

SPINDLEMATE Tester Checks	
SWITCH POSITION	NOMINAL METER READING
Armature Voltage	90 to 100%
Field Current	Minimum
Speed Command	100%
Tachometer Voltage	100%

5) ACCELERATION

Motor acceleration time from zero to full speed and deceleration from full speed to stop is set with the ACCEL adjustment. Standard range is 0.5 to 5 seconds to an unloaded motor. With a large inertial load, however, torque capability will limit short accel/decel times.

6) IR COMP

NOTE: The IR COMPENSATION adjustment is used only with systems which do not have tachometer feedback. If your system has tachometer feedback, TURN THE ADJUSTMENT FULLY CCW.

If improved low speed regulation is desired on systems with BEMF feedback, turn the IR COMP adjustment CW until the desired regulation is achieved. Recheck at other speeds to be certain motor operation is stable. Most applications will allow a setting of about 50%.

7) DEAD BAND (NOT USED)

The Dead Band adjustment (R167) is normally turned full CCW. Its effect is to cause a "Dead Band" of response to a speed command signal. This means the drive will be motionless until the command signal reaches a particular level. Most applications will not require any dead band. To increase the amount of circuit "Dead Band", turn pot CW.

3.5 SPEED COMPARATOR ADJUSTMENTS

NOTE: The speed comparator circuits are incorporated into the controller to provide an indication of overall system operation. Precise setting of these adjustments is not required for proper controller operation.

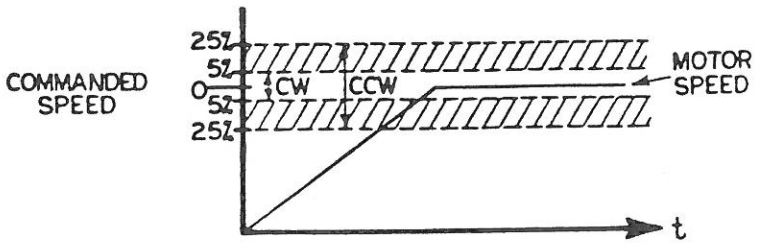
1) SET SPEED

The Set Speed circuit detects commanded speed when accelerating from zero or a low speed to a higher speed, and from a high speed to a lower speed. It operates the same in both forward and reverse direction of motor rotation.

Full CW rotation of the SET SPEED adjustment sets the trip point closer to set speed while with full CCW rotation, the trip point will be within approximately 25% of set.

FIGURE 3-1

OPERATION OF SET SPEED ADJUSTMENT



2) LOW SPEED

The LOW SPEED adjustment is approximately ±2 to ±25% of max. motor speed. CW rotation increases the sensitivity.

3) AUX

The AUX comparator circuit is normally wired to detect the presence of a speed command signal. (This comparator is sometimes wired for special speed sensing circuits.) CW rotation of the AUX adjustment increases the sensitivity.

3.6 FIELD REGULATOR ADJUSTMENTS

NOTE: The Field Regulator is factory-set and further adjustment should not be required unless motor parameters were not known at time of shipment.

Use this procedure for standard 240 volt and 500 volt motors which have 150 volt and 300 volt fields. Motors with non-standard field voltages require a special set-up procedure. Consult CMC Applications Engineering.

Adjustments are located on the Logic and Firing Main Circuit Board, A2. Open the swing-out board assembly fully for access.

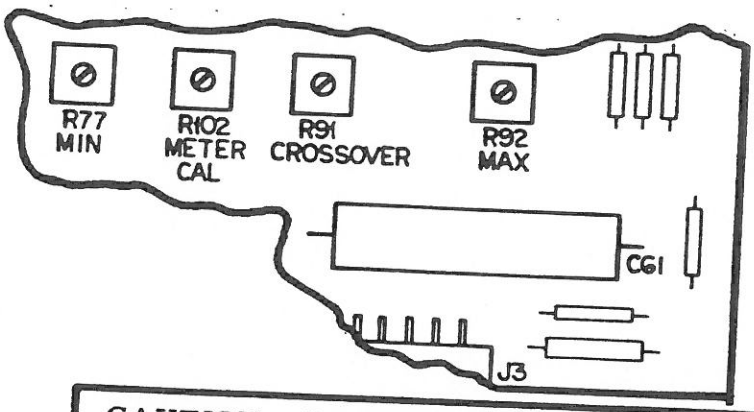


FIGURE 3-2

FIELD REGULATOR ADJUSTMENTS ON MAIN BOARD ASSEMBLY, A2

CAUTION: DO NOT ATTEMPT TO OPERATE MOTOR IN THE FIELD WEAKENING RANGE WITHOUT TACHOMETER FEEDBACK. LOSS OF CONTROL AND EXCESSIVE SPEED WILL RESULT.

1) Initial Adjustment

MAXIMUM FIELD (MAX)	-	Fully CW
MINIMUM FIELD (MIN)	-	Mid Position
CROSSOVER	-	Fully CW

2) Warm-Up Period

Operate the motor at low speed (less than 1/2 base speed) for 1/2 hour to allow the shunt field to come up to operating temperature.

3) MAXIMUM FIELD

After the warm-up period, make MAXIMUM FIELD adjustment with motor contactor closed but with a zero speed command signal.

a) SPINDLEMATE Tester

Switch the tester to the FIELD CURRENT position. Adjust the MAX FIELD control CCW until the meter reading starts to decrease. This indicates that the regulator is out of saturation and in active control. Leave the adjustment set at about 5% (1 LED) below its saturated level.

b) VOM or DMM

If SPINDLEMATE Tester is not available, make the adjustment by monitoring field voltage or field current with a separate voltmeter. If voltage is checked to make the adjustment, follow instructions in (a) above. Field current can be checked by measuring the voltage across the shunt field current sensing resistor R9 on Field Isolator and Interlock Circuit Board, A3. Adjust the MAX FIELD control for the field current shown on the motor nameplate.

CAUTION: HIGH VOLTS. The shunt field power circuit is at line potential.

4) METER CALIBRATION

The METER CAL adjustment is used only to calibrate the SPINDLEMATE Tester. Adjust the control after the MAX FIELD adjustment is made for a reading of 100% on the FIELD CURRENT position.

5) MINIMUM FIELD

Estimate the minimum shunt field current necessary for maximum motor speed. Refer to Figure 3-3. Open the AC line contactor and wait for about 10 seconds for the AC field to go to the economized level (controlled with the MINIMUM FIELD adjustment). Adjust the MIN FIELD control to the estimated level:

Example: 1150 RPM Base Speed Motor
3450 RPM Maximum
Adjust MIN FIELD control for
30% current

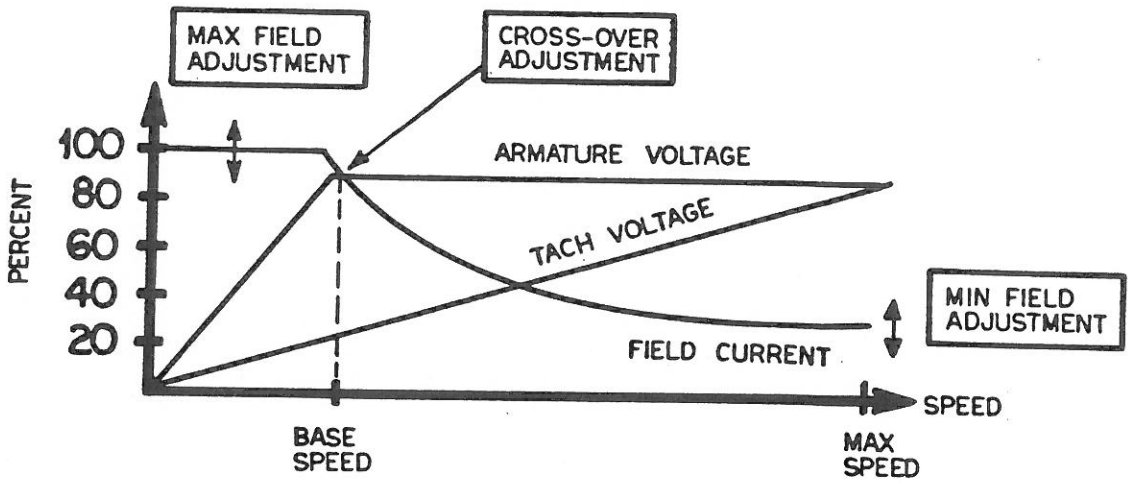


FIGURE 3-3. FIELD REGULATOR CHARACTERISTICS

6) CROSSOVER

Monitor the armature voltage with the SPINDLEMATE Tester on a DMM and apply a low level (non reversing) speed command signal. Close the AC line contactor and slowly increase the speed signal to base operating speed as indicated by 240 volts or 500 volts (as applicable) at the armature. Turn the CROSSOVER adjustment CCW until the armature voltage reduces to 90%.

220 VDC - 240 volt Motors

460 VDC - 500 volt Motors

Monitor motor speed by measuring the tachometer voltage or by checking with a hand-held tachometer and continue to increase the speed command signal to full motor speed. Note that the armature voltage remains constant as the speed increases. If the armature voltage starts to increase at high speeds, turn the MIN FIELD control CCW a little. Field regular adjustment is now complete. Check operation in the reverse direction of motor rotation if applicable.

3.7 SPINDLEMATE TESTER

The built-in circuit tester is a valuable aid when first starting up a controller, or as a check on a system already in operation. It is calibrated in percent so that the same tester can be utilized to check controllers of various horsepowers. Indication is on LED bar graph scale. The following chart lists tester functions :

SWITCH POSITION	CIRCUIT MEASURED	NOMINAL METER READING
1 LED TEST	Individually checks all LEDs of Tester	
2 - LINE VOLTS 4 L1 to L2 L2 to L3 L1 to L3	Reference Transformer Secondary Voltage	100%
5 FIELD CURRENT	Motor Shunt Field Supply Current: Economized Drive On Below Base Speed Drive On Above Base Speed	Min. Field Setting 100% Reduces to Min.Field Setting at Max Speed
6 ARM VOLTS	Output of Armature Voltage Buffer Amplifier	0 to 100%, Proportional to Motor Speed
7 ARM CUR	Output of Armature Current Buffer Amplifier	0 to 150%, Proportional to Motor Torque
8 SPEED CMD	Speed Command Signal	0 to 100%, Proportional to Motor Speed
9 TACH VOLTS	Tachometer Feedback Signal	0 to 100%, Proportional to Motor Speed
10 +12 VDC	+12 Volt Ref Supply	100%
11 -12 VDC	-12 Volt Ref Supply	100%
12 CUR CMD	Input Command Signal to Current Loop Amplifier	0 to 150%, Proportional to Motor Torque
13 TORQUE LIMIT	Current Limit (TORQUE) Setting, Drive Disabled	0 to 150%, Proportional to TORQUE Control Setting

NOTE: Voltage measurements are positive (+) unless NEG LED is on.

4.0 THEORY OF OPERATION

CMC's SPINDLEMATE^{TM} controllers utilize a three-phase, full-wave (six pulse) regenerative SCR (silicon controlled rectifier) power circuit to control 240 VDC and 500 VDC motors of 3 HP and up. The standard control consists of the motor armature controller and the shunt field regulator.

The SPINDLEMATE incorporates a full time current loop to enable the drive to rapidly and accurately follow torque commands and tachometer feedback for precision control. Adjustable controlled acceleration/deceleration is standard. This provision allows setting acceleration and deceleration in the range from 0.5 to 5 seconds for zero to full speed with other adjustment ranges available as options. Acceleration is limited by the automatic current limit circuitry if the acceleration setting demands armature current exceeding the adjustable current (torque) limit setting. Figure 4-1 shows the current and rate feedback arrangements in a simplified block diagram.

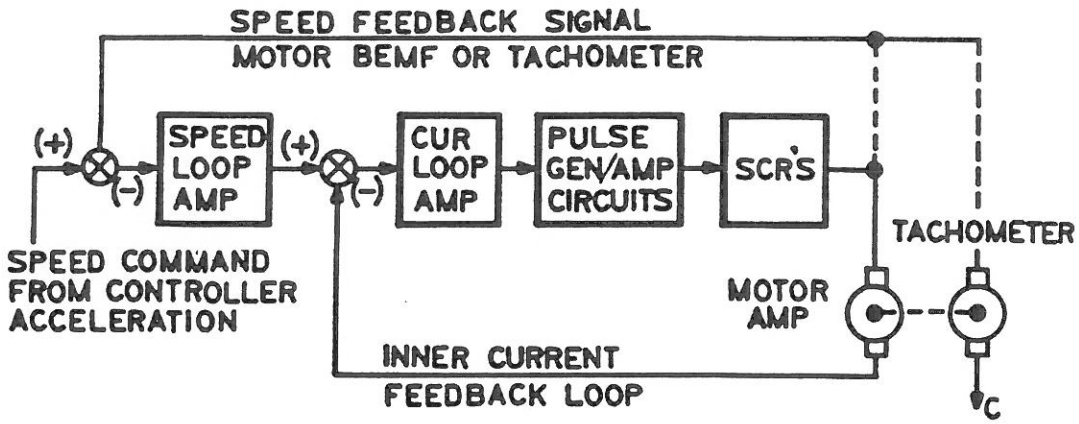


FIGURE 4-1. CONTROLLER CURRENT AND SPEED FEEDBACK ARRANGEMENT

The input to the SPINDLEMATE controller is isolated from the AC lines and ground and may be used with grounded or non-isolated signal sources. More than one drive may be operated from a common speed potentiometer or other signal source.

4.1 ARMATURE CONTROLLER POWER CIRCUIT

The power circuit, shown in Figure 4-2, is a full-wave, bi-directional bridge with twelve controlled SCRs for three-phase full-wave rectification of the incoming AC input power in both directions. This full-wave SCR bridge assembly consists of six sets of SCR assemblies which control current flow in the load. Each SCR is directly mounted to a finned aluminum heatsink assembly which dissipates the heat generated by current flow through the SCR. Phase control of the SCRs in the bridge assembly controls the magnitude of the DC power to the load.

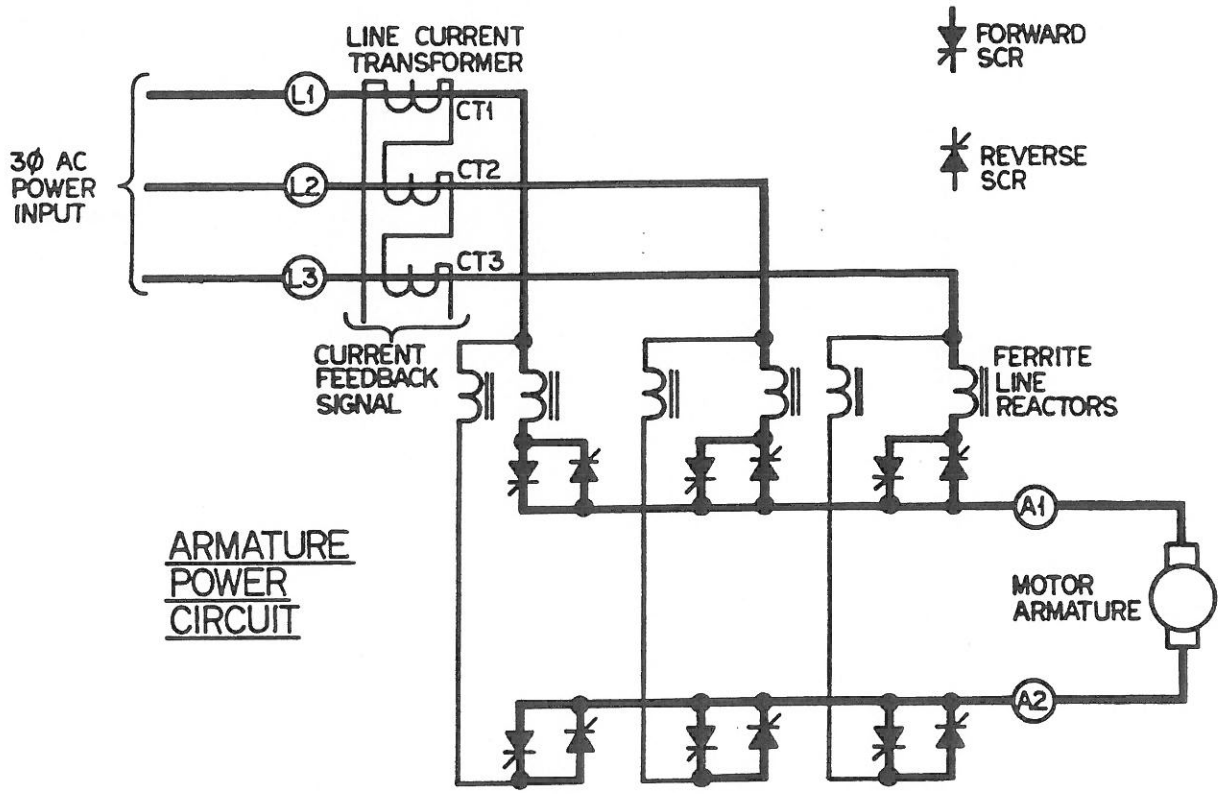
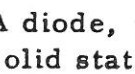
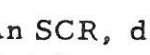


FIGURE 4-2. ARMATURE POWER CIRCUIT

4.1.1 SCR Phase Control

All phase controlled SCR power converters operate by connecting each phase of the AC line sequentially to the motor armature by controlling the firing of the SCRs. An SCR operates in a manner very similar to that of a diode.

A diode, which is denoted by the symbol (A)  (K), is a solid state rectifier which allows current flow in the direction of the arrow symbol whenever the anode end of the diode is more positive in voltage than the cathode end, but prevents current flow when the voltage is reversed.

An SCR, denoted by the symbol (A)  (K), is different in that it prevents current flow in both directions unless "fired", when the voltage on the anode is positive relative to the cathode; it then "turns on" and allows current flow exactly as if it were a diode. Firing is accomplished by applying a positive voltage to the gate relative to the cathode of the SCR. Once turned ON, the SCR will remain ON until the current through the SCR has been reduced to zero and the voltage is zero or reversed (i.e., anode negative to cathode). It then shuts off and prevents current flow until fired again. The voltage drop across a diode or an SCR in the "ON" condition is about one volt, thus the power losses are very low. The SCR firing sequences are as follows (see Figure 4-2):

SCR's	Line to Line Phases	
A1 and B4	L1-L2	Forward
A1 and C4	L1-L3	
B1 and C4	L2-L3	
B1 and A4	L2-L1	
C1 and A4	L3-L1	
C1 and B4	L3-L2	

Repeats

A3 and B2	L1-L2	Reverse
A3 and C2	L1-L3	
B3 and C2	L2-L3	
B3 and A2	L2-L1	
C3 and A2	L3-L1	
C3 and B2	L3-L2	

Repeats

4.1.2 Power Circuit Waveforms

Typical controller output voltage and current waveforms are shown in Figures 4-3 and 4-4. The waveforms of Figures 4-3 and 4-4 apply for the forward SCR set only; the voltages and currents in the reverse SCR set have the same shape with opposite polarity.

When each SCR pair is fired (turned ON by the control circuitry, to be discussed later), the voltage across the load is switched to that of the AC input supplying the SCRs which are fired. For example, on the extreme left of Figures 4-3 and 4-4, the output voltage becomes that between L1 and L2 when SCRs A1 and B4 are fired.

This applies a positive voltage across the load and the output current rises until the L1 to L2 voltage crosses the output average voltage. The current then decreases until zero current is reached, at which point the SCR shuts off and the load voltage rises to the average value.

The load voltage remains at this value until SCRs A1 and C4 (L1 to L3) are fired and the sequence is repeated. At the low output currents illustrated at the left of Figures 4-3 and 4-4, each SCR pair shuts off at zero current before the next pair is fired; at high currents as shown at the right side of the figures, each succeeding SCR is turned on before the current in the SCR which has been ON falls to zero. This type of high current operation is referred to as "continuous conduction" since the load current is never shut off between cycles but is commutated from one incoming AC line to the next.

Note that the full range of control is attained by varying the firing pulses over a range of about 120 electrical degrees referred to one line cycle.

4.1.3 Transient Suppression

Associated with each SCR Assembly are snubber networks and transient suppressors across the SCRs.

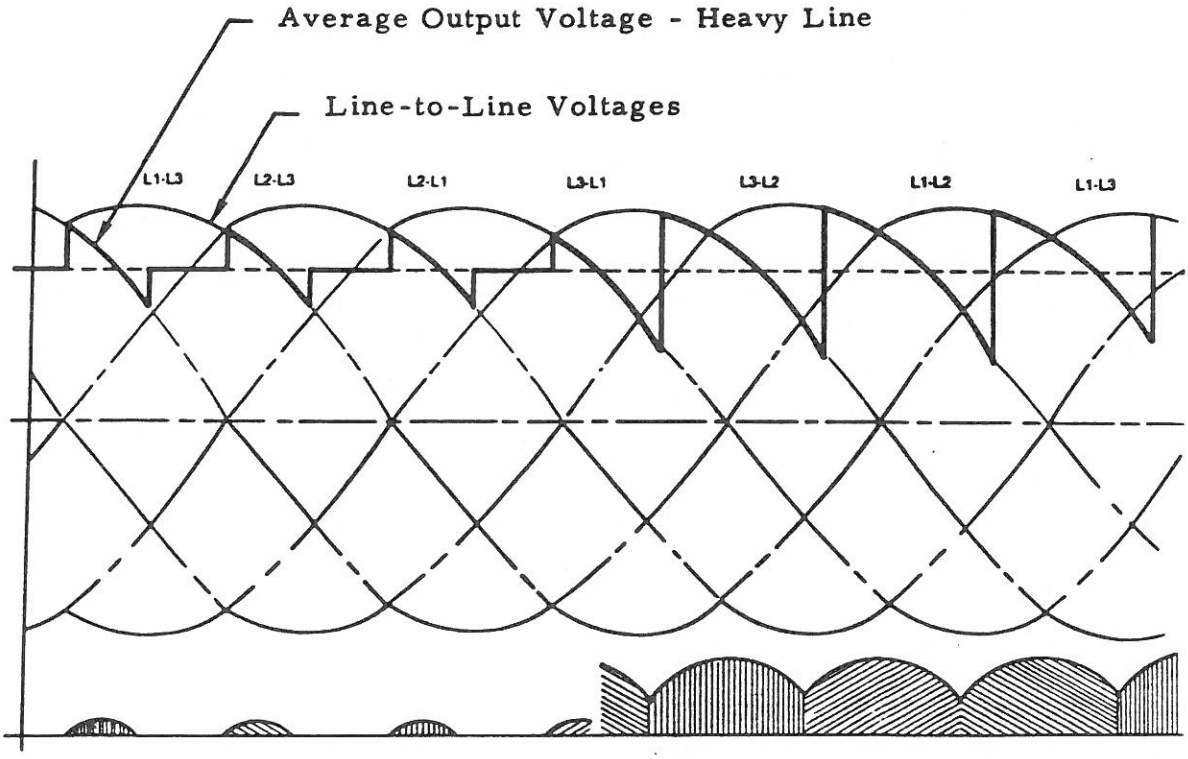


FIGURE 4-3. THREE-PHASE FULL-WAVE BRIDGE WAVEFORMS - HIGH OUTPUT VOLTS

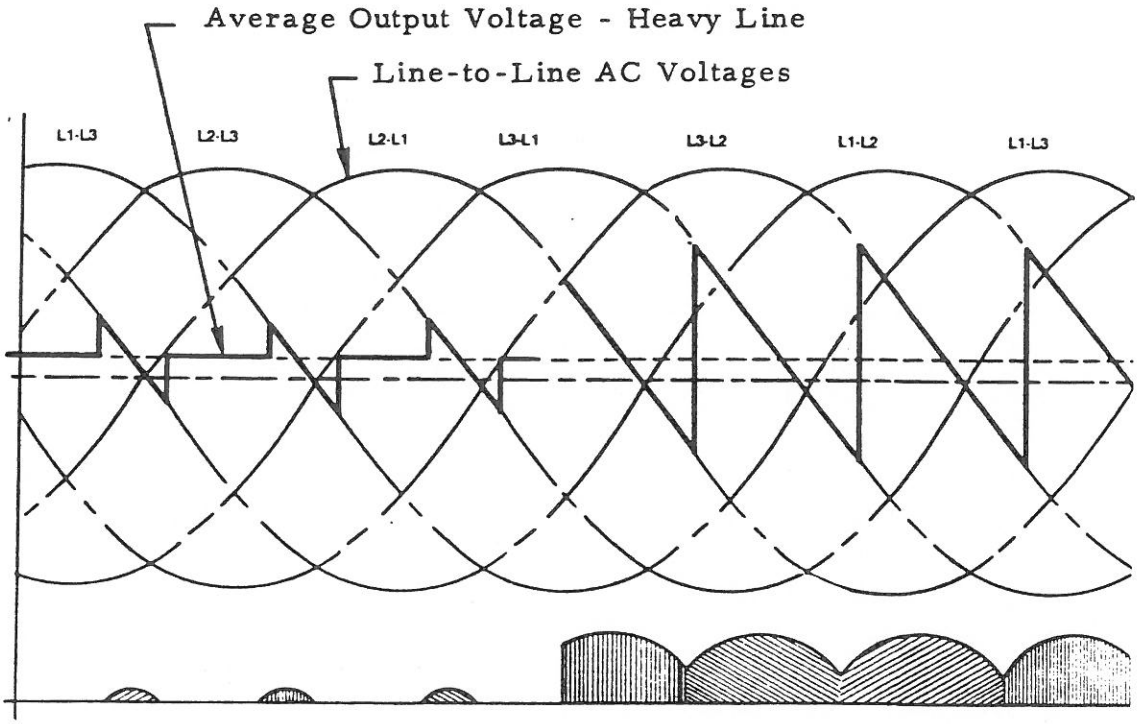


FIGURE 4-4. THREE-PHASE FULL-WAVE - WAVE BRIDGE WAVEFORMS - LOW OUTPUT VOLTS

The snubber networks consist of a series RC network connected across from anode to cathode. There are six of these networks (one for each SCR pair). This network acts to limit the rate of change of voltage (dv/dt) across the SCR to a value within the device rating.

Ferrite reactors in series with each SCR pair limit the rate of change of current (di/dt) through the SCR and also work with snubber network components to limit dv/dt.

Peak transient voltage suppression is attained with metal oxide varistors (MOV's) matched to the SCR voltage rating. These suppressors are installed across the SCRs in parallel with the snubbers. They serve to clamp voltage spikes to a level well within the peak voltage rating of the SCRs.

4.1.4 Current Feedback

Current transducers mounted on TB4 are used to sense current in the three incoming main power lines. These transducers are toroidal transformers whose output signal is proportional to the current in each phase of the AC line. The AC line power bus bars passing through the center of the coil form the transformer primary. The secondary coil voltage is rectified with diode bridges and loaded with resistors. The outputs of the three transducers are summed together and the resulting DC signal is proportional to controller output current. This signal is used directly on the circuit board assembly for current feedback since it is electrically isolated from the high voltage SCR section.

4.2 MAIN CIRCUIT BOARD ASSEMBLIES

The two main circuit board assemblies, A1 and A2, contain most of the electronic components and circuitry necessary to operate the controller. The boards are mounted back-to-back and interconnect at connector J7.

Major functions of the Control Board, A1, are:

1) Speed and current regulator circuits
2) Interlock, Status and Fault LED circuitry
3) Comparator circuits with opto-isolated outputs

Major functions of the Logic and Firing Board, A2, are:

1) ±12 volts and ±24 volts power supplies
2) Line synchronization, SCR firing pulse generation, distribution and amplifier circuits, output current polarity steering logic.
3) Field current regulator and adjustments

4.2.1 Speed Regulator Circuits

The speed regulator circuitry is made up of several individual circuits which condition the speed command and feedback signals to properly control motor speed. These circuits are:

1) The controlled acceleration/deceleration circuit
2) The armature voltage amplifier
3) The speed loop amplifier

4.2.1.1 The Controlled Acceleration Circuit

This circuit includes operational amplifiers U8A and U8B and associated components. The circuit determines the rate of change of speed command signal which is applied to the speed error amplifier by changing sudden or step command input signals into linear ramp functions. See Figure 4-5.

The input to this circuit is fed from TB1-6 through resistor R28. The output is to TB1-7. In operation, the positive command signal is applied to the non-inverting input of U8-B. This amplifier has a very high forward gain which means that even

very small input signals cause its output to saturate in either the positive or negative direction -- depending on whether an accelerating or decelerating command is received.

Accelerating (positive) and decelerating (negative) commands are directed to the ACCEL/DECEL Control, R25. Either signal polarity causes a constant current to flow into the input of integrating amplifier U8-A through R27. The output of the circuit then changes at a linear rate until it has the same magnitude but opposite polarity to that of the input signal. The overall gain of the circuit is approximately minus 1.0 and is set with input resistor R28 and feedback resistor R29. To assure a controlled start-up regardless of input signal condition, the output amplifier, U8-A, is clamped to a zero condition with FET switch Q5 until the controller output contactor is energized.

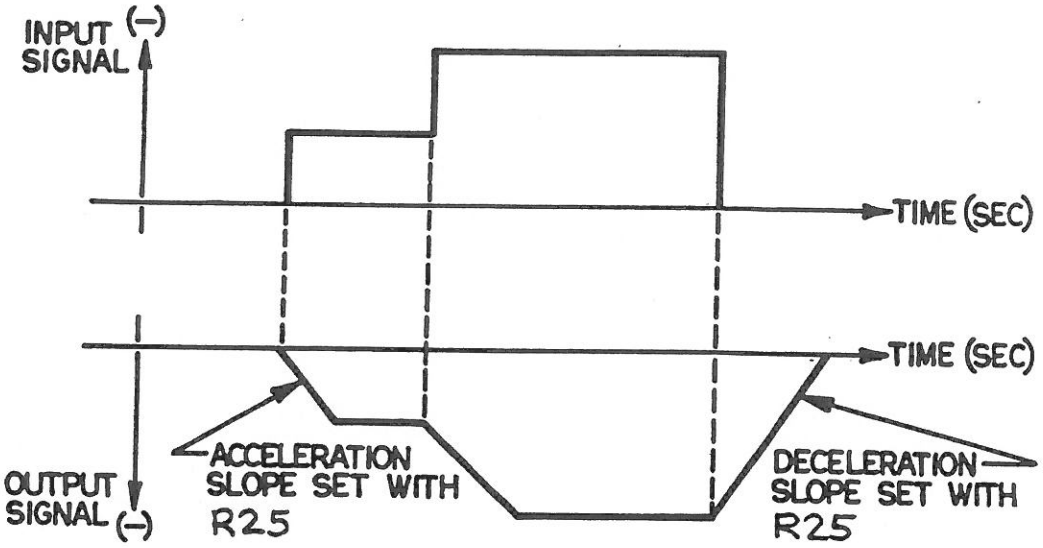


FIGURE 4-5. CONTROLLED ACCELERATION CIRCUIT

The Armature Voltage Amplifier provides a signal, referenced to signal common, which is proportional to the motor armature voltage. This signal is needed for the speed loop amplifier, the field regulator control, the speed comparator circuits and for the tachometer loss detector. The circuit is comprised of operational amplifier U10-A and associated components which are connected in a differential amplifier configuration. The motor armature voltage, wired to connector P1, Pins 5 and 7, is divided down to a level compatible with the operational amplifier circuitry by means of external resistors. The overall circuit gain from motor armature voltage to U10-A output is 0.29 volts/volt for 240V units, and 0.014 volts/volt for 480V units.

Resistors in U9 and R30 are selected to give maximum common mode voltage rejection and capacitors C6 and C7 provide filtering of noise which is commonly present on the armature leads.

Diodes CR10 through CR13 are used to clip any high voltage transients at the input of U10-A.

The Speed Loop Amplifier, U15-A, sums the acceleration speed command signal input of TB1-8 with the speed feedback signal from either the armature voltage amplifier or a motor-mounted tachometer. The resulting signal is amplified through U15-A and applied to the current regulator circuitry as the torque command signal.

When tachometer feedback is used, the DC tachometer is connected to TB1-1 or TB1-3, depending upon the expected maximum output of the tachometer. The tachometer signal is applied to U15A through R23 (the MAX SPEED adjustment), R44 and R45. Capacitors C25 and C26 and resistor R45 form a low frequency "lead" network which is selected for optimum motor response to sudden speed commands. If back EMF feedback is used, the output of the armature voltage amplifier, U10A, at TB1-13 is connected to the tachometer feedback input of TB1-3. Note that constant horsepower field operating range cannot be used with back EMF feedback.

Two other inputs are connected to amplifier U15-A. One is the IR compensation signal from the wiper of potentiometer R22 through R17 and R46. (Turn R22 fully CCW when tachometer feedback is used.) The last input is from P6, Pin 5 through R1 and diode CR16. A voltage from the external tester is connected to this point in order to saturate U15-A for the TORQUE LIMIT SET position.

The gain and frequency response of the amplifier are determined by resistor R77 and capacitors C23 and C24 in conjunction with the STABILITY control R20. FET switch Q8 calmps the amplifier to a zero condition until the contactor is energized.

4.2.1.2 Current Regulator Circuits

The current amplifier, U24-A, sums the current feedback signal from the current transformer at connector P1-2 through R39 with the current command signal through R59. It frequency-compensates the resulting current error signal and applies it to the pulse generator circuits on the A2 board. U24-A is connected as an integrator whose gain, set by feedback components R40, C21 and C22, is selected to give a closed current loop response of approximately 25 Hz. Maximum controller output current (motor torque) is set by controlling the input signal to the current amplifier. This input signal is actually the output of the speed loop amplifier, U15-A. Maximum current with the TORQUE control fully clockwise (CW) for peak controller output is 200% of nameplate rating. Output current can be reduced from the maximum setting down to zero by simply rotating the TORQUE control counterclockwise (CCW). FET switch Q7 cages the amplifier output until the controller is started.

Amplifiers U13-A and B form a di/dt limiter which is used to limit the rate of change of the current command signal to the current loop amplifier. U13-A is connected as a non-inverting comparator (no feedback elements) with an input signal applied through R38 and a feedback signal thru R37. Any differences between the signals will cause the output to switch to either plus or minus saturation ($\pm$ 10 volts). This saturated signal is then

applied to U13-B through R36, U13-B is connected as an inverting integrator, therefore its output will increase until it reaches the same level as the input signal at R38.

Collectively, these two amplifiers behave as a single amplifier with a gain of one and an output slew rate limited to approximately 0.55 volts/msec.

4.2.1.3 Current Feedback Signal Circuits

The current feedback signal derived from the current transformers is unipolar in nature and must be modified to allow bi-directional operation.

Amplifiers U-3A and B are used to obtain both plus and minus current signals and the FET switches Q1 and Q2 then select the proper polarity to always end up with negative feedback at R39. The gates of these FETS are driven by the Direction Flip-Flop, U32, via a pair of buffer comparators (U16), both on the A2 board.

The switched feedback signal is also applied to amplifier U17-B through U16. Its output is only used for test and monitoring of the output current.

4.2.2 Interlock,Status and Fault LED Circuitry

Both the interlock relay and the firing angle pulses are inhibited when the output of Comparator U25-2 is at a "high" state (+12 volts). When U25-2 goes "low" (-12V), current flow through R99 turns on Q9 to energize the interlock relay (mounted on A3 PC board). The READY LED will be ON when the interlock relay is energized. The DRIV E ON LED is ON when the enable circuit is closed; i.e., +24 VDC is applied to TB1-16.

An interlock condition will result from the following:

4.2.2.1 Phase Loss & Power Loss - The power supply monitor circuit consists of transistor Q10 which will be turned ON if the +24 volt supply exceeds approximately +18 volts and transistor Q11

which is turned on if the potential across the +12V to -12V supplies exceeds 22 volts. If Q10 turns off, the phase loss LED will be ON. If Q11 turns off, the ±12V LED will be OFF.

4.2.2.2 Overvoltage - The armature voltage signal from U10-A is fed to comparator input U20B through an "absolute value" circuit (U38-A and U38-B). This signal is compared to an adjustable reference voltage (set by U21-A) and causes the output U20-14 to go "low" if the voltage exceeds the set level. Under normal conditions, the output will be high to allow operation.

4.2.2.3 Zero Volts - The armature voltage signal is also fed to comparator input U30-10 where it is compared to a small fixed reference voltage at U20-11. The output, U20-13, will go "low" whenever the output voltage exceeds the reference voltage. The signal is fed to "NAND" gate U33-9 along with the "Controller ON" signal.

"Controller ON" signal is removed while the output voltage is greater than the set level, the interlock relay is de-energized.

4.2.2.4 Tach Loss - The armature voltage signal and tachometer signal are compared in U20A. If the tach signal drops below the armature signal by a sufficient amount, the tach signal is presumed to be open or shorted and the output, U20-1, goes low.

4.2.2.5 Overspeed - The tachometer signal is fed to comparator U20-B and compared to an adjustable reference voltage (set by U21-B). If the tachometer signal exceeds the set level, the output, U20-2, will go low.

4.2.2.6 Field Loss - Signal is generated on the A2 PC assembly. Field current feedback is compared with the MIN FIELD setting on U22-A. If the field current is less than the minimum setting, Field Loss is signalled.

4.2.2.7 Overheat - is signalled when excessive heatsink temperature causes thermal switch to open.

4.2.2.8 Stall Current Limit - The tachometer signal and armature current feedback are fed to comparator U12 and associated components. If the tachometer is less than a preset low level ("stalled") and current is above a certain preset level, then the stall current limit circuit reduces the output current to 10% of the normal TORQUE control setting by turning off FET Q6. It does not latch and does not turn the control off. When the stall is cleared, the current limit will revert to its normal level.

4.2.2.9 Static Current Limit - This circuit is a passive integrator made up of R56 and C33 that is connected to the armature current feedback signal. The voltage and rate of voltage change on capacitor C33 depends on the magnitude of the current signal. Connected to the capacitor is comparator U23-A. The output of this comparator will switch to a low value indicating a running overcurrent fault when the capacitor voltage reaches a value equivalent to 15% of the rated drive current. After a running overcurrent fault the circuit will reset (cooldown) in about 2-1/2 minutes. In operation, this circuit will trip in approximately 2-1/2 minutes when the current is 150% and in one minute when the current is 200%.

4.2.3 Comparator Circuits - As described in Section 3.5, the comparator circuits are usually connected to annunciate SET SPEED, LOW SPEED and speed command present. U42, U44 and U46 are optically coupled transistors which can be switched by comparators on U41 with associated components. Speed command, armature voltage signal, tachometer signal and +12V are readily available at the jumper matrix, and any other signals available on the board could be used if required.

4.2.4.1 DC Power Supplies - Reference Transformer Assembly A4 is used to isolate and transform the incoming 240/480 VAC down to 23 VAC for the power supplies. The three transformers have their primaries connected in a delta configuration across the incoming power lines. Jumper wires on the circuit board (A, B and C, three places) are factory-connectable for controller operation on 240 or 480 VAC power. There are four DC supply voltages on the circuit board; +24V and -24V unregulated, +12V and -12V regulated voltages. The unregulated supplies are used in the pulse amplifier circuits and for driving relays which are external to the circuit board. The regulated voltages are

used for integrated circuit operational amplifier power, in the pulse generator circuits and as reference voltages.

The 24 volts is obtained with diodes CR1, CR2 and CR4-7 which are connected in a plus and minus three-phase half-wave rectifier configuration. These outputs are filtered with capacitors C16 and C13. The ±24 volts is then regulated down to ±12 volts by the regulators Q5 and Q4. Additional high frequency filtering is provided by capacitors C29 and C28.

4.2.5 SCR Firing Logic

The voltages from the reference transformers are also applied to the input of the synchronizing circuits (one for each phase). The logic outputs of these circuits control the ramp generator and the pulse distribution circuits which create the SCR firing pulses. These firing pulses go to amplifier circuits which drive the pulse transformers, (one for each SCR), located on the snubber boards. These isolate the main PC boards from power circuit voltages.

The control allows current to flow only in one direction at a time. The requested direction of current (from the di/dt limiter) and the actual current determine the direction of current flow, forward or reverse. If a current direction change is required, the current is decreased to zero and locked out, the turnaround logic disables firing pulses to one-half of the power bridge and enables firing pulses to the other half. The current regulator is then enabled again.

4.2.6 Field Current Regulator

The field regulator is a two-thirds wave power circuit. The Field Rectifier Module REC1 contains three diodes and one SCR which is phase-controlled by a current regulator circuit.

Armature voltage and an adjustable reference voltage, CROSS-OVER, are the inputs to operational amplifier U30-B which is operated as an integrator. The output from U30-7 is fed through potentiometer R92 to set MAX FIELD current command.

Diodes CR14 and CR12 act as a gate network to select, as the field current request, either the output of U30-7 or the voltage set by R77, the MIN FIELD setting, whichever is greater.

This field current request is compared with the field current feedback signal at the field current regulator U23-A. The output of U23-A is compared with the output of a ramp generator to create the SCR firing pulse train.

As the magnitude of the armature voltage signal approaches and equals the setting of the CROSSOVER potentiometer, the output of U30-B tries to go negative. However, CR18 then starts to conduct, reducing the field current and thereby the armature voltage.

Ten seconds after the drive enable circuit is opened, +12V is applied to the input of U30B. This clamps the output to zero and field current is reduced to the level of the MIN SPEED setting for field economizing during idle periods.

5.0 MAINTENANCE & TROUBLESHOOTING

SAFETY NOTICE: This equipment should be installed, adjusted and serviced by qualified personnel familiar with electrical equipment and the contents of this manual. High voltage (240/480 VAC) is present when the power is on. Use appropriate high voltage troubleshooting techniques.

Accidental short circuits can result in high currents, equipment damage and personnel injury. Make any module changes with power off. Check for short circuits and loose connections before applying power. Use ground isolated instruments for all measurements.

5.1 CONTROLLER MAINTENANCE

ALWAYS TURN OFF THE AC POWER before attempting any controller maintenance. The only periodic maintenance for the CMC SPINDLEMATE Controller is an occasional inspection for accumulated dust or dirt on heatsinks and circuit boards. Also, shop dust in some environments tends to be electrically conductive and can cause controller malfunction. If cleaning is needed, carefully vacuum loose dirt or use dry compressed air. Check and tighten where necessary power connections at terminals, contactor and fuses.

The SPINDLEMATE Controller is designed for module replacement for easy and straightforward servicing. Modules are connectorized or have terminal strips so that no desoldering is required in case replacement is necessary. Size A & B controllers have swing-out circuit board assemblies with two captive fastening thumbscrews for SCR and module access.

The Sizes C & D controllers have a hinged swing-out panel with two captive fastening thumbscrews for SCR assembly and module access. Circuit board assemblies are mounted to the swing-out panel with a front-hinged plexiglass cover for viewing LED status indicators, access to adjustments and for mating the tester plug. (Refer to Figure 5-1.)

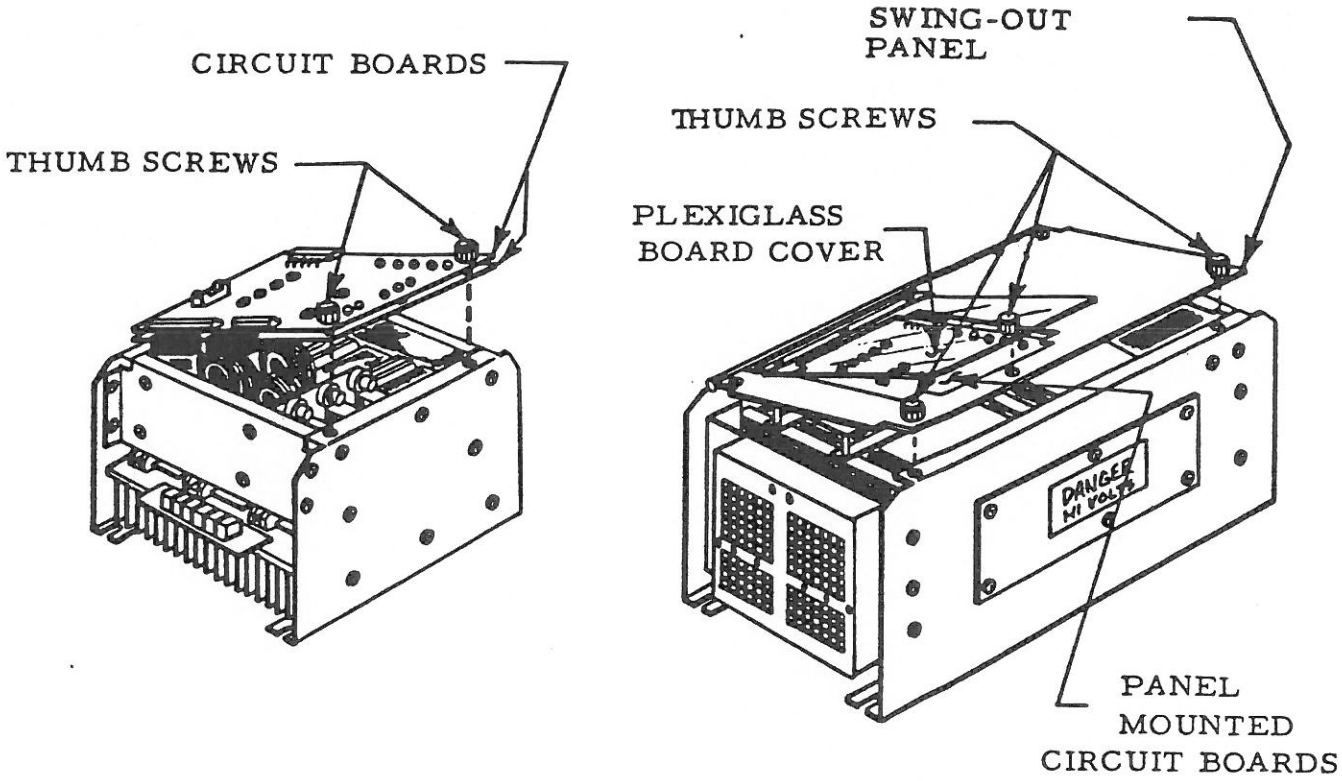


FIGURE 5-1. SWING-OUT CIRCUIT BOARDS

5.1.1 Main Printed Circuit Board (Refer to Figure 5-2)

1) Removal

a) Pull off TB1 and TB2 plug-in strips from circuit board A1.

b) Disconnect circuit board connectors A1P1, A2P2, A2P3 and A2P4 from circuit board A1. Use a wide blade screwdriver if necessary per Figure 5-2.

c) Remove the four corner mounting screws from the circuit board assemblies.

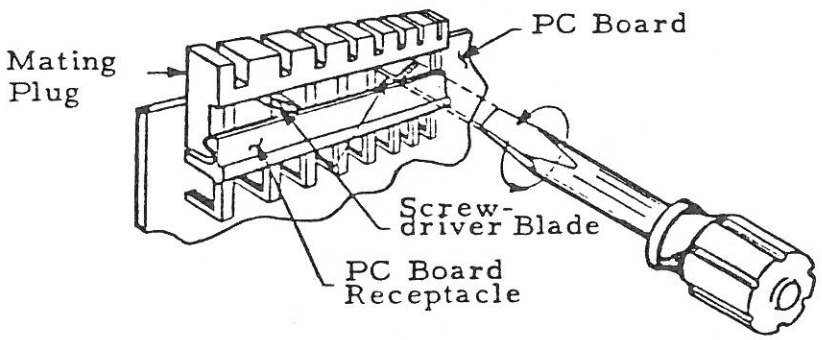


FIGURE 5-2. MODULE CONNECTOR REMOVAL

2) Installation

Reverse above procedure. Take care to polarize connector and plug-in terminal strips.

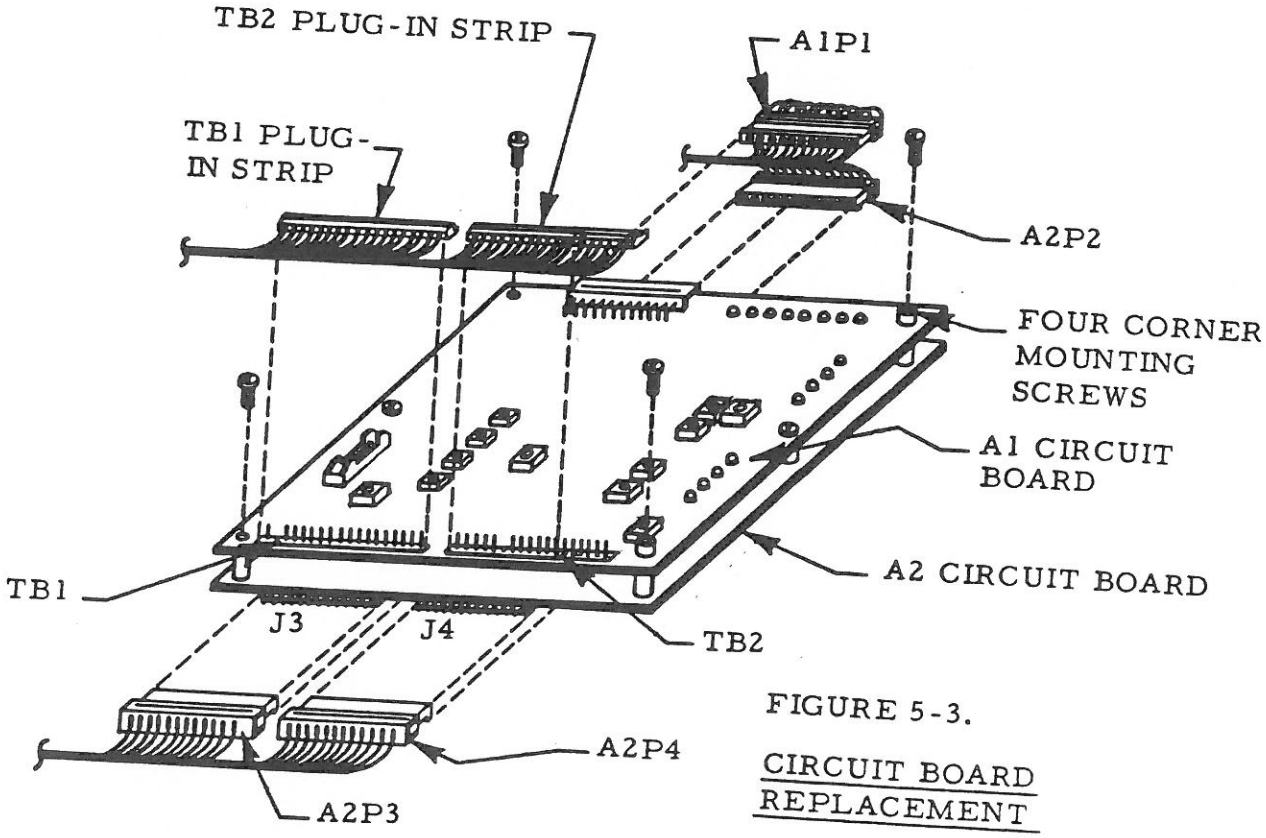


FIGURE 5-3.

CIRCUIT BOARD REPLACEMENT

5.1.2 SCR Assembly (Refer to Figures 5-4 thru 5-8)

The SCRs used in the SPINDLEMATE Controller are sized conservatively to handle the peak currents and voltages encountered in this application. SCR failures are rare. If an SCR failure is suspected, check for shorts using a Simpson type ohmmeter from anode to cathode (plus/minus bus-bar to AC terminal on Size A and B controllers; left or right heatsink to AC bus-bar on Size C & D controllers) with the SCR assembly installed in the controller. Resistance should be high (greater than 500 Kohms on the RX 10,000 scale) for either ohmmeter polarity.

NOTE: "Hockey puck" type SCRs used in the SPINDLEMATE Sizes C & D Controllers must be compressed between anode and cathode surfaces to assure a contact with the internal chip.

The SCR gates can also be checked with the ohmmeter but the gate leads must first be removed. On Sizes A and B controllers, disconnect gate lead terminals from slimline SCR and on Size C & D controllers, disconnect gate leads from snubber board gate terminals. In these cases, gate to cathode resistance in either polarity should be low (less than 100 ohms on the RX1 scale).

5.1.3 SCR Assembly Replacement, Sizes A and B (Refer to Figures 5-4 & 5-5)

1) Removal (Procedure applies to any of the six slimline SCR modules)

a) Pull off the gate lead terminals at the SCR assembly to be replaced.

b) Remove the SCR AC and plus/minus bus-bar screws to disconnect the snubber, line and power wiring.

c) Remove the two SCR heatsink mounting screws and remove the SCR.

2) Installation

a) The new SCR should be installed with thermal compound between it and the heatsinks. (Usually the compound left on the heatsink when the old one is removed is sufficient.) Replace using the two mounting screws.

b) Take care to correctly connect color coded gate, color coded snubber and power wires per Figure 5-4 and appropriate interconnect diagram in Drawing Section 6.0.

5.1.4 SCR Assembly Replacement, Size C & D (Refer to Figure 5-6)

1) Removal (Procedure applies to any of the six SCR assemblies)

a) Pull off the gate lead connector at the snubber board of the SCR assembly to be replaced.

b) Remove the bolt that connects the power lead to the AC bus bar with a 7/16 hex combination wrench or with a 7/16 hex swivel socket and ratchet wrench (preferred). (Size D 9/16 wrench or 9/16 socket.)

c) Remove the two 1/4-20 x 5/8 long, Grade 5, mounting bolts from the armature bus mounting angles with a 7/16 socket, with extension and ratchet wrench. (Size D 1/2 socket.)

CAUTION:	CHECK FOR CORRECT WIRING, LOOSE WIRES AND HARDWARE BEFORE APPLYING POWER

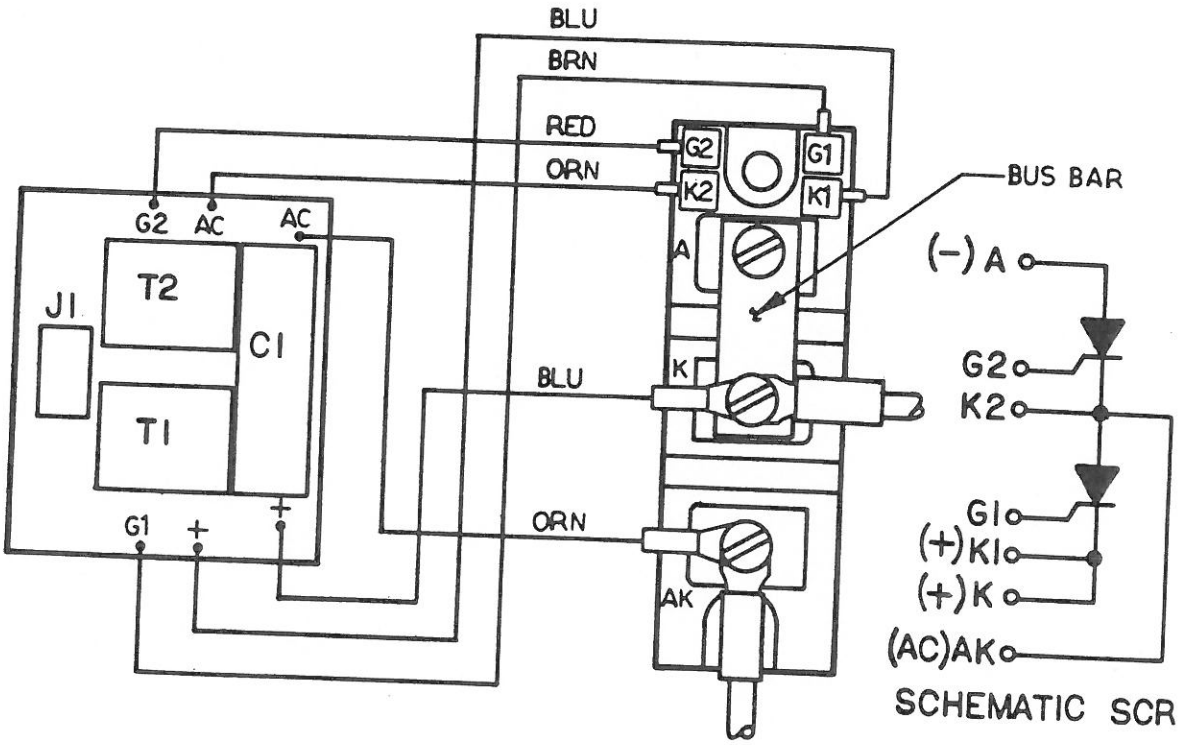


FIGURE 5-4. SLIMLINE SCR WIRING, SIZES A AND B

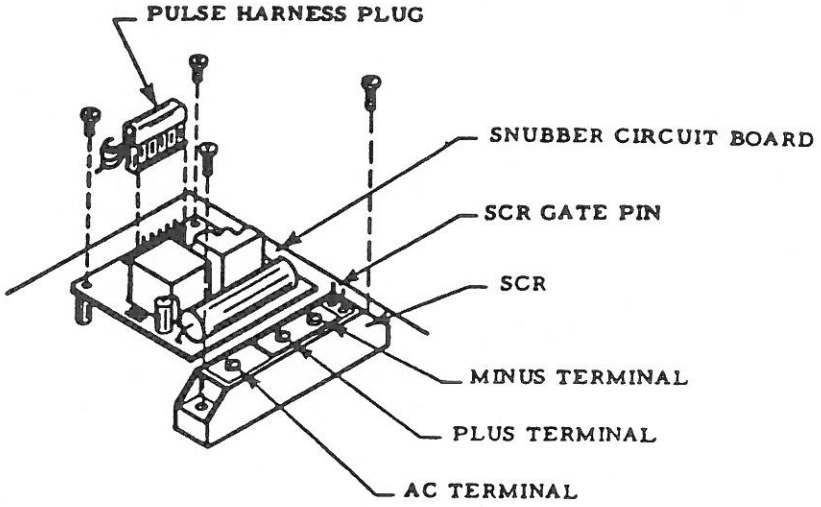


FIGURE 5-5. SLIMLINE SCR REPLACEMENT, SIZES A & B

2) Installation

Reverse above procedure. The SCR assembly should be installed with an aluminum joint compound between its mounting bars and the armature bus mounting angles. (Usually the compound left on the mounting angles is sufficient.) Take care to correctly polarize gate lead connector at the snubber board.

CAUTION:	CHECK FOR LOOSE WIRES AND HARDWARE BEFORE APPLYING POWER.

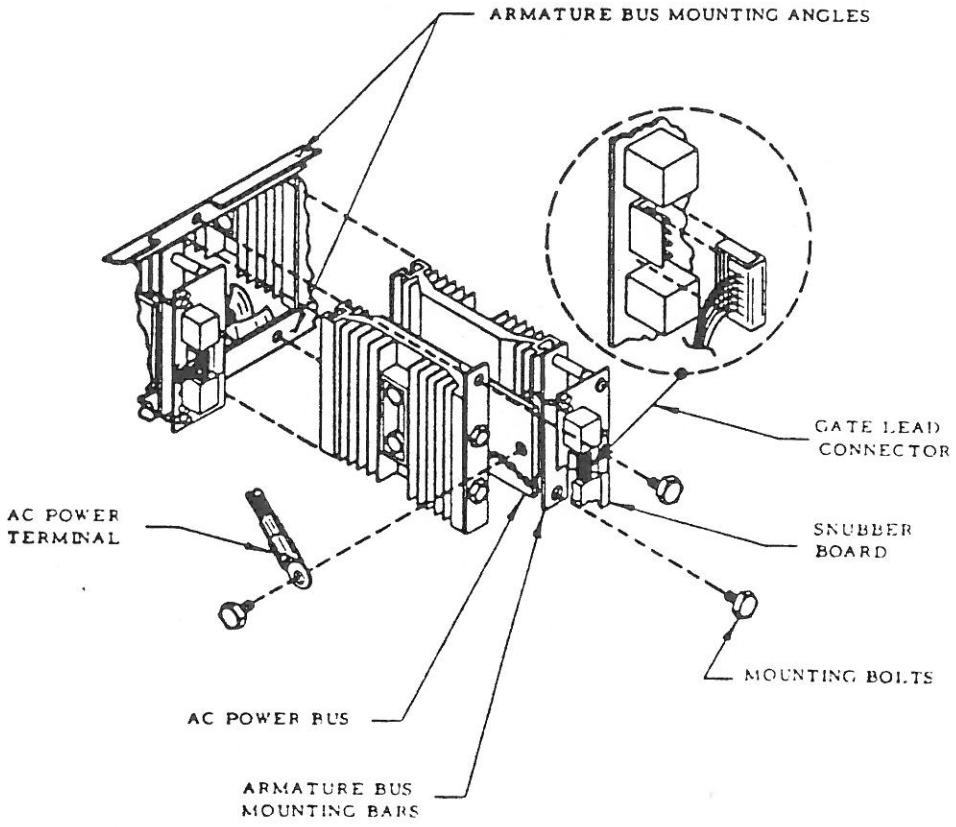


FIGURE 5-6. SCR ASSEMBLY REPLACEMENT, SIZES C & D

5.1.5 Individual SCR Replacement, Sizes C & D

The SCR assemblies are designed for easy replacement as functional and fully tested modules. To minimize "downtime" and assure proper performance it is strongly recommended that repairs be made on a module substitution basis as described in Paragraph 5.1.4. Individual SCRs can, however, be field-replaced provided proper tools are utilized and procedures are followed.

> CAUTION: Improperly assembled heatsinks can cause further damage and may void the equipment warranty.

Tools Required

1) Socket wrench with 7/16" socket (Size D 9/16" socket.)
2) Screwdriver
3) SCR force calibration gauge
4) Electrical joint thermal compound

1) Removal

a) Remove SCR module from SPINDLEMATE controller as described in 5.1.4 and take it to a convenient, clean work location.

b) Remove the screw which connects the brown AC snubber lead at the AC bus bar.

c) Remove the gate and cathode lead screws from terminals on snubber board, each SCR.

d) Loosen the two bolts in the SCR clamp with 7/16" socket wrench, each one turn, then unscrew completely from right heatsink. SCR can now be removed. (Size D 9/16" socket.)

NOTE: Keep parts clean. Take care when handling SCRs and heatsinks not to damage contact surfaces or gate/cathode leads.

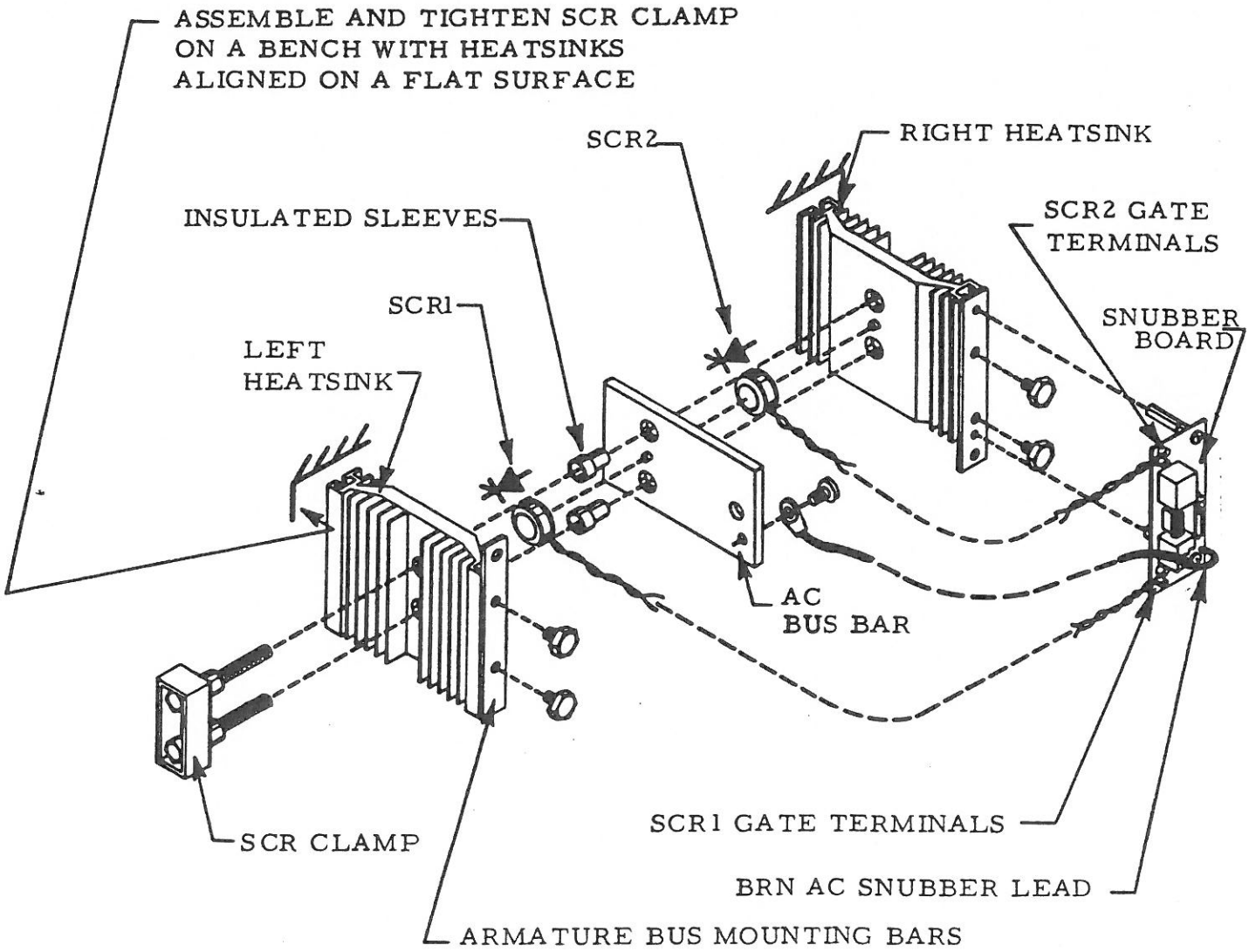


FIGURE 5-7. EXPLODED VIEW, SCR ASSEMBLY SIZES C & D

2) Installation

a) Make certain that all contact surfaces are clean and free of scratches.

b) Apply a small amount of thermal joint compound to both pole-faces of both SCRs to be installed.

c) Align right SCR on roll pin on right heatsink and position AC bus-bar on top of the SCR with its roll pin aligned. Similarly, place left SCR on the bus-bar and install left heatsinks on top of it. Refer to Figure 5-7.

d) Install the clamp through the left heatsink, the bus bar (with sleeve spacer) and screw bolts into right heatsink. Tighten bolts finger tight a little at a time to keep thread insertion equal. Stop and refer to Figure 5-7 and be certain that:

- o SCRs are positioned with cathode facing left
- o SCRs are rotated with gate/cathode leads toward front of assembly
- o AC bus bar has captive nut on right side
- o Assembly is square and SCRs are centered on roll pins

e) Tighten SCR clamp on a bench with heatsinks aligned on a flat surface. Tighten each bolt 1/2 turn with 7/16" socket wrench. (Size D 9/16" socket.)

f) Place force calibration gauge firmly against clamp spring to check torque. See Figure 5-8. Tighten each bolt a little at a time until correct force is achieved.

g) Install gate/cathode leads at terminals on snubber board. White lead is the gate; red lead is the cathode.

h) Install the brown AC snubber lead to the AC bus bar.

i) Install the SCR module assembly per 5.1.4.

5.1.6 Reference Transformer Assembly, A4

1) Removal

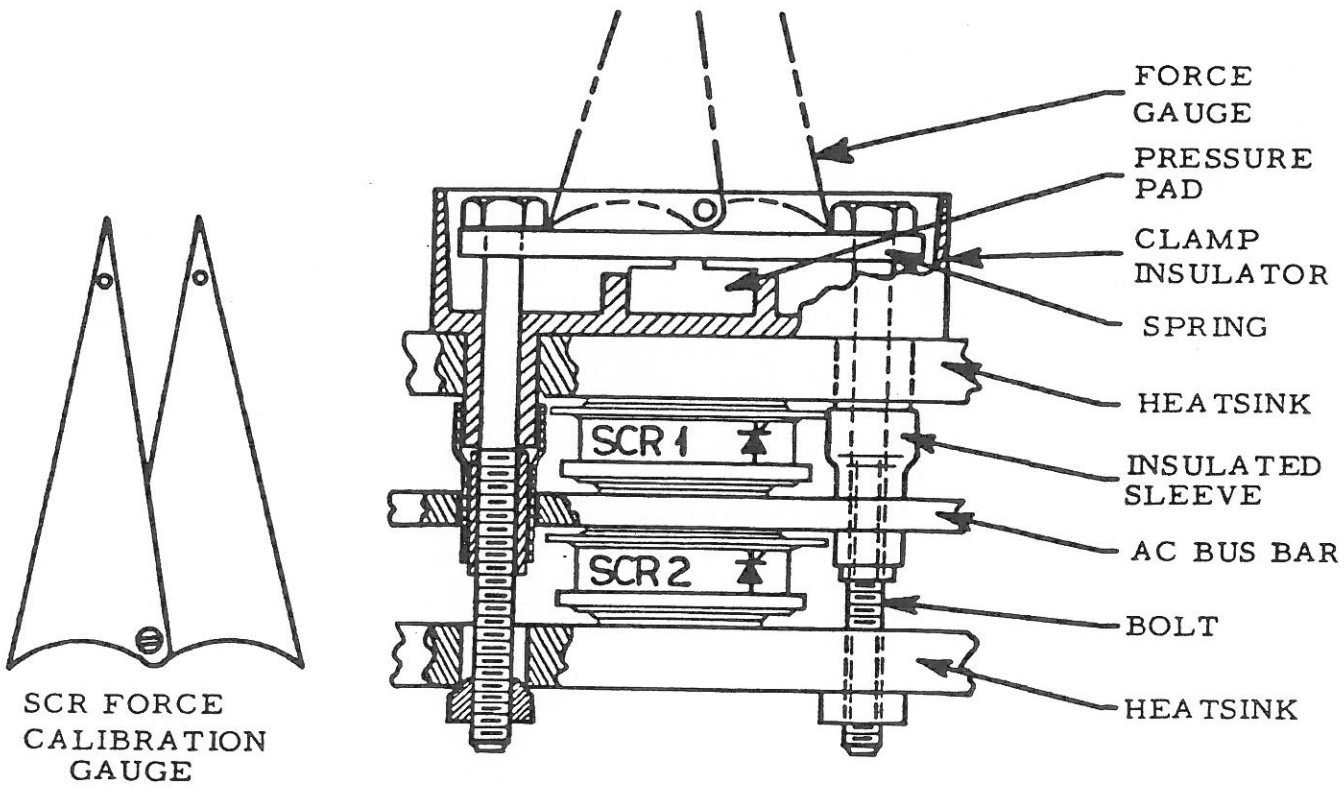
a) Disconnect the seven fast-on terminal wires connected to the assembly

b) Remove the four corner mounting screws

2) Installation

Reverse above procedure. Take care to correctly connect color coded wire fast-on terminals per interconnect diagram in Drawing Section 6.0.

CAUTION:	CHECK FOR CORRECT WIRING, LOOSE CONNECTIONS AND HARDWARE BEFORE APPLYING POWER





LESS THAN RATED FORCE
Tighten bolts alternately 1/4 turn until holes coincide.



CORRECT FORCE
Holes lined up



EXCESSIVE FORCE
Loosen nuts and start over. DO NOT try to adjust spring force by backing off. Always loosen and start over.

FIGURE 5-8. SCR FORCE GAUGE

5.1.7 Field Isolator & Interlock Circuit Board Module, A3

1) Removal

a) Disconnect circuit board connectors A3P1 and A3P2 from circuit board. Use a wide blade screwdriver if necessary per Figure 5-2.

b) Disconnect the three fast-on terminal wires connected to the circuit board and the two fast-on wires connected on the Field Power Circuit Module, REC 1. On Size C controllers it will be necessary to remove the Reference Transformer Assembly, A4, per 5.1.6 for fast-on terminal access.

c) Remove the four corner mounting screws from the circuit board assembly.

2) Installation

Reverse above procedure. Take care to polarize connectors and to correctly connect color coded wire fast-on terminals per interconnect diagram in Drawing Section 6.0.

CAUTION:	CHECK FOR CORRECT WIRING, LOOSE CONNECTIONS AND HARDWARE BEFORE APPLYING POWER

5.1.8 Field Power Circuit Module, REC 1

1) Removal

a) Remove the Reference Transformer Assembly, A4, per 5.1.6 for module access (Size "C" only).

b) Disconnect the seven fast-on terminal wires connected to the module.

c) Remove the two mounting screws

2) Installation

a) The new module should be installed with thermal compound between it and the chassis. (Usually the compound left on the chassis when the old one is removed is sufficient.) Replace using the two mounting screws.

b) Take care to correctly connect color coded wire fast-on terminals per interconnect diagram in Drawing Section 6.0.

c) Replace Reference Transformer Assembly per 5.1.6. (Size "C" Only)

CAUTION:	CHECK FOR LOOSE WIRING, LOOSE CONNECTIONS AND HARDWARE BEFORE APPLYING POWER.

5.2 TROUBLESHOOTING

SAFETY NOTICE: This equipment should be installed, adjusted and serviced by qualified personnel familiar with electrical equipment and the contents of this manual. High voltage (480 VAC) is present when power is on. Use appropriate high voltage troubleshooting techniques.

Accidental short circuits can result in high currents, equipment damage and personnel injury. Make any module changes with power off. Check for short circuits and loose connections before applying power. Use ground-isolated instruments for all measurements.

To minimize the equipment "downtime", it is strongly recommended that any repairs be made on a module substitution basis. DO NOT ATTEMPT TO REPLACE COMPONENT PARTS ON THE CIRCUIT BOARD. This could cause further problems and void the equipment warranty.

Troubleshooting should begin with a systematic check of command signals and power to the controller.

- Check input speed command signals - do they reach controller terminal strip?
- Check the "Enable" signal to the controller terminal strip.
- Check external limit switches and interlocks
- Check 115 VAC control power and AC input power

Make a physical inspection, looking for the following:

- Open fuses or circuit breakers
- Abnormally hot components
- Loose terminals
- Burned parts or insulation

NOTE: If a fault has developed on a system which was working properly, DO NOT MAKE ANY ADJUSTMENTS. The problem must be properly diagnosed by observing the LED indicators and using troubleshooting charts.

5.2.1 Status and Fault LED Indicators

Status LEDs

AC Power	-	Incoming line power applied to controller
± 12 Volts	-	Normal operation of on-board power supplies
READY	-	Controller is set to operate when the "Enable" circuit is closed. (No fault present)
DRIVE ON	-	"Enable" circuit is closed, normal drive operation.

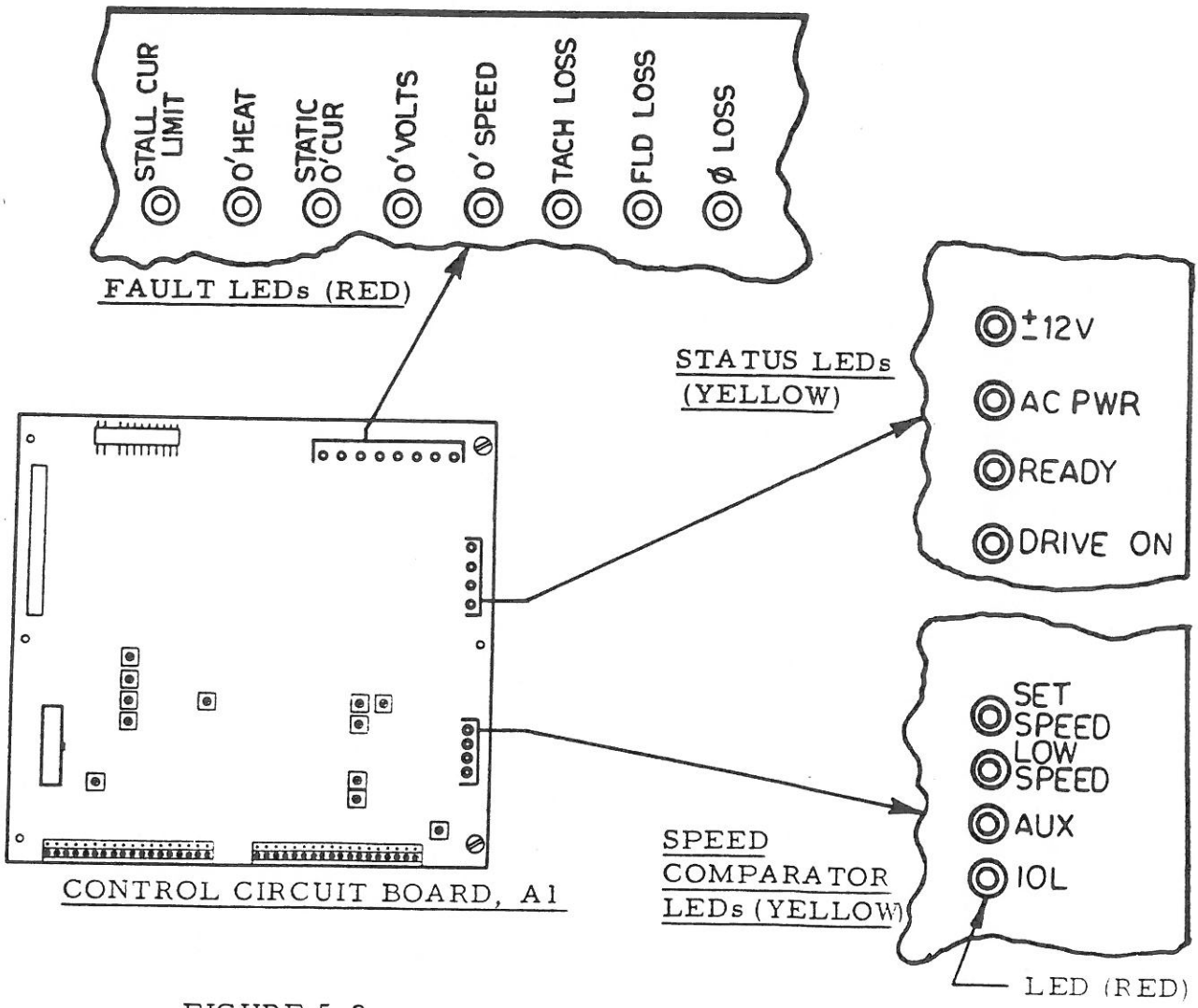


FIGURE 5-9

STATUS & FAULT LED INDICATORS

Speed Comparator LEDs

SET SPEED	-	Motor speed is within SET SPEED adjustment range.
LOW SPEED	-	Motor speed is above LOW SPEED trip point
AUX	-	Normally wired to indicate signal present

Fault LEDs

Ø LOSS	-	Loss of incoming power line phase voltage
FLD LOSS	-	Loss of motor shunt field current
TACH LOSS	-	Open or shorted tachometer feedback signal
O'SPEED	-	Motor overspeed as detected by tachometer signal.
O'VOLTS	-	Motor armature overvoltage
STATIC O'CUR	-	Excessive armature current
O'HEAT	-	Excessive heatsink temperature
STALL CUR LIMIT	-	Armature current without motor rotation for more than 1 sec (non-latching).
IOL	-	Instantaneous Overload

If any of the above FAULT conditions occur (except STALL CURRENT LIMIT), it will latch the corresponding LED on and the drive off. Interlock relay CR1 is also de-energized to open the 115 VAC control circuit to AC contactor M1. To reset, depress the external RESET pushbutton or momentarily remove and reapply line power.

The STALL CURRENT LIMIT circuit reduces the output current to 10% of the normal TORQUE control setting - it does not latch or turn the control off. When the stall is cleared, the current limit will revert immediately to its normal level.

WARNING: In the process of troubleshooting a system fault, DO NOT JUMPER OUR THE SAFETY INTERLOCK CIRCUITRY. This could cause dangerous motor overspeed.

6.0 DATA SHEET

An approved Job Data Sheet will be supplied with each Motor Controller specifying the motor controller nameplate data, the motor data and the shipping documents, as follows:

CMC DATA SHEET
NAMEPLATE - DOCUMENT - APPROVAL

JOB NO.	PART NUMBER

MOTOR CONTROLLER NAMEPLATE:

CMC CLEVELAND MACHINE CONTROLS, INC.

DWG NO. 545D
MOD. SP1-500- SER.
INPUT 460 VOLTS 3 Ø 60 HZ
OUTPUT 0± 500 VDC A. ARM.
HP 300 VDC 0 TO A. FLD
MAX AMBIENT 55°C JOB NO.

CUSTOMER

- ☐ MODULE
- ☐ PANEL ASSY
- ☐ ENCLOSURE ASSY
- ☐ WITH INTEGRAL TESTER

MOTOR DATA	ARM VOLTS:	RPM BASE: TOP RATED:
	FIELD VOLTS:	FIELD CURRENT MAX: MIN:
HP	FIELD SENSE RESISTOR A3R9:	OHMS I A MAX I

SHIPPING DOCUMENTS

NUMBER	DOCUMENT
SS-00-781	INSTRUCTION MANUAL, SPINDLEMATE

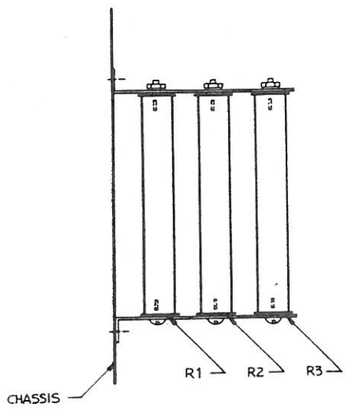
DISTRIBUION:
JOB FILE
ENGR
Q C

ENGR		
TEST		
Q C		
.		
APPROVED		DATE

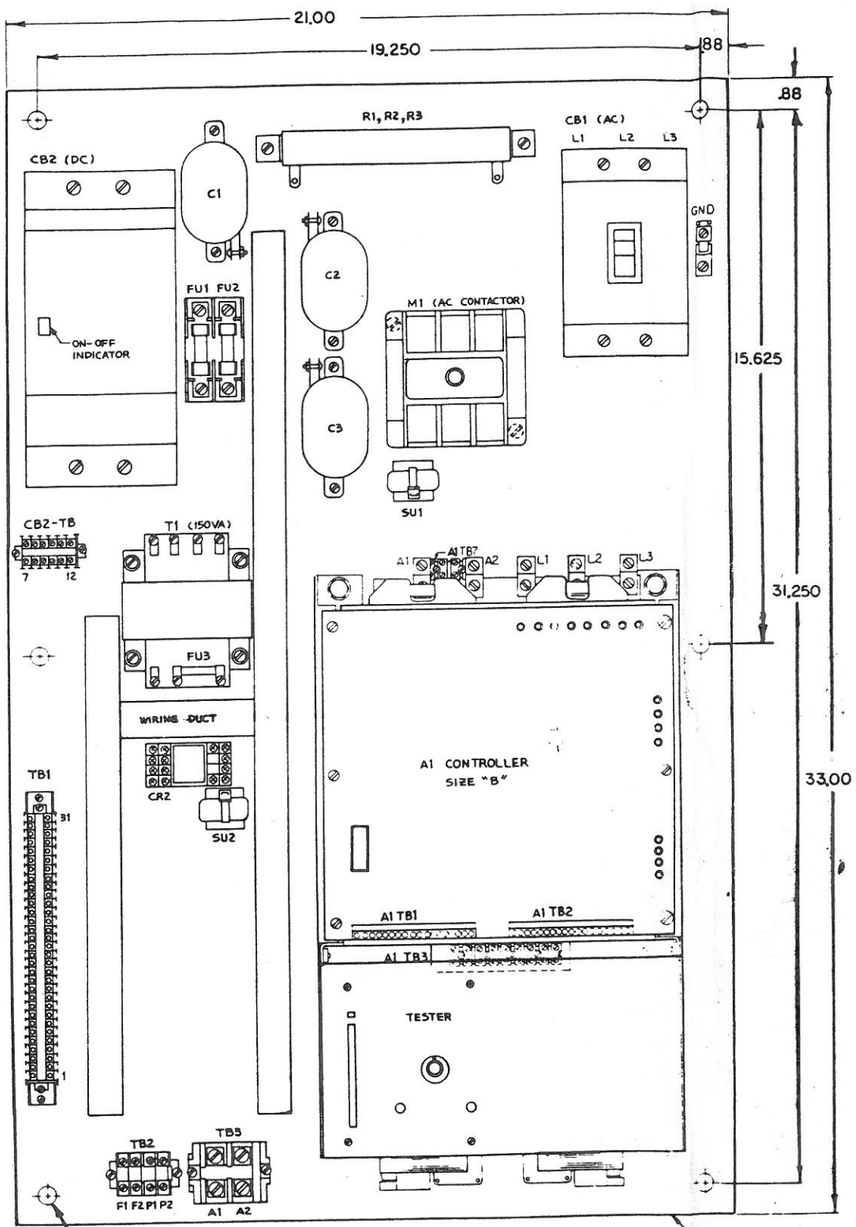
7.0 DRAWINGS

DRAWING NO.	TITLE
545D4120X	SPINDLEMATE Panel, 5 HP - 50 HP, Fuseless with CB & Tester
545B4300X	SPINDLEMATE Fuseless Controller Diagram, 5HP - 50 HP
545B26516	A1 Control PCB Assembly 0.5 - 5 Second Accel/Decel, Unipolar Current Signal with Restart in Motion
545D01814	A2 Logic & Firing PCB Assembly with Field Regulator
545D0030X	A3 Field Isolator & Interlock PCB Assembly
545D4620X	Spindlemate Panel, 60 HP Fuseless with CB & Tester
545B4640X	Spindlemate Fuseless Controller Diagram, C Size.

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
C	RELEASE FOR PRODUCTION	1-24-86	BD
C_1	ADDED R1,R2,R3,C1,C2,C3 & BKTS.	1-28-86	BD
C_2	CHANGED C1-C3, R1-R3 & FU1, FU2 POSITIONS.	1-30-86	BD
D	TB1-18 & TB1-19 CMD WAS ±8VDC	2-12-86	BD
E	ADDED CB2-TB & #14,#16 WIRE SIZE.	2-19-86	BD
F	TB1-23 WAS TO CB2-AUX N.O. 5-30HP T1 WITH FUSES CHANGED TO 150 VA.	3-11-86	BD
G	CHANGED PANEL LAYOUT PER CUSTOMER REQUEST. ECO #W637	4-11-86	BD



R1, R2, R3
MOUNTING DETAIL



CONFIGURATION						
HP	PART NO.	MODEL NO.	WIRE SIZE #L LINE	WIRE SIZE #A ARM.	CB1 AC	CB2 DC
5	545D41299	SP1-500-05 BTSP	#12	#12	20A	20A
7.5	545D41287	SP1-500-07 BTSP				
10	545D41275	SP1-500-10 BTSP				
15	545D41263	SP1-500-15 BTSP	#8	#8	50A	50A
20	545D41251	SP1-500-20 BTSP				
25	545D41248	SP1-500-25 BTSP				
30	545D41236	SP1-500-30 BTSP	#6	#4	75A	100A
40	545D41212	SP1-500-40 BTSP				
50	545D41224	SP1-500-50 BTSP	#4		100A	

ITEM NO OR REF. DES	PART NO. OR IDENT	DESCRIPTION	CODE IDENT	SPEC/MFG
		PARTS LIST		

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES
FRACTIONS ±
DECIMALS
2 PLACES ±
3 PLACES ±

MATERIAL
SEE PARTS LIST
545D4120X

CONTRACT NO
5171, 5103

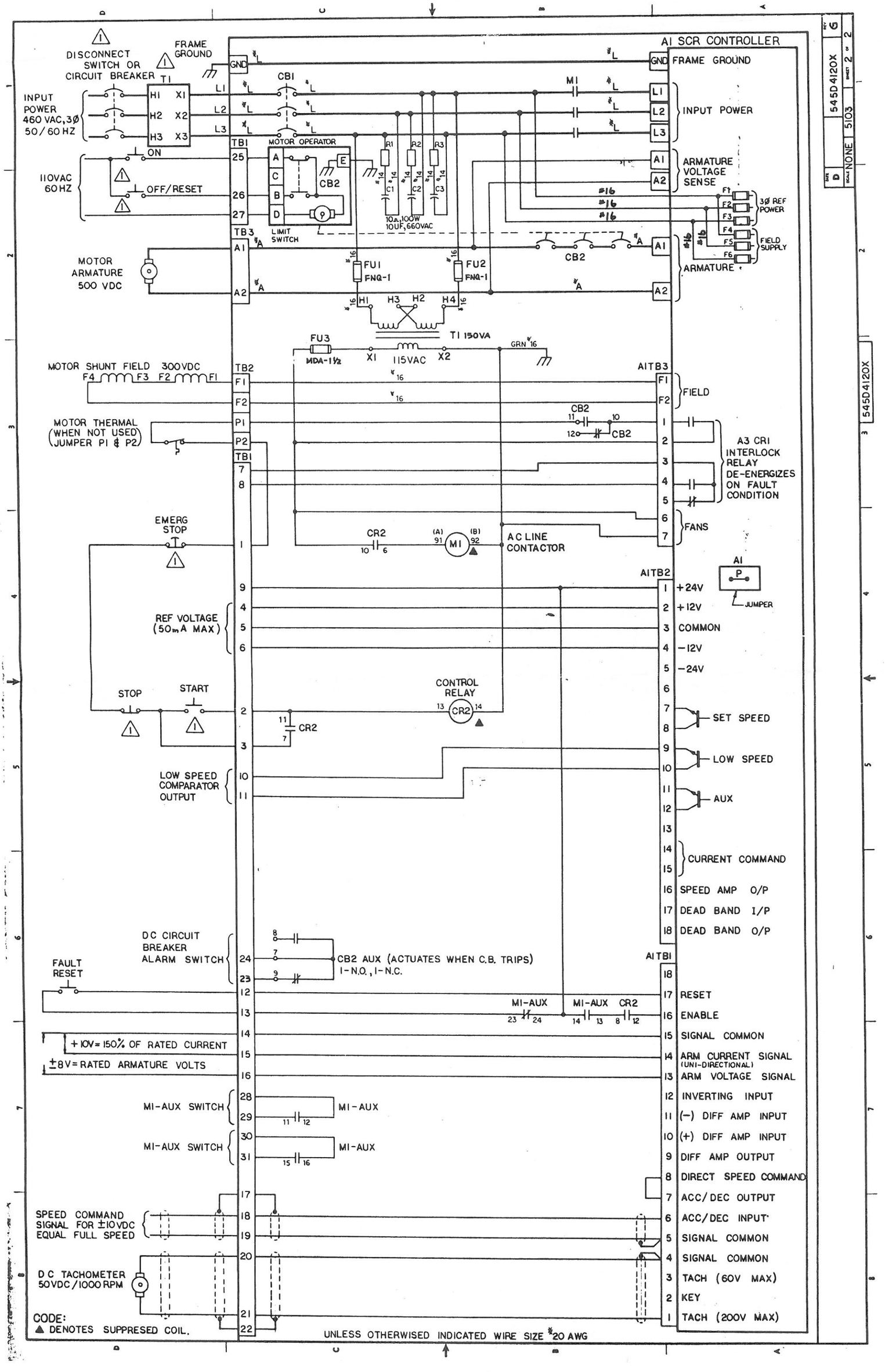
PREPARED — DATE 2-28-86
CHECKED BD 1/27/86
APPROVED 1/27/86
APPROVED

CMCT CLEVELAND MACHINE CONTROLS, INC. WESTERN OPERATIONS

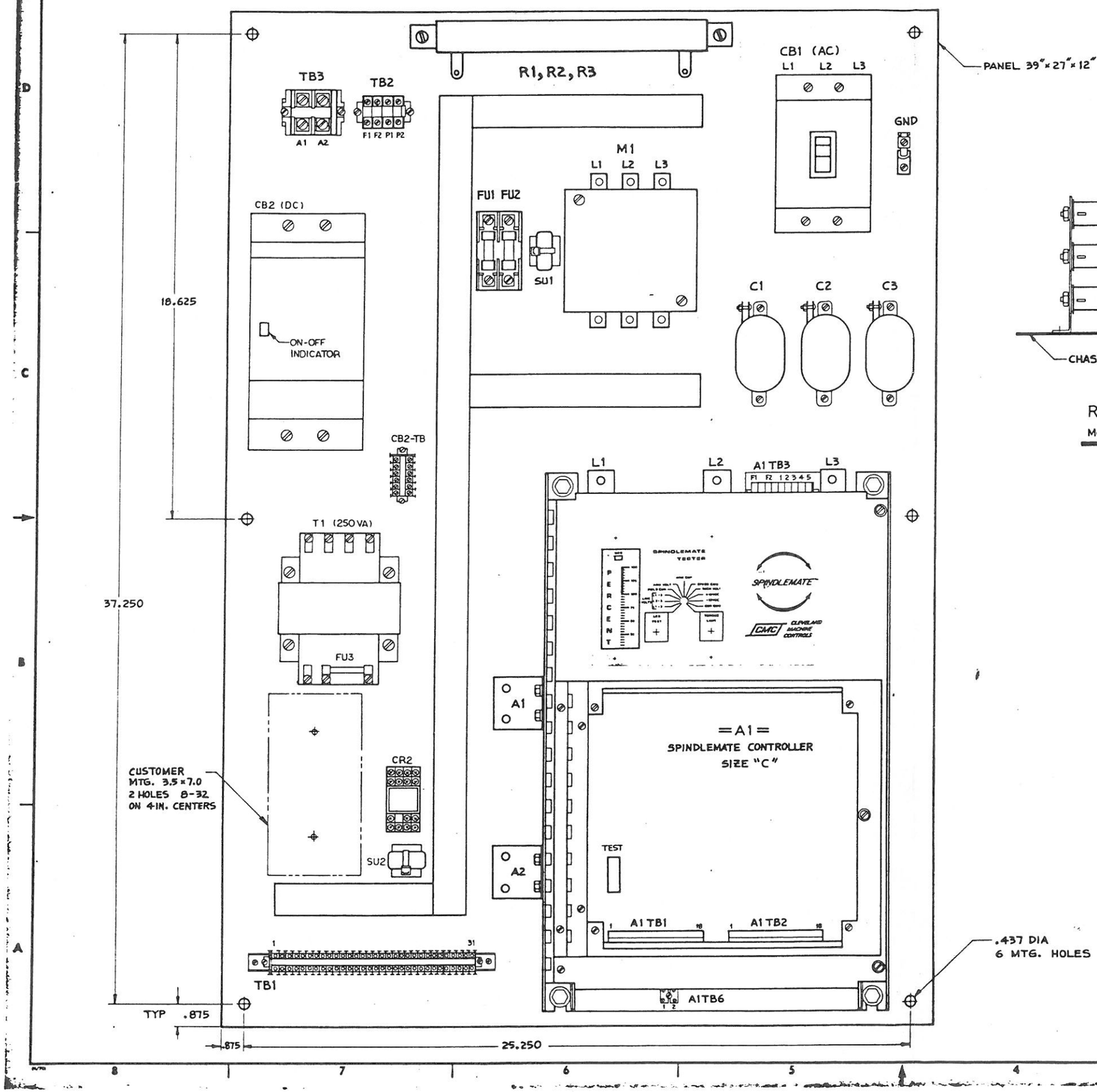
SPINDLEMATE PANEL 5HP-50HP, FUSELESS, WITH C.B. SIZE "B" WITH TESTER

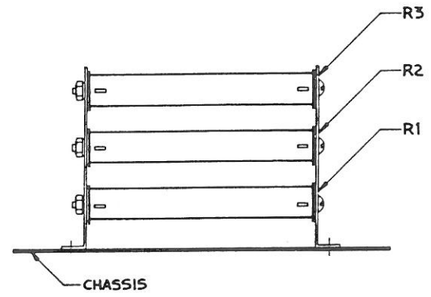
SIZE D | CODE IDENT | 545D4120X | REV G
SCALE 1/2:1 | SHEET 1 OF 2

DASH NO. | SIZE | NEXT ASSY
545D4120X


A1 SCR CONTROLLER
DISCONNECT SWITCH OR CIRCUIT BREAKER
FRAME GROUND
INPUT POWER 460 VAC, 3Ø 50/60 HZ
T1
CB1
M1
INPUT POWER
ARMATURE VOLTAGE SENSE
110VAC 60HZ
OFF/RESET
ON
MOTOR OPERATOR
LIMIT SWITCH
CB2
R1
R2
R3
C1
C2
C3
10Ω, 100W
10UF, 660VAC
3Ø REF POWER
FIELD SUPPLY
ARMATURE
MOTOR ARMATURE 500 VDC
FU1
FU2
FNQ-1
H1 H3 H2 H4
T1 150VA
FU3
MDA-1½
X1 115VAC X2
MOTOR SHUNT FIELD 300VDC
F4 F3 F2 F1
FIELD
MOTOR THERMAL (WHEN NOT USED JUMPER P1 & P2)
A3 CR1 INTERLOCK RELAY DE-ENERGIZES ON FAULT CONDITION
EMERG STOP
CR2
AC LINE CONTACTOR
FANS
REF VOLTAGE (50mA MAX)
+24V
+12V
COMMON
-12V
-24V
JUMPER
STOP
START
CONTROL RELAY
SET SPEED
LOW SPEED
LOW SPEED COMPARATOR OUTPUT
AUX
CURRENT COMMAND
SPEED AMP O/P
DEAD BAND I/P
DEAD BAND O/P
DC CIRCUIT BREAKER ALARM SWITCH
CB2 AUX (ACTUATES WHEN C.B. TRIPS) 1-N.O., 1-N.C.
FAULT RESET
MI-AUX
RESET
ENABLE
+10V = 150% OF RATED CURRENT
±8V = RATED ARMATURE VOLTS
SIGNAL COMMON
ARM CURRENT SIGNAL (UNI-DIRECTIONAL)
ARM VOLTAGE SIGNAL
MI-AUX SWITCH
INVERTING INPUT
(-) DIFF AMP INPUT
(+) DIFF AMP INPUT
DIFF AMP OUTPUT
DIRECT SPEED COMMAND
ACC/DEC OUTPUT
ACC/DEC INPUT
SPEED COMMAND SIGNAL FOR ±10VDC EQUAL FULL SPEED
DC TACHOMETER 50VDC/1000RPM
TACH (60V MAX)
KEY
TACH (200V MAX)
CODE:
▲ DENOTES SUPPRESED COIL.
UNLESS OTHERWISED INDICATED WIRE SIZE #20 AWG
545D4120X
REV G
SHEET 2 OF 2
SIZE D
SCALE NONE
5103

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	RELEASE	2-5-87	BB
B	R1,R2,R3 WAS 100W, ECO # W716 .	3/26/87	BB





R1, R2, R3
MOUNTING DETAIL

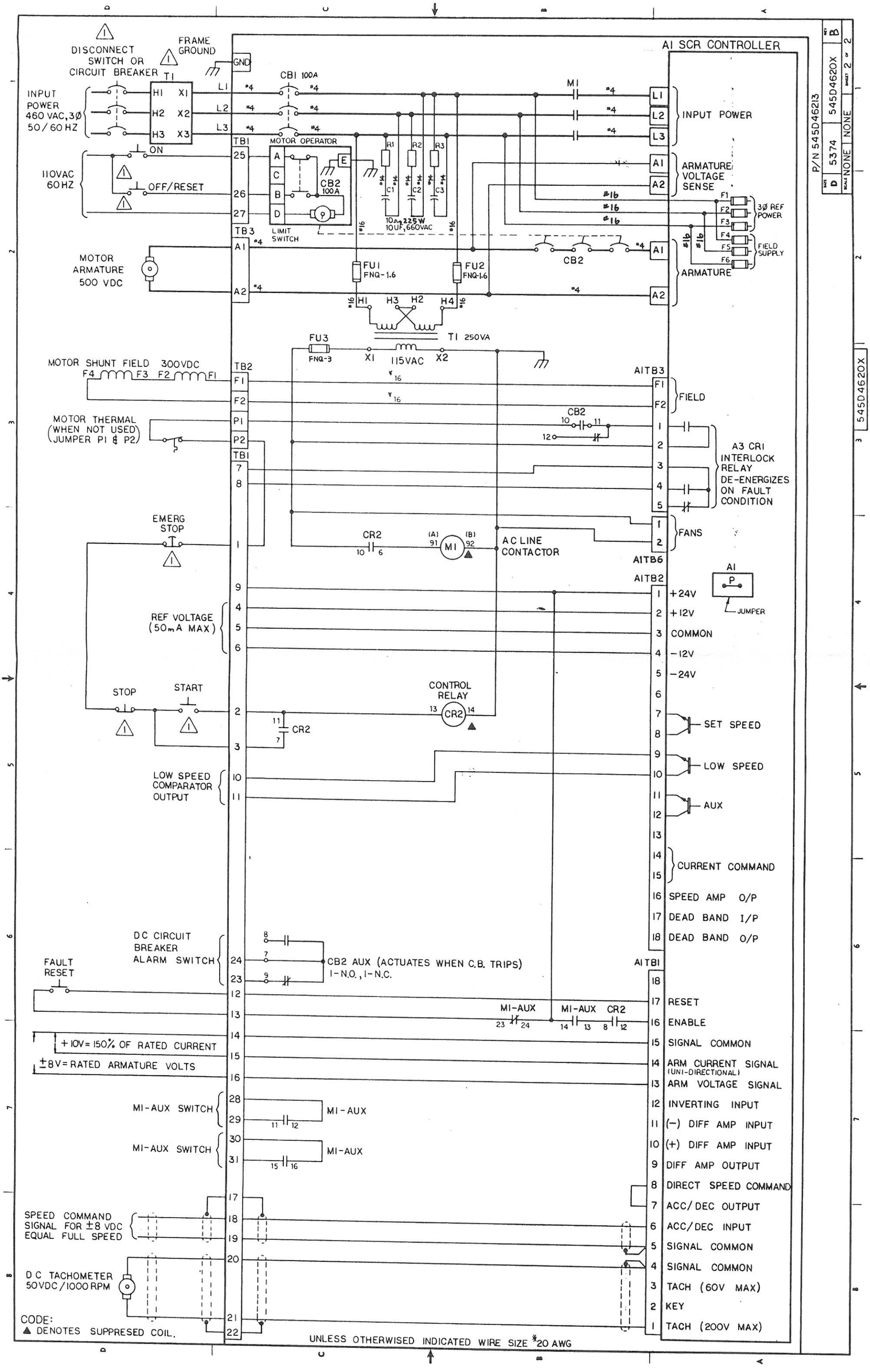
NOTES: UNLESS OTHERWISE SPECIFIED.

1. ⚠ CUSTOMER SUPPLIED.
2. ALL CONTROL CIRCUIT WIRING IS #20 AWG.
3. USE SHIELDED WIRE FOR INPUT COMMAND SIGNAL AND TACHOMETER WIRING.
4. LINE INDUCTORS REQUIRED IF ISOLATION TRANSFORMER IS NOT USED.

P/N 545D46213

—4	—3	—2	—1	ITEM NO. OR REF. DES	PART NO. OR IDENT	DESCRIPTION	CODE IDENT	SPEC/MFG
QTY REQUIRED PER DASH NO.				PARTS LIST				

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES	CONTRACT NO. 5374	CLEVELAND MACHINE CONTROLS, INC. WESTERN OPERATIONS	
TOLERANCES FRACTIONS ± DECIMALS 2 PLACES ± 3 PLACES ±	PREPARED DATE 2-5-87	SPINDLEMATE PANEL 60 HP, FUSELESS, WITH C.B. SIZE "C" WITH TESTER	
	CHECKED 2/11/87		
MATERIAL SEE PARTS LIST	APPROVED 2/11/87	SIZE D	CODE IDENT
	APPROVED	545D4620X	REV B
DASH NO. 545D4620X	APPROVED	SCALE ½ : 1	SHEET 1 OF 2
SIZE	CODE IDENT	NEXT ASSY	


A1 SCR CONTROLLER
P/N 545D46213
REV B
SHEET 2 OF 2
SIZE D
5374
545D4620X
SCALE NONE
NONE
DISCONNECT SWITCH OR CIRCUIT BREAKER
FRAME GROUND
INPUT POWER 460 VAC, 3Ø 50/60 HZ
T1
CB1 100A
M1
INPUT POWER
110VAC 60HZ
ON
OFF/RESET
MOTOR OPERATOR
CB2 100A
LIMIT SWITCH
ARMATURE VOLTAGE SENSE
3Ø REF POWER
FIELD SUPPLY
MOTOR ARMATURE 500 VDC
FU1 FNQ-1.6
FU2 FNQ-1.6
CB2
ARMATURE
MOTOR SHUNT FIELD 300VDC
FU3 FNQ-3
T1 250VA
115VAC
FIELD
MOTOR THERMAL (WHEN NOT USED JUMPER P1 & P2)
A3 CR1 INTERLOCK RELAY DE-ENERGIZES ON FAULT CONDITION
EMERG STOP
CR2
AC LINE CONTACTOR
FANS
REF VOLTAGE (50mA MAX)
+24V
+12V
COMMON
-12V
-24V
STOP
START
CONTROL RELAY
SET SPEED
LOW SPEED
LOW SPEED COMPARATOR OUTPUT
AUX
CURRENT COMMAND
SPEED AMP O/P
DEAD BAND I/P
DEAD BAND O/P
DC CIRCUIT BREAKER ALARM SWITCH
CB2 AUX (ACTUATES WHEN C.B. TRIPS) 1-N.O., 1-N.C.
FAULT RESET
RESET
ENABLE
+10V = 150% OF RATED CURRENT
±8V = RATED ARMATURE VOLTS
SIGNAL COMMON
ARM CURRENT SIGNAL (UNI-DIRECTIONAL)
ARM VOLTAGE SIGNAL
MI-AUX SWITCH
MI-AUX
INVERTING INPUT
(-) DIFF AMP INPUT
(+) DIFF AMP INPUT
DIFF AMP OUTPUT
DIRECT SPEED COMMAND
ACC/DEC OUTPUT
ACC/DEC INPUT
SIGNAL COMMON
SIGNAL COMMON
SPEED COMMAND SIGNAL FOR ±8 VDC EQUAL FULL SPEED
DC TACHOMETER 50VDC/1000RPM
TACH (60V MAX)
KEY
TACH (200V MAX)
CODE:
▲ DENOTES SUPPRESED COIL.
UNLESS OTHERWISED INDICATED WIRE SIZE #20 AWG

LTR	REV DESCRIPTION	DATE
B	ADDED R5-C4 TO Z1-Z6 ECO W760	12-22-87

3φ AC POWER INPUT

3φAC POWER REFERENCE & FIELD

TB4 L1 L2 L3

FRAME GND G GND

115 VAC TB6 BLK BLK

FAN FAN FAN FAN TB5

INTERLOCK RELAY CONTACTS 5 VIO, 4 YEL, 3 ORN, 2 RED, 1 BRN TB3

BRN RED ORN F1 F2 F3 F6 F4 F5

P8 J8 BRN 5 5, RED 6 6

REC2 REC3 REC4 CT1 CT2 CT3 R9 R8 R10

A1 TB2

18 DEADBAND O/P
17 AUX SPEED CMD
16 VELOCITY AMP O/P
15 CURRENT COMMAND
14 CURRENT COMMAND
13
12 AUX
11
10 LOW SPEED
9
8 SET SPEED
7
6 KEY
5 -24V
4 -12V
3 POWER COM
2 +12V
1 +24V

CONTROL P.C.B. A1

OPTO-ISOLATED COMPARATOR OUTPUTS 30V, 30MA, MAX.

A1 J1: 12 -24V WHT, 11 INTLK GRY, 10 -24V YEL, 9 THERMAL ORN, 8, 7 ARM A1, 6 COMMON, 5 ARM A2, 4, 3 KEY, 2 ARM CUR FB RED, 1 FB COM BRN

SEE "D" ONLY TS1 TS2

HEATSINK THERMOSTAT

ARMATURE VOLTAGE DIVIDER (R4 - R7) VIO → P8-2, BLU → P8-3, GRN → P8-1

A1 TB1

RESET CIRCUIT

18 RESET
17 ENABLE
16 SIG COM
15 ARM CUR SIG
14 ARM VOLT SIG
13 INVERTING INPUT
12 DIFF AMP −
11 DIFF AMP +
10 IN
9 DIFF AMP OUT
8 DIRECT SPEED CMD
7 ACC /DEC OUT
6 ACC / DEC IN
5 SIG COM
4 SIG COM
3 TACH (60V MAX)
2 KEY
1 TACH (200V MAX)

8V EQUALS MAX RATED ARM VOLTS

4V EQUALS 150 % RATED CURRENT

SPEED COMMAND SIGNAL SCALED FOR ±10 VDC EQUALS FULL SPEED

TACHOMETER (MOTOR MOUNTED)

A1 J7 — PRINTED CIRCUIT BOARD INTERCONNECTION W1 — A2 P7

FIELD ISOLATOR & INTERLOCK A3

A3J2: 9 VIO, 10, 8 YEL, 7 ORN, 2 RED, 3 BRN, 1, 5 WHT, 6 KEY, 4 GRY

CR1 CR1 CR1 CR1

A3J1: 6 GRN FIELD CUR, 5 ORN SIGNAL COM, 4 BLK +12V, 3 KEY, 2, 1 BRN FIELD SCR FIRING PULSE

L3 K YEL, G GRY, S SENSE WHT, F2 BLU

REC1 (4 REC 1)

R1 C1

GRN

A2

LOGIC AND FIRING P.C.B.

A2J2: 12 BRN, 11 FIELD SCR FIRING PULSE, 10 BLK +12V, 9 ORN SIGNAL COM, 8 GRN FIELD CUR, 7, 6, 5 KEY, 4 BLU, 3 GRN, 2 YEL, 1 VIO — REFERENCE TRANSFORMER SECONDARY (ØA, ØB, ØC, N)

A4 REFERENCE TRANSFORMER T1 — L1 L2 L3 BRN RED ORN — N C B A

A2J3: A1 12 GRN, 11 BRN, 10 WHT, 9, B1 8 GRY, 7 VIO, 6 BLU, B2 5 KEY, 4 YEL, C1 3 ORN, 2 RED, C2 1 — Z1P1 Z2P1 Z3P1

A2J4: A3 12 GRN, 11 BRN, 10 WHT, A4 9 KEY, B3 8 GRY, 7 VIO, 6 BLU, B4 5, C3 4 YEL, 3 ORN, C4 2 RED, 1 — Z4P1 Z5P1 Z6P1

L2 L1 L4 L3 L6 L5

Z1K2 Z1G2 SCR 2A Z1G1 Z1K1 SCR 1A
Z2K2 Z2G2 SCR 2B Z2G1 Z2K1 SCR 1B
Z3K2 Z3G2 SCR 2C Z3G1 Z3K1 SCR 1C
Z4K1 Z4G1 SCR 3A Z4G2 Z4K2 SCR 4A
Z5K1 Z5G1 SCR 3B Z5G2 Z5K2 SCR 4B
Z6K1 Z6G1 SCR 3C Z6G2 Z6K2 SCR 4C

FUSE A1 A2 M1 A1 A2 M1 CONTACTOR MOTOR ARMATURE TO TACHOMETER

A1P1-7 A1P1-6 A1P1-5 P8 J8 — R5 R4 R6 R7 — TB4-A1 GRY, TB4-A2 WHT

TB3 GRN F1, TB3 BLU F2 — F1 F2 F3 F4 300 VDC MOTOR SHUNT FIELD

SNUBBER TYPICAL Z1 - Z6

P1 1 2 3 4 — T1 CR1 R1 — G1 WHT, K1 RED — SCR 1A / SCR 1B / SCR 1C SCR 3A / SCR 3B / SCR 3C

T2 CR2 R2 — K2 RED, K2 WHT — SCR 2A / SCR 2B / SCR 2C SCR 4A / SCR 4B / SCR 4C

R3 C1 — DC1 AC1 — R5 C4 — DC2 AC2

SIZE - C & D

SPINDLEMATE FUSELESS CONTROLLER DIAGRAM 60 HP

CMC 545B4640X B

3 Ø AC POWER INPUT

3 Ø AC POWER REFERENCE & FIELD

TB4 L1 L2 L3

L2 L1 L3

FRAME GND G GND

FAN FAN

FANS ONLY SIZE B

TB3

115 VAC 7 BLK 6 BLK

INTERLOCK RELAY CONTACTS 5 VIO 4 YEL 3 ORN 2 RED 1 BRN

F1 F2 F3 BRN RED ORN

F6 ORN F4 BRN F5 RED

P8 J8 BRN 5 5 RED 6 6

REC2 REC3 REC4

CT1 CT2 CT3

R9 R8 R10

FIELD ISOLATOR & INTERLOCK A3

A3J2 VIO 9 YEL 10 ORN 7 RED 2 BRN 3 WHT 1 GRY 5 6 KEY 4

CR1 CR1 CR1 CR1

A3J1 GRN 6 FIELD CUR ORN 5 SIGNAL COM BLK 4 +12 V 3 KEY 2 FIELD SCR FIRING PULSE 1

L3 K YEL G GRY

REC1

REC 1

WHT GRN R1 C1

S SENSE WHT F2 BLU

A1 TB2

18 DEADBAND O/P

17 AUX SPEED CMD

16 VELOCITY AMP O/P

15 CURRENT COMMAND

14 CURRENT COMMAND

CONTROL P.C.B. A1

OPTO-ISOLATED COMPARATOR OUTPUTS 30V, 30MA, MAX.

12 AUX

11

10 LOW SPEED

9

8 SET SPEED

7

6 KEY

5 -24V

4 -12V

3 POWER COM

2 +12V

1 +24V

A1J1 12 WHT -24V

11 GRY INTLK

10 YEL -24V

TS1

9 ORN THERMAL

HEATSINK THERMOSTAT

8

7 VIO P8-2 ARM A1

6 BLU P8-3 COMMON

5 GRN P8-1 ARM A2

ARMATURE VOLTAGE DIVIDER (R4 - R7)

4

3 KEY

2 RED ARM CUR FB

1 BRN FB COM

A1 TB1

18

17 RESET

16 ENABLE

15 SIG COM

14 ARM CUR SIG

13 ARM VOLT SIG

12 INVERTING INPUT

11 DIFF AMP -IN

10 DIFF AMP +IN

9 DIFF AMP OUT

8 DIRECT SPEED CMD

7 ACC /DEC OUT

6 ACC / DEC IN

5 SIG COM

4 SIG COM

3 TACH (60 V MAX)

2 KEY

1 TACH (200V MAX)

RESET CIRCUIT

± 8V EQUALS MAX RATED ARM VOLTS

10 V EQUALS 150 % RATED CURRENT

SPEED COMMAND SIGNAL SCALED FOR ±10VDC EQUALS FULL SPEED

TACHOMETER MOTOR MOUNTED

A1 J7

PRINTED CIRCUIT BOARD INTERCONNECTION W1

A4 REFERENCE TRANSFORMER T1 N C B A

BRN RED ORN L1 L2 L3

BLU ØA GRY ØB YEL ØC VIO N REFERENCE TRANSFORMER SECONDARY

A2 LOGIC, AND FIRING P.C.B.

A2J2 12 FIELD SCR FIRING PULSE BRN 11 BLK 10 +12 V ORN 9 SIGNAL COM GRN 8 FIELD CUR 7 6 5 KEY

A2 P7

A2J3 A1+ 12 GRN A2- 11 BRN 10 WHT Z1P1

B1+ 8 GRY B2- 7 VIO 6 BLU Z2P1

KEY 5 C1+ 4 YEL C2- 3 ORN 2 RED 1 Z3P1

A2J4 A3+ 12 GRN A4- 11 BRN 10 WHT Z4P1

KEY 9 B3+ 8 GRY B4- 7 VIO 6 BLU Z5P1

C3+ 4 YEL C4- 3 ORN 2 RED 1 Z6P1

FUSELESS SCR

A G2 K2 G1 K1 K AK

L1 L2 L3 L4 L5 L6

Z1 Z2 Z3 Z1G2 Z2G2 Z3G2 A2 B2 C2 Z1G1 Z2G1 Z3G1 A1 B1 C1 Z1 Z2 Z3

Z4 Z5 Z6 Z4G1 Z5G1 Z6G1 A3 B3 C3 Z4G2 Z5G2 Z6G2 A4 B4 C4 Z4 Z5 Z6

TB4 A1 TB7 A1 A2 TB4 A2

MOTOR ARMATURE

A1P1-7 A1P1-6 A1P1-5 P8 J8

R5 R6 TB4 R4 R7 GRY WHT

SNUBBER TYPICAL Z1 - Z6

ALTERNATE

KEY J1 T1 T2

(G1) BRN (K1) BLU (K) BLU SCR A1 / SCR B1 / SCR C1 SCR A3 / SCR B3 / SCR C3

(AK) ORN (K2) ORN (G2) RED SCR A2 / SCR B2 / SCR C2 SCR A4 / SCR B4 / SCR C4

TB3 GRN F1 BLU F2

F1 F2 F3 F4 300 VDC MOTOR SHUNT FIELD

F1 F2 F3 F4 150 VDC MOTOR SHUNT FIELD

SIZE A & B

SPINDLEMATE FUSELESS CONTROLLER DIAGRAM 5 HP - 50 HP

CMC 545B4300X B

REV "D" PER ECO #W711 & #W719. 4-28-87

J1
ARM SIG 7
SIG COM 6
ARM SIG 5

TB1
ARM VOLTS 13
TACH (200V MAX) 1
TACH (60V MAX) 3
SIG COMMON 5
SIG COMMON 4
DIRECT SPEED COMMAND 8
ACC/DEC OUTPUT 7
ACC/DEC INPUT 6
INVERTING INPUT 12
DIFF AMP OUTPUT 9
DIFF AMP INPUT (-) 11
DIFF AMP INPUT (+) 10
COMMON 15
CURRENT SIG 14

J1
CUR SIGNAL (+) 2
+10V = 150%
CUR SIGNAL RTN 1

ARM VOLTS
TACH VOLTS
ARM VOLTAGE SIG
TACH SIGNAL
SPEED COMMAND
CURRENT COMMAND

NOT USED

25 TURN MAX SPEED
ACCEL
OFFSET
STABILITY
IR COMP
STALL CUR LIMIT
LINE REACTANCE
BIAS
+TORQUE
-TORQUE
JUMPER
DEADBAND

TB2 15 14 17 16 18

POLARITY
OP-AMP ENABLE
TORQUE LIMIT SET
BIAS AMP CLAMP
CURRENT ERROR
LINE XL CLAMP
ARM CUR TEST
REV
FWD
ARM CUR
ARM CUR

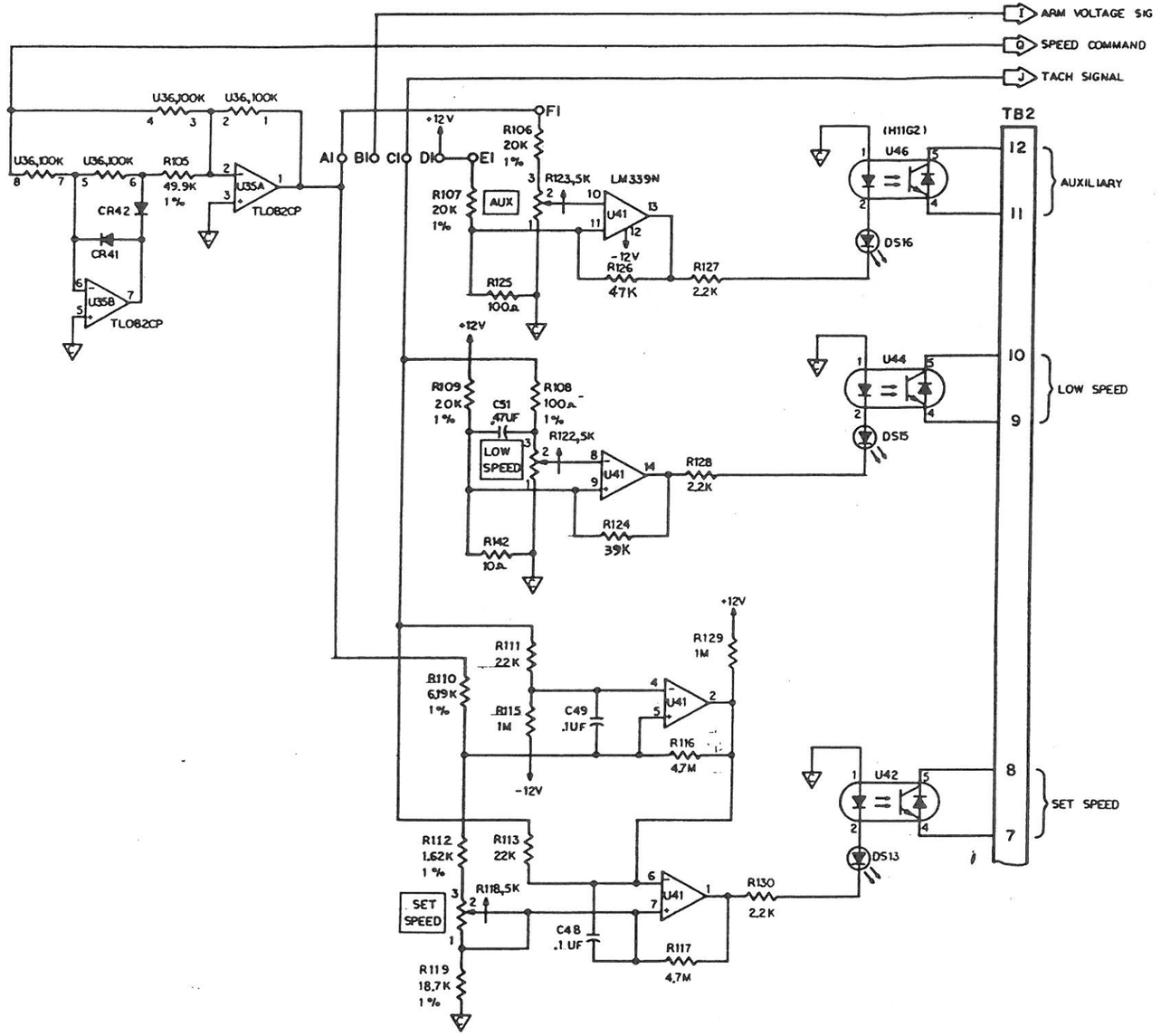
PROPRIETARY PER SHEET 2

A1 CONTROL PC ASSY — 0.5-5 SEC. ACCEL/DECEL UNIPOLAR CURRENT SIGNAL WITH RESTART IN MOTION

D		545B26516	D
SCALE NONE		SHEET 1 OF 3	

545B26516

TB2
SES5001
CR59
+24V
+12V
C53
.1UF
COM
-12V
-24V
RESET
TB1
DRIVE ON
+24V
17
16
R82, 2.2K
R83, 2.2K
R81
220K
CR36
IN758A
C35
10UF
20V
CR35
CR49
R84
220K
CR37
IN758A
R147
4.7K
DRIVE ON
DS12
C36
.22UF
100V
R178, 2.2K
+6V
R102
10K
R103
10K
U26
LM339
CR38
IN963B
R131
10K
R136
1K
R135
470Ω
Q10
2N5172
U31
4049
R132
470Ω
R133
1K
CR39
IN966B
DS9
Q11
2N5366
R134
10K
C54
.001UF
C55
.001 UF
U43A
CA3290
R163
20K, 1%
R165
20K
1%
R164
27.4K, 1%
R166
27.4K
1%
R177
2=2K
10L
DS14
R173
2.2K
U43B
CA3290
U32
4044
Q9
Q10
Q11
U28, 2.2K
DS8
DS7
DS6
DS5
DS4
DS3
DS2
Ø LOSS
FIELD LOSS
TACH LOSS
OVER SPEED
OVER VOLTS
STATIC CUR LIMIT
O'HEAT
U34
4002
U33
4011
U30
4049
U31
4049
U22
10K
U22 10K
R155
22K
LM339
U23
CR52
R154
4.7M
R101
10K
U22
10K
CR34
R100
100K
C34
.01UF
U26
LM339
CR26
CR58
R153
10K
U12
LM339
CR3
U25
LM339
OP-AMP
ENABLE
CR4
BIAS
AMP
CLAMP
CR31
CR30
REACT
AMP
CLAMP
CR29
CR33
Q9
2N5366
R99, 4.7K
C38
1UF
R80
10K
R79
10K
C18
.1UF
DS10
CR40
AC POWER
R152, 1.5K
R151, 1.5K
R183, 100K
CR62
CR63
CR64
CR65
R182
10K
R181
10K
R180
100K
Q12
2N5172
R104
10K
C44
.01 UF
TEST CONNECTOR
J6
M
C3
1UF
50V
P
R1, 1K
U1, 10K
O
Q
L
N
COMMON
TORQUE LIMIT SET
CUR COMMAND
-12V
+12V
TACHOMETER
SPEED COMMAND
ARM CUR TEST
ARM VOLTS
FIELD CUR
ØC
ØB
ØA
U1
10K
J7
ØA
ØB
ØC
-24V
-12V
+12V
+24V
COMMON
COMMON
FIELD CUR
FIELD LOSS
ENABLE
ARM VOLTS
PULSE INHIBIT
TURN AROUND RESET
ARM CUR
POLARITY
CUR ERROR
REV
FWR
C1
C2
50UF
25V
J1
INTLK
RLY
H'SINK
THERMAL
DS11
READY
R140
4.7K, 1/2 W
R76, 2.2K
R150, 22K
R93
10K
R94
100K
C39
1UF
CR27
IN758A
CR50
CR51
ARM
VOLTS
I
TACH
HOLD
J
R71, 20K, 1%
R70, 20K, 1%
R66, 220K
R68
4.7M
U20
LM339
R144
6.81K
1%
C31
.1UF
C32
.1UF
R69
22K
R73
22K
C30
.1UF
R90, 10K, 1%
R21B
10K
O'SPEED
R89
20K
1%
R67, 4.7M
R91, 10K, 1%
R21A
10K
O'VOLTS
R87
4.7M
R85
20K
1%
R88
4.7M
C37
1UF
50V
R86
1K
R57
43K
H
R74
1.5M, 1%
R56
2.43M, 1%
C33A&B
47UF
16VDC
R75
22K
R58
15K
1%
CR25
U19
10K
U22
10K
PROPRIETARY PER SHEET 2
A1
D
NONE
545B26516
D
SHEET 2 OF 3
545B26516



LAST REFERENCE DESIGNATION USED	
USED	NOT USED
C55	
CR61	
DS16	
J7	
Q11	
R178	
TB2	
U47	

DECOUPLING CAPS

+12V	−12V
C15	C8
C29	C41
C43	C46
C45	C16
C50	C28
C42	

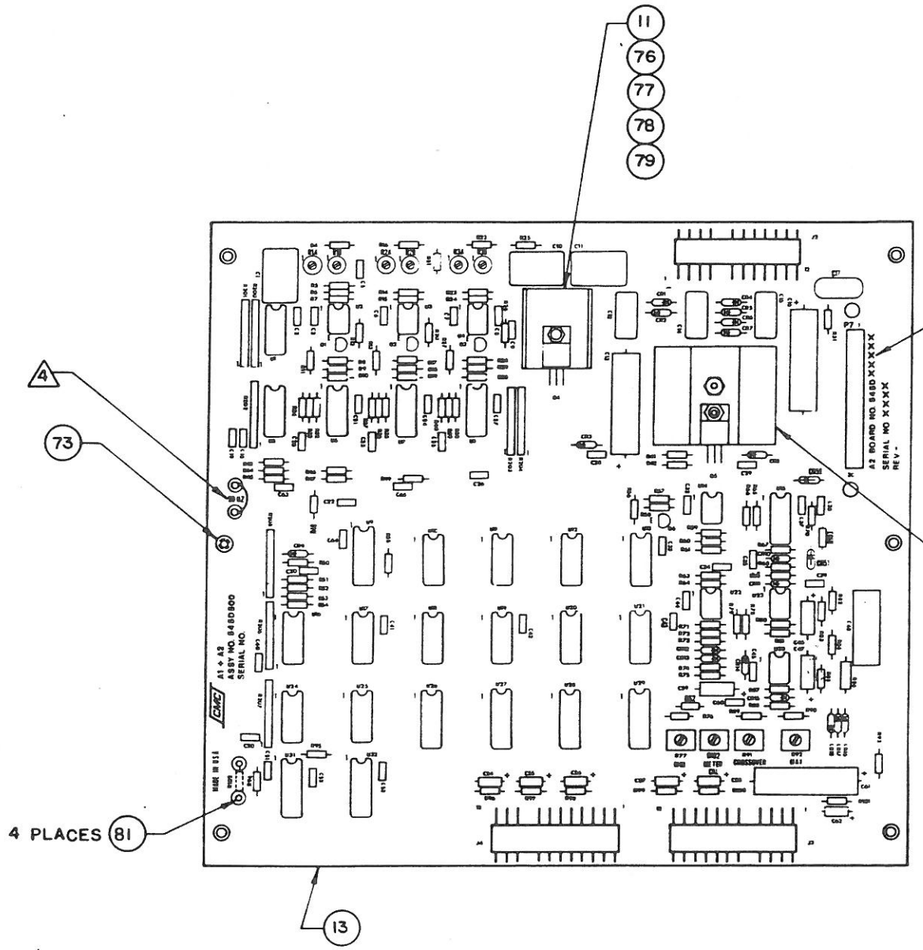
A1

PROPRIETARY PER SHEET 2

D		545B26516	D
SCALE NONE		SHEET 3 OF 3	

545B26516

REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	RELEASE FOR PRODUCTION	8-18-81 IEC	
B	CHANGES PER ECO # 302	8-11-83	
C	P/L CHANGES ONLY SEE ECO # 321	4/14/84	
D	ECO#366; R41 WAS 243K, IS 243Ω (NL only)	2-4-85	
E	ECO#455: C44, C47 WERE 5.6 UF	7-1-85	
F	ECO#505. change R47, add R48 to allow 50HZ	11-6-85	
G	REVISED PER ECO 558	7-25-86	
G1	REVISED PER ECO # W648.	9-8-86	
H	REMOVED PLUG P7, ECO#W695.	2-26-87	
H1	CHANGED TITLE PER ECO W765	2-8-88	



NOTES: UNLESS OTHERWISE SPECIFIED.
1. SYMBOLS AND ABBREVIATIONS PER MIL-STD-140.
2. REMOVE BURRS AND BREAK SHARP EDGES.

3 RUBBER STAMP ISSUE LETTER AND SERIAL NUMBER APPROX AS SHOWN.

4 REMOVE JUMPER FOR 50 HZ OPERATION.

Q1 Q2 Q3 & Q6



TRANSISTOR MOUNTING TOP VIEW

P/N 545D01814 A2

PARTS LIST

CONTRACT NO. 9513

CMC CLEVELAND MACHINE CONTROLS, INC. WESTERN OPERATIONS

PRINTED CIRCUIT BOARD ASSY LOGIC & FIRING WITH FIELD WEAKENING

SIZE	CODE IDENT	545D01814	REV
D	33831		H1

SCALE 1=1 SHEET 1 OF 4

545D01814

INTEGRATED CIRCUIT POWER SUPPLY/ PIN ASSIGNMENT

REFERENCE DESIGNATION	DESCRIPTION	MANUFACTURES PART NUMBER	GROUND PIN	+12 PIN	−12 PIN
U11, U12, U13, U17, U19, U20, U21, U24	GATE, QUAD NAND	MC14011BCP	7	14	
U10, U18, U25	GATE, QUAD NOR	MC14001BCP	7	14	
U1	GATE, QUAD EXCLUSIVE OR	MC14070BCP	7	14	
U9	HEX INVERTER	MC14049BCP	8	1	
U32	J-K DUAL FLIP FLOP	MC14027BCP	8	16	
U15	QUAD, NAND SCHMIDT	CD4093B	7	14	
U5, U6, U7, U8, U16	QUAD COMPARTOR	LM339M		3	12
U2, U3, U4, U14, U22, U23, U30	OP AMP	TI TL082CP		8	4
U26, U27, U28, U29	NPN DARLINGTON TRANSISTOR ARRAY, 50V, 500 mA	ULN2004A	8		
U31	MONO MULTI, DUAL	CD4098B	8	16	

UNUSED GATES
U17-11

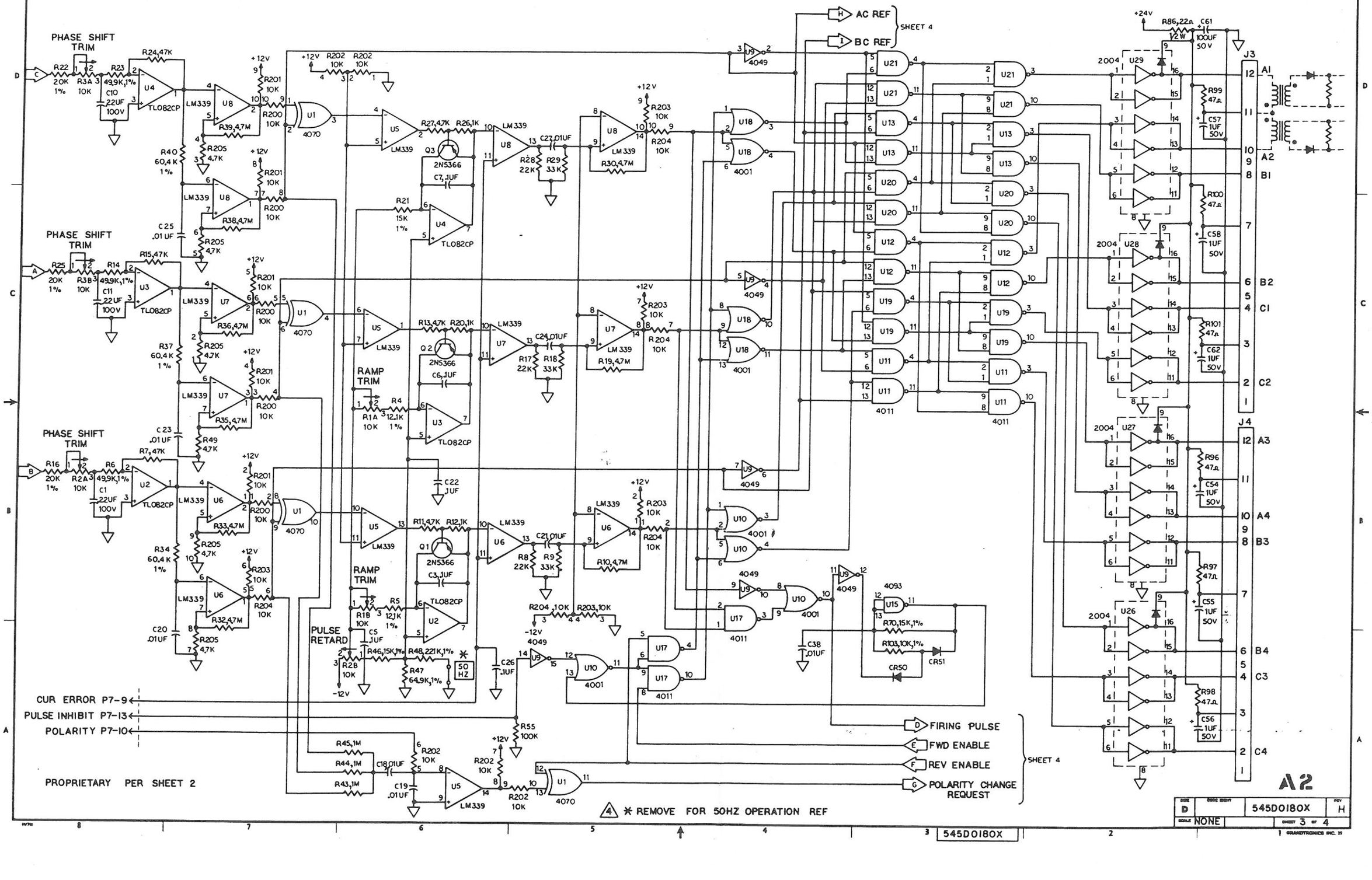
UNUSED DRIVERS
U27-10
U28-10
U29-10

NOTES: (UNLESS OTHERWISE SPECIFIED)

1. DIODES ARE IN914.
2. RESISTORS ARE 1/4 W, 10% , RC07. RESISTORS RATED AT 1% ARE 1/8W RN55D.
3. CAPACITORS VALUES GIVEN IN UF DECOUPLING CAPS ARE .1UF CK06.

PROPRIETARY INFORMATION

DATA CONTAINED HEREIN IS THE PROPERTY OF CMC, INC., AND SHALL NOT BE USED OR DISCLOSED, EXCEPT FOR EVALUATION PURPOSES, WITHOUT THE EXPRESS WRITTEN CONSENT OF CMC INC.


PHASE SHIFT TRIM
RAMP TRIM
PULSE RETARD
AC REF
BC REF
SHEET 4
CUR ERROR P7-9
PULSE INHIBIT P7-13
POLARITY P7-10
PROPRIETARY PER SHEET 2
FIRING PULSE
FWD ENABLE
REV ENABLE
POLARITY CHANGE REQUEST
SHEET 4
* REMOVE FOR 50HZ OPERATION REF
50 HZ
A2
545D0180X
NONE
SHEET 3 OF 4

CROSSOVER

MIN FIELD

MAX FIELD

METER CAL

ARM_VOLTAGE P7-14

ENABLE P7-15

FIELD LOSS P7-16

FIELD CUR P7-17

ARM CUR SIGNAL P7-11

SHEET 3

BYPASS CAPS. .1UF

+12V	-12V
C2	C9
C8	C34
C33	C45
C37	C64
C41	C65
C42	
C53	
C63	

J2

12	FIELD SUPPLY AND ISOLATOR
11	
8	CUR SIG (-)
9	COMMON
10	+12V
7	
6	
5	
4	Ø A
3	Ø B
2	Ø C
1	NEUTRAL

23VAC REF VOLTAGE FROM XFMR ASSY

P7-20 Ø A

P7-19 Ø B

P7-18 Ø C

P7-1 -24V

P7-4 +24V

P7-3 +12V

P7-2 -12V

P7-5, P7-6 COMMON

P7-8 REV

P7-7 FWD

P7-12 TURN-AROUND RESET

PROPRIETARY PER SHEET 2

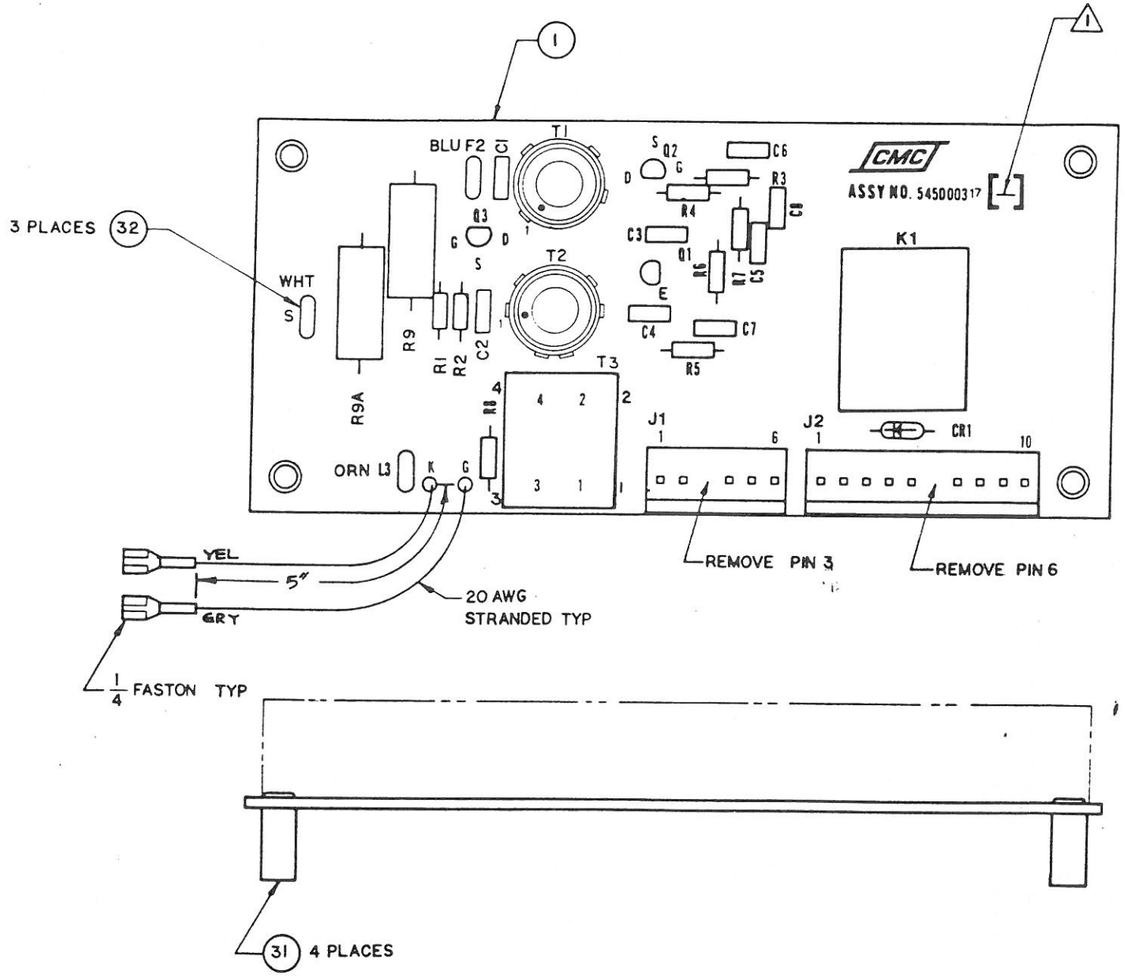
A2

SIZE	CAGE SHEET	545D0180X	REV
D			H
SCALE NONE		SHEET 4 OF 4	

545D0180X

1 GRANDTRONICS INC. 19

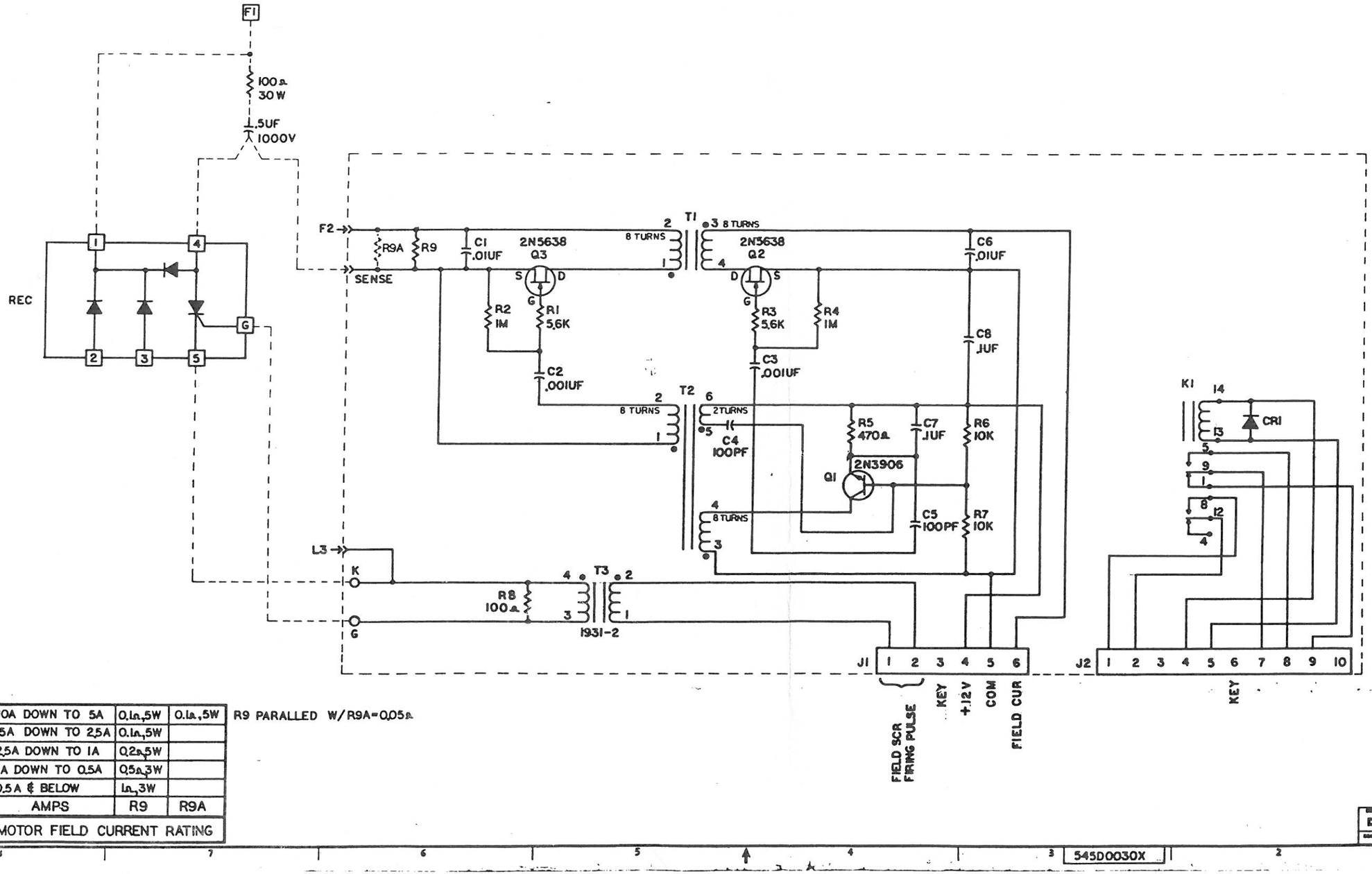
REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	RELEASE FOR PRODUCTION	4-22-81 IEC	
B	REV PER PCB ARTWORK REV B	6/5/81	
C	REVISED ECO #451	9-9-82 IEC	
C_1	REVISED ARTWORK- TO ACCEPT NEW STYLE T1 & T2	2-2-84	
D	INCREASE LENGTH OF GRAY & YELLOW WIRES FROM 3½" TO 5".	8-31-84	
E	ADDED R9A AND VALUE TABLE	4-17-85	



⚠1 RUBBER STAMP ISSUE LETTER AND PART NUMBER.

P/N 545D00317 A3

	PARTS LIST		
	9513	CMC CLEVELAND MACHINE CONTROLS, INC. WESTERN OPERATIONS	
	IEC 11-6-84	PRINTED CIRCUIT BOARD ASSY FIELD ISOLATOR & INTERLOCK	
	SEE PARTS LIST 545D0030X	D 545D0030X	E
545D0030X		SCALE 2=1 9513	SHEET 1 OF 2



10A DOWN TO 5A	0.1Ω,5W	0.1Ω,5W
5A DOWN TO 2.5A	0.1Ω,5W	
2.5A DOWN TO 1A	0.2Ω,5W	
1A DOWN TO 0.5A	0.5Ω,3W	
0.5A & BELOW	1Ω,3W	
AMPS	R9	R9A
MOTOR FIELD CURRENT RATING		

R9 PARALLED W/R9A=0.05Ω

D		545D0030X	E
NONE	9513	2 OF 2	

545D0030X