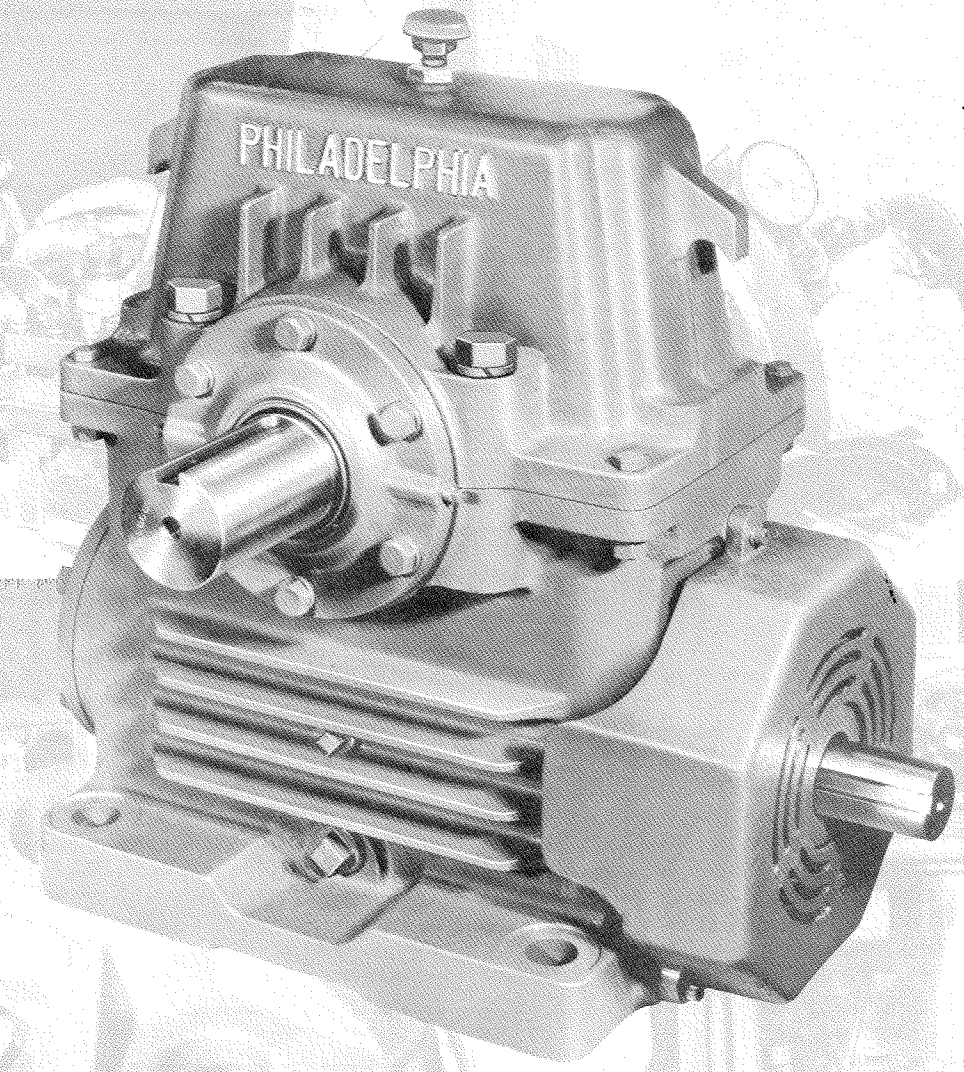
PHILADELPHIA

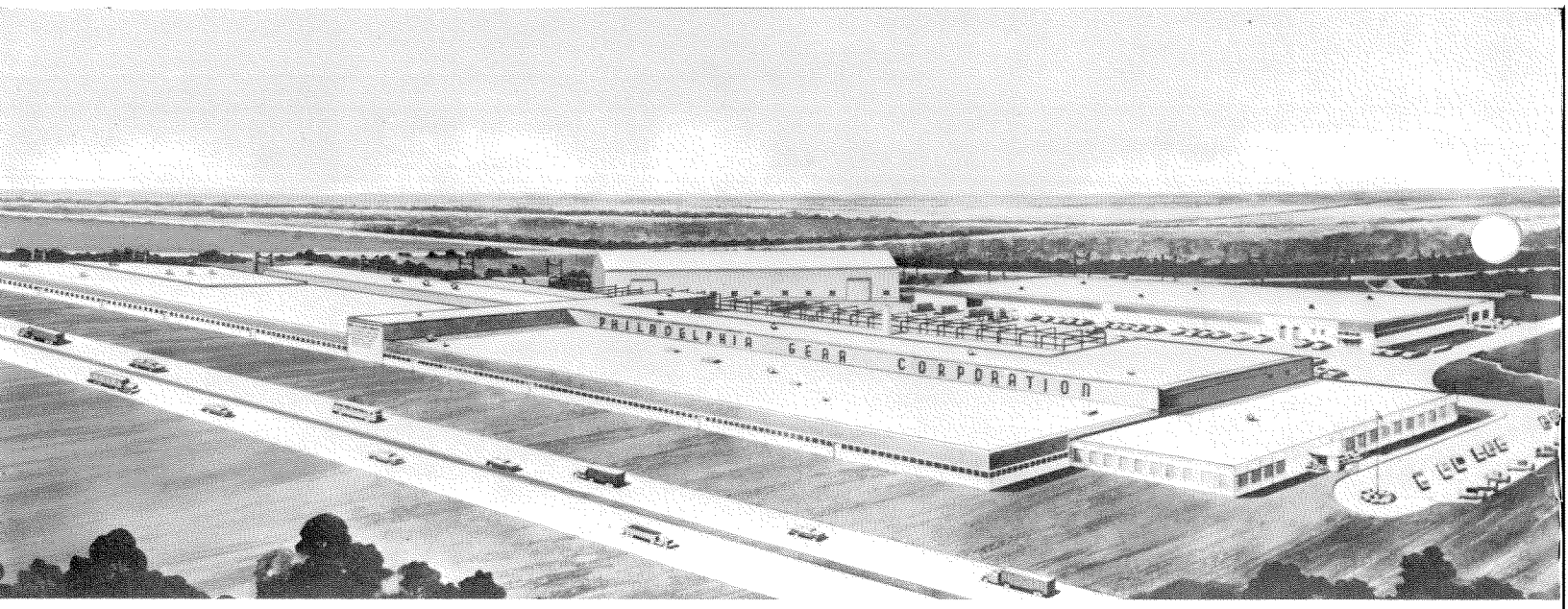
WGM-369



WORM GEAR SPEED REDUCERS

SERVICE MANUAL

A PRODUCT OF THE PHILADELPHIA GEAR CORPORATION



Philadelphia Gear Corporation/King of Prussia, Pennsylvania

FOREWORD

■ This Service Manual covers Philadelphia Worm Gear Speed Reducers. Generally, these gear units have input and output shafts positioned at right angles to each other and are referred to as Worm Gear Reducers.

The procedures described in this manual relate to Philadelphia Gear worm gear units, used as a single reduction unit, or with the proper attachments, as a single helical worm unit, a double helical worm unit, or a double reduction unit.

Your Philadelphia Speed Reducer is a high quality, rugged machine designed in accordance with Standards of the American Gear Manufacturers Association to give long hours of trouble-free service. However, certain precautions and procedures must be observed in handling, installing, and servicing the unit in order to obtain optimum performance.

The booklet contains general installation, operating, maintenance and trouble-shooting instructions for your reducer. Should questions arise that are not covered, additional information can be obtained by contacting your local representative, or the Service Manager—Reducer Division —at Philadelphia Gear Corporation, King of Prussia, Pennsylvania. (Telephone: 215-265-3000—TWX Number: 510-660-3952.)

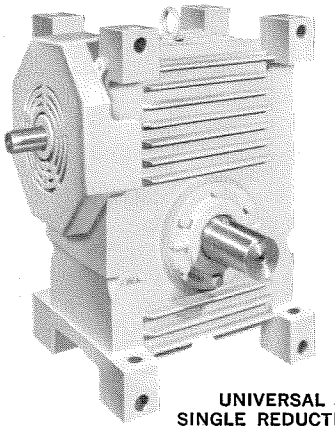
All inquiries should be accompanied by the following information, which can be obtained from the unit nameplate:

Unit size and type
Philadelphia Gear Corporation Order Number
Serial Number
(Orders for renewal parts should include description and part number shown on parts list.)

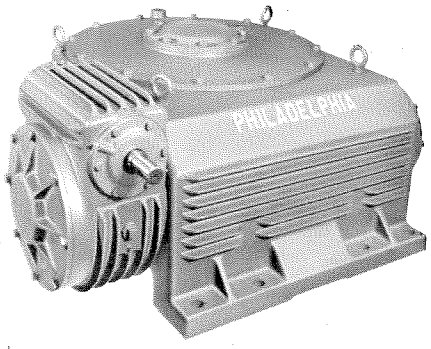
GENERAL INSTRUCTIONS

1. Any apparent or suspected damage sustained by equipment manufactured or furnished by Philadelphia Gear Corporation during transport from the factory to the user should be immediately reported to both the Philadelphia Gear Corporation and to the Carrier.
2. Upon delivery all equipment furnished should be carefully inventoried against shipping papers to determine whether any shortages exist in delivered material. Any such shortages must immediately be reported to Philadelphia Gear and the Carrier if a timely claim is to be made.
3. The installation of most power transmission equipment does not normally require the services of a factory engineer. These services are not included in the selling price of the equipment, unless specifically agreed upon in writing between the seller and purchaser. In applications requiring a more complex arrangement of components, consideration should be given to the use of a factory engineer for construction supervision or check-out of the installation. These services are available from Philadelphia Gear by contacting the Service Department.
4. The Seller's Warranty applies insofar as the unit is operated within the rating and service conditions for which it was specifically sold.
   The purchaser must prevent the existence of any destructive external conditions, which might typically include vibratory loads due to critical speeds, severe shock loading, mechanical or thermal overloads, or other conditions concerning which the seller was not fully advised. Also, the unit must be installed and maintained in accordance with instructions contained in service instructions.
5. Adequate installation, maintenance and safety instructions must be given by the user to personnel directly responsible for the operation of the equipment.
6. Guards, alarms, heaters and other safety devices furnished by the manufacturer must be installed by the user. In addition, the procedures set forth in the operating instructions must be carefully followed.
7. The user is also responsible for furnishing and installing any guards or other safety equipment needed to protect operating personnel, even though such safety equipment may not have been furnished by the seller with the equipment purchased.
8. All unauthorized personnel should be required to remain a safe distance away from rotating shafts, couplings, clutches, etc.
9. In the event of malfunction within the warranty period, the manufacturer must be informed promptly or, in any event, within thirty days if it is intended that the warranty is to cover the incident.

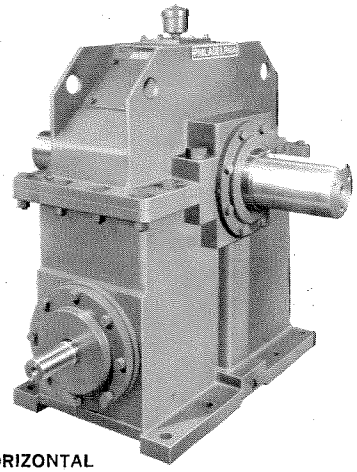
WORM GEAR SPEED REDUCERS



UNIVERSAL
SINGLE REDUCTION
UNIT



VERTICAL
DOUBLE REDUCTION
WORM UNIT



HORIZONTAL
SINGLE REDUCTION
UNIT

GENERAL SPECIFICATIONS

■ Worm gear drives are designed and rated in accordance with the American Gear Manufacturers' Association Practice for Single and Double-Reduction Cylindrical Worm and Helical-Worm Speed Reducers.

Threads are cut on a cylindrical member to produce the worm. The gear is cut on hobbing machines with a cutter that is a facsimile of the worm thread. The teeth on the worm slide against the gear teeth and at the same time produce a rolling action similar to that of a rack against a spur gear. Because of the screw action, worm gear drives are relatively quiet and vibration free.

Worm gearing of higher ratios cannot be driven backward thru the worm gear. A worm gear set is called "self-locking" when this condition occurs. Although the amount of effort required to reverse worm gearing increases with its ratio, a gear set is considered fully self-locking when the lead angle of the worm is less than 5 (five) degrees. Usually gear sets having a ratio of 30:1 or greater can be furnished "self-locking".

Materials for worms and worm gears must be selected with extreme care, in order to provide combinations that will reduce friction to a minimum and eliminate any galling between mating teeth. Worm gears for some smaller units are made in one piece of special bronze, to AGMA specifications. For most sizes, the gear is made in two parts—a rim made of the same high strength bronze braze-welded to a steel or semi-steel center.

Worms are made of alloy steel with case hardened threads. Normally, they are precision ground after hardening.

Gears in the helical attachments are helical gears hobbed and precision finished by shaving. The material used for helical pinions and gears is a heat treated SAE 4140 steel.

Input shafts of single and double reduction units are integral with the worm. Helical pinion shafts are made of heat-treated SAE 4140 steel. Gear shafts are also heat-treated SAE 4140 steel. All shafts are designed within the limits set by AGMA for shaft stresses and are finished to close tolerances by grinding.

Anti-friction bearings of ample size to permit overhung loads are used throughout. The use of anti-friction bearings assures high efficiency and proper shaft alignment. Seals on both worm and gear shafts prevent oil leakage and provide protection from dust and dirt for the bearings.

For smaller units, worm shafts are mounted on two opposed tapered roller bearings. On larger units and units with torque control, worm shafts are mounted on double tapered roller bearings on the blind end to take thrust and radial loads. On the shaft extension end, they are mounted on ball bearings or cylindrical roller bearings to take gear radial loads and overhung loads. Gear shafts are mounted on two tapered roller bearings.

Bearings are conservatively selected to meet all conditions of horsepower, speed and ratio, listed in the rating tables, for either direction of rotation.

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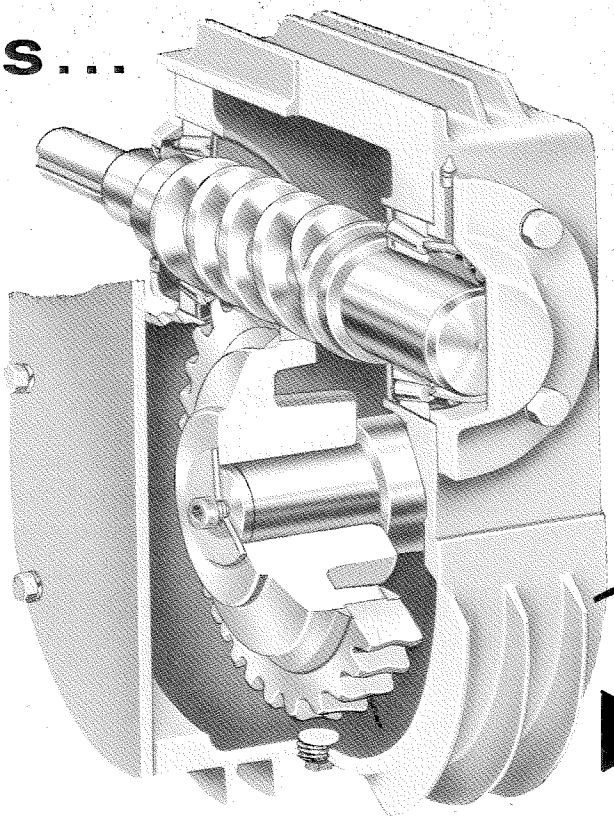
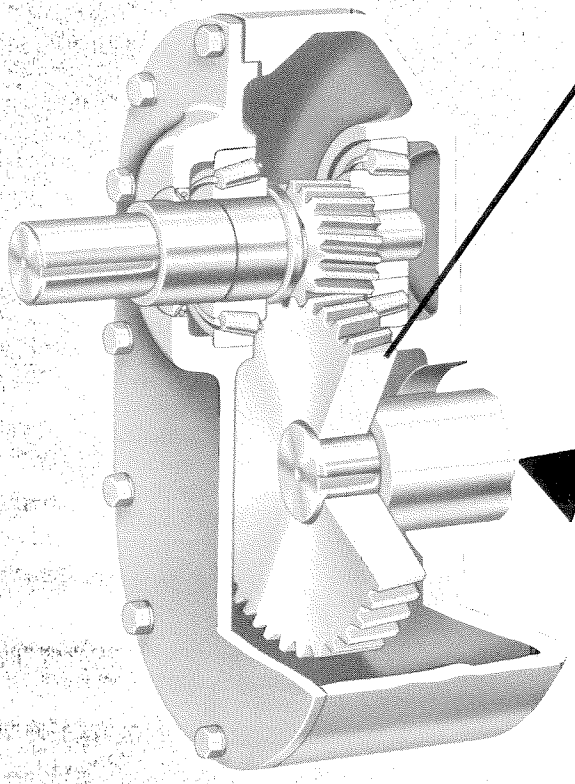
CONSTRUCTION FEATURES . . .



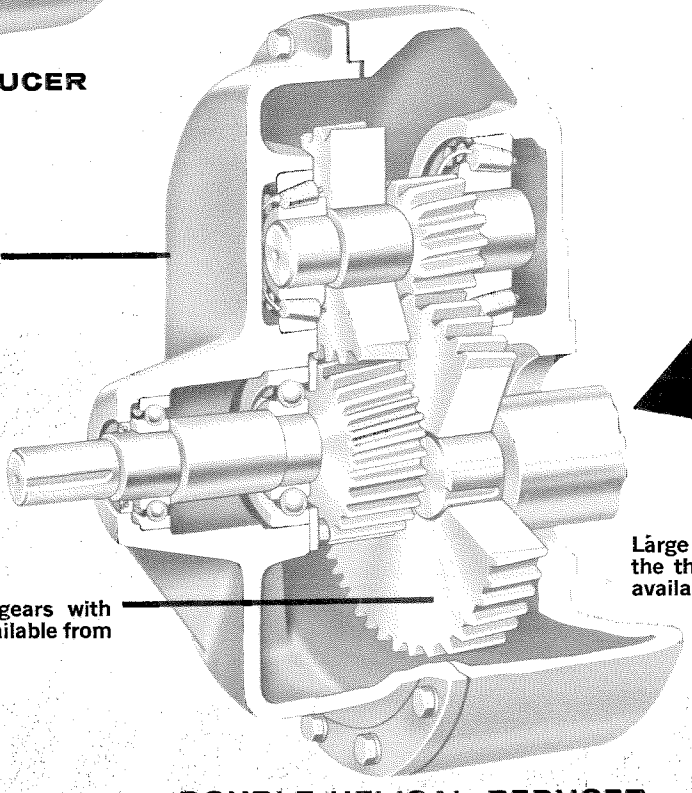
DOUBLE WORM GEAR REDUCER

Helical gears are used to produce high ratios with maximum efficiency.



SINGLE HELICAL REDUCER

Philadelphia close grained cast iron housing is designed to provide maximum rigidity and support for gears and shafting.

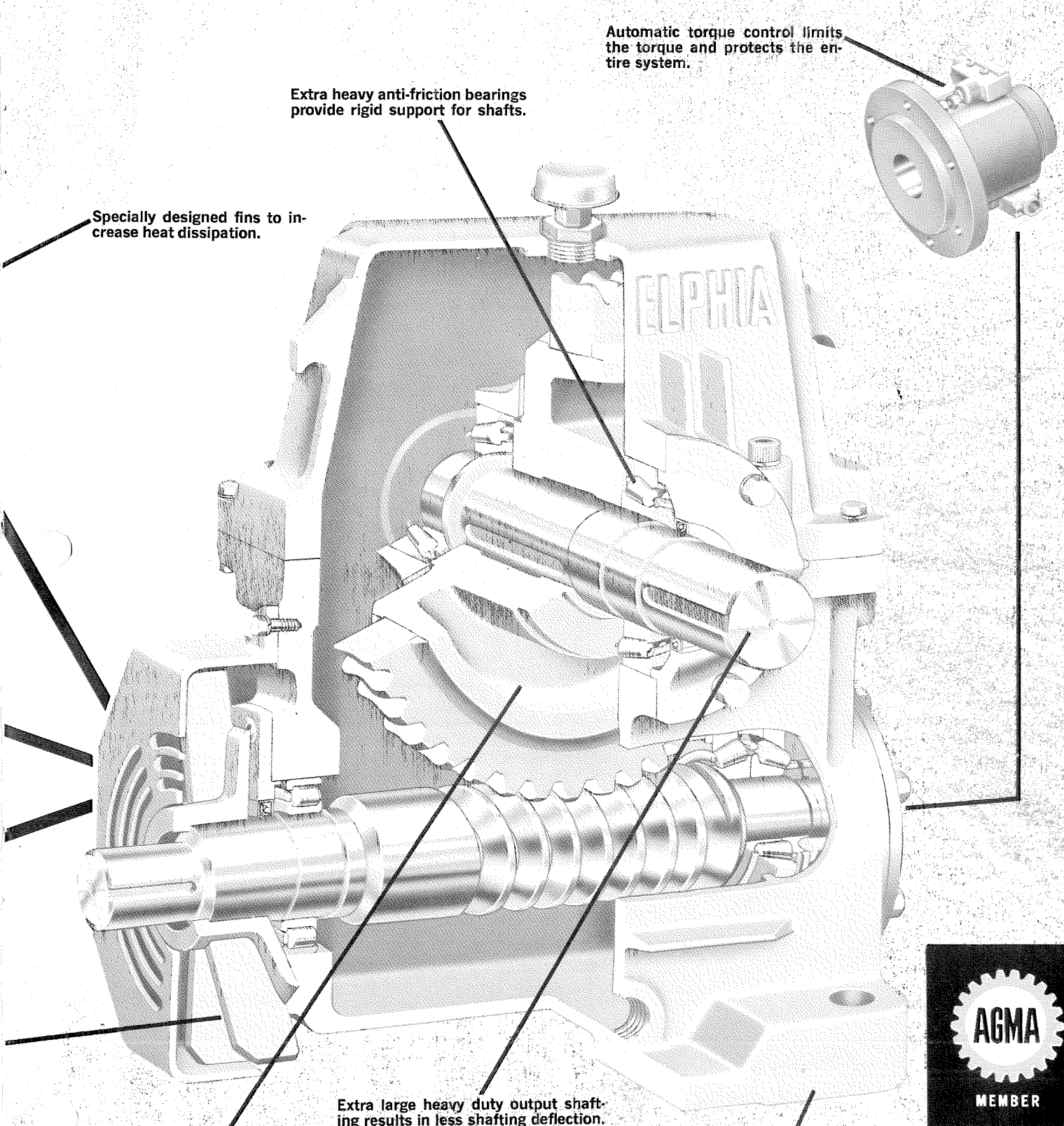


Large size fan designed to increase the thermal rating when necessary available on all units.

Precision helical gears with standard ratios available from stock.

DOUBLE HELICAL REDUCER

Philadelphia Worm Gear Reducers



AGMA MEMBER

DESIGNED AND RATED IN ACCORDANCE WITH STANDARDS OF THE AMERICAN GEAR MANUFACTURERS ASSOCIATION.

GENERAL DESIGN FEATURES

■ The following descriptive material applies to the majority of Philadelphia gear drives. There are occasions when operating conditions or design considerations dictate deviations from the standard arrangements described in this booklet; when special instructions are required, contact factory.

The Philadelphia Worm Gear speed reducer design consists of a basic unit which can be used as a single reduction unit, or with the proper attachments, as a single helical worm unit, a double helical worm unit, or a double reduction unit. All of the above can be fitted with a torque control, a mechanically actuated device which can be set to shut off the driving motor when the output torque reaches a predetermined figure. The basic units can be divided into three distinct types:

1. The universal type, used in center distances up to and including 7¾″. This unit has mounting surfaces on three sides of the housing, making it possible to mount the unit with the gear shaft projecting horizontally above or below the worm or with the gear shaft projecting vertically up or down.
2. The horizontal type, with 9″ centers and above, in which the gear shaft projects horizontally above or below the worm.
3. The vertical type, with 9″ centers and above, in which the gear shaft projects vertically up or down.

The single helical, double helical, or double worm attachment each consists of a sub-assembly. These contain the necessary gears, shafts, bearings, and seals in a separate attachment housing which is securely bolted to the basic unit.

HOUSING—The rotating parts of a Philadelphia Worm Gear speed reducer are contained in an oil tight housing.

1. The universal type has a one piece cast iron finned housing with three machined mounting surfaces.
2. The horizontal type includes a cast iron or welded steel housing which is split horizontally at the low speed shaft centerline. The surface of the housing split is machined to a high finish and coated with a fluid sealing compound. The housing is fastened at the split by cap screws locked by split type lockwashers. In some cases, studs are used with hex nuts secured by lockwashers or jam nuts.
3. The vertical type has a one-piece cast iron or welded steel housing.

BEARING ARRANGEMENT—Shafts are supported on anti-friction bearings throughout. The output shaft in all units is supported by two tapered roller bearings in an opposed mounting. The worm shaft, in the universal units (up to 7¾″ center distance), is supported on two tapered roller bearings in an opposed mounting, except when the unit is equipped with torque control. In this case, the worm shaft has two tapered roller bearings on the blind end in an opposed mounting and one ball bearing on the extension side in a mounting where it is free to float. Worm shafts, in all units 9″ center distance and larger, are supported by two tapered roller bearings on the blind end in an opposed mounting and one cylindrical roller bearing on the extension end in a mounting where it is free to float. Worm shafts in double worm attachments are the same as used in the single reduction worm reducers of the appropriate center distance.

Input shafts in helical attachments are supported on ball bearings in sizes to 18″ worm gear center distance. In larger size units, the input shaft is mounted on tapered roller bearings in an opposed mounting. The intermediate shaft of the double helical attachment is mounted on ball bearings in sizes to 10″ worm gear centers and on opposed tapered roller bearings in larger sizes.

Ball bearings have internal clearance preset. Opposed tapered roller bearings must be adjusted to proper lateral end play. Tapered bearings are held in place by end caps which have a shim set between the cap flange and the housing boss. The bearings are adjusted by altering the shim thickness. Output shaft bearings are adjusted correctly when they are set to .000 to .002″ lateral end play. Worm shaft and helical attachment bearings should be adjusted to .002 to .004″ lateral end play.

OIL SEALS—The oil seals used on the shaft extensions are a lip type and are spring loaded with sealing elements of leather or synthetic rubber.

SPECIAL SEALS—Speed reducers operated in dusty or corrosive atmospheres should be equipped with special seals and breathers designed for these conditions. Similarly, units subjected to moisture and vapor laden atmospheres, or hose-down, should be furnished with a special seal designed for these conditions. Unusual environmental conditions should be detailed to the manufacturer at the time the gear drive is ordered.

DRY WELL CONSTRUCTION—is used for sealing shafts that extend vertically downward. The dry well consists of a tube concentric with the shaft, extending above the oil level and covered by the gear to prevent any oil leakage.

GEARING—Threads are cut on a cylindrical member to produce the worm. The number of threads are usually one to eight, depending upon ratio and the number of gear teeth. Worms are cut integrally on shafts. They are made of alloy steel with case hardened threads and are precision ground after hardening.

Worm gears are cut on hobbing machines with a cutter that is a facsimile of the worm thread. Worm gears for smaller units are made in one piece of special worm gear bronze. For larger sizes the gear is made in two parts—a rim of the same high strength bronze, braze welded to a semi-steel center. Worm gears are mounted on shafts with keys and a press fit.

Gears in the helical attachments are helical gears hobbed and precision finished by shaving. The helical gears and pinions are mounted on shafts with keys and a shrink fit. The intermediate pinion, in double helical attachments, is cut integrally on the shaft.

LUBRICATION SYSTEM—All gear sets in Philadelphia Worm Gear units are submerged in oil. Gear shaft bearings are grease lubricated except in units where the low speed shaft projects vertically upward. In these units the upper bearing is grease lubricated, but the lower bearing is submerged in oil.

Worm shaft bearings are submerged in oil except in units where the worm shaft is located above the worm gear. In these units the worm shaft bearings are grease lubricated. Bearings in helical attachments are lubricated by splash or submersion.

FAN COOLING—Single reduction worm gear reducers, up to and including 12″ center distance units, are normally supplied with fans, when input speed exceeds 870 RPM. However, fans can be applied to all sizes of units and shaft speeds, if it is desirable for thermal reasons. The fan is mounted on the worm shaft and driven at input speeds. The fan cover is designed to direct the air over the oil sump area of the finned housing, thus increasing the thermal rating of the unit and eliminating the need for oil coolers or cooling coils.

TORQUE CONTROL—All Philadelphia worm reducers can be supplied with a Torque Control. This is a mechanical device operated by the thrust on the worm shaft, which actuates limit switches at pre-determined output torques. A Torque Control can be used to sound an alarm or shut the motor down when an overload occurs. Single Torque Controls are set up for one direction of rotation only. Double Torque Controls can be set for shaft rotation in either direction.

HANDLING INSTRUCTIONS

SAFETY—In the maintenance and operation of gear drives, SAFETY COMES FIRST. By using the proper clothes, tools and methods of handling, serious accidents can be prevented.

This manual lists a number of safety precautions. Follow them, and insist that those working for you do the same. An accident is usually caused by neglect or oversight.

HANDLING—When handling a Philadelphia Gear reducer, care must be taken to avoid supporting or lifting in a manner that would place excessive stress on parts that are not designed to support the unit weight. When the unit is resting on the floor it always should be in a normal upright position with the weight resting on the mounting surface. Gear units of the vertical type, having shafts projecting below the mounting base, should be supported by blocks under the mounting surfaces to avoid placing the unit weight on the shaft.

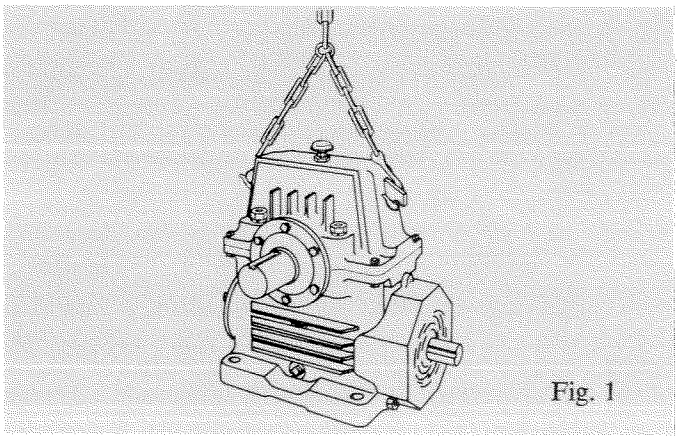


Fig. 1

The unit should be lifted only with the heavy lifting lugs or eyebolts provided for this purpose, as illustrated in Figure 1. When more than one lifting lug or eyebolt is provided, slings should be used to distribute the load evenly.

The following additional precautions should be observed in handling Philadelphia Speed Reducers:

(a) Never drag the reducer. This will mar the machined mounting surfaces and may over-stress the housing.

(b) When attaching slings to the unit, attention should be given to the behavior of the sling under load. Do not attach a sling in a manner which will cause it to crush or rip loose exterior piping or gauges when it is placed under load.

INSTALLATION INSTRUCTIONS

■ The basic gear unit is shipped from the factory completely assembled. Mating gears and pinions are carefully assembled at the factory to provide proper tooth contact. Nothing should be done to disturb this setting.

A SOLID FOUNDATION — The reducer foundation should be rigid enough to maintain correct alignment with connected machinery. The foundation should have a flat mounting surface in order to assure uniform support for the unit (Figure 2). If the unit is mounted on a surface which is other than horizontal, consult factory to insure that design provides for proper tooth contact and adequate lubrication.

Design of fabricated pedestals or base plates for mounting speed reducers should be carefully analyzed to determine that they are sufficiently rigid to withstand operating vibrations. Vibration dampening materials may be used under the baseplate to minimize the effect of vibration.

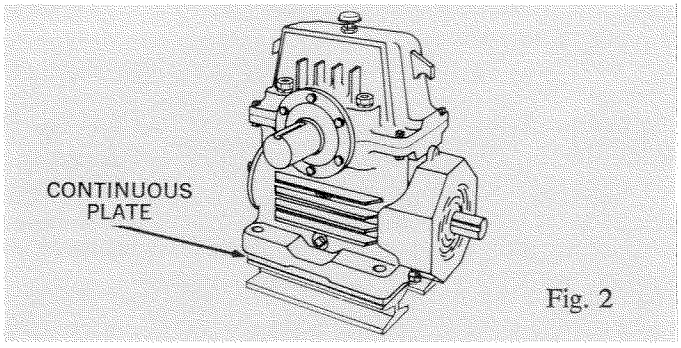


Fig. 2

When mounting a Philadelphia drive on structural steel, the use of a rigid baseplate is strongly recommended. Bolt unit and baseplate securely to steel supports with proper shimming to insure a level surface.

If a drive is mounted on a concrete foundation, allow the concrete to set firmly before bolting down the unit. For the best mounting, grout structural steel mounting pads into the concrete base, rather than grouting the gear unit directly into the concrete (Figure 3).

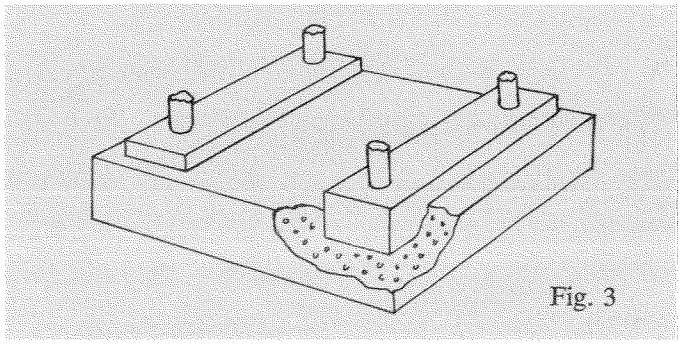


Fig. 3

LEVELING—If shims are employed to level or align the unit, they should be distributed evenly around the base under all mounting pads to equalize the support load, to

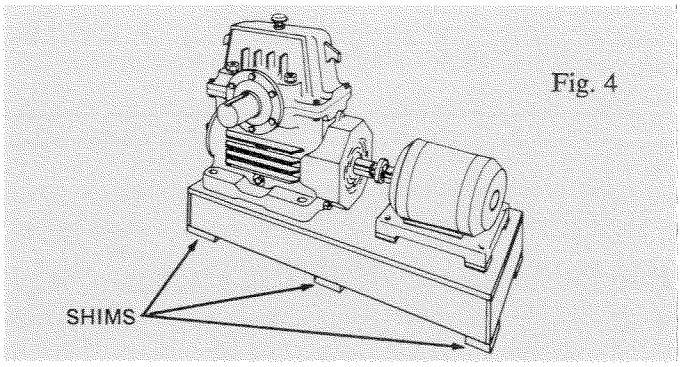


Fig. 4

avoid distortion of the housing and highly localized stresses (Figure 4).

Use a feeler gauge to determine thickness of required shims. All pads must be squarely supported to prevent distortion of the housing when the unit is bolted down.

ALIGNMENT—If equipment is received mounted on a bed plate, it has been aligned at the factory. However, it may have become misaligned in transit. During field mounting of the complete assembly, it is always necessary to check alignment by breaking the coupling connection and shimming the bed plate under the mounting pads until the equipment is properly aligned. (See Coupling Alignment Instructions on Page 12 for alignment tolerances.) All bolting to the bed plate and foundation must be pulled-up tight and each member doweled in place. After satisfactory alignment is obtained, close up the coupling.

REMOVE SHIPPING COVERS—All protective shipping covers should be removed from the unit. The shaft extensions and outside machined surfaces are protected during shipment by an anti-rust compound. This can be removed by using a solvent.

MOUNTING ACCESSORIES—Any field mounted couplings, sprockets, pinions, pulleys, etc., should be installed carefully to provide good contact on the driving keys, as well as to prevent cocking on shaft extensions. Since an endwise blow on the shaft may damage gears and bearings, these attachments should not be hammered into position but, preferably, should be heated to about 375 degrees F. and slipped onto shafts (Figure 5).

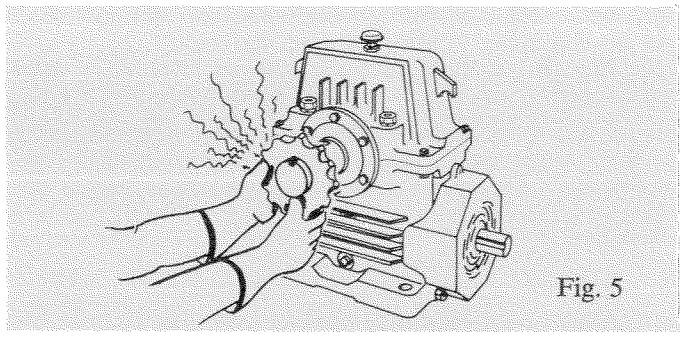


Fig. 5

Sprocket, pulleys, and pinions should be mounted as close as possible to the gear case in order to reduce the cantilever effect of these overhung loads on adjacent bearings.

COUPLINGS—Drive shafts should be connected using flexible couplings. The couplings should be aligned as closely as possible following instructions on Page 12.

INSTALLATION OF TORQUE CONTROL — Units equipped with a Torque Control are adjusted to the approximate output torque rating at the factory. They can be adjusted in the field to suit actual conditions (See Page 18). The limit switches in the Torque Control should be wired in accordance with the typical wiring diagrams illustrated on Page 18 or in accordance with purchasers' wiring diagram.

ALIGNMENT AND BOLTING—The gear unit, together with the prime mover and the driven machine, should be correctly aligned. Coupling alignment instructions on Page 12 should be carefully followed. After precise alignment, each member must be securely bolted and doweled in place. It may be necessary, on fan cooled units, to unbolt the fan cover and move it away from the mounting holes while bolting down the unit. This can be done by unscrewing the three cap screws holding the fan cover in place. After the unit is bolted down, the fan cover should be fastened securely in place.

It is essential that a gear unit be securely bolted down to its foundation using bolts of the proper diameter to fit mounting holes.

Bolts should be S.A.E. Grade 5 or equivalent. Shear blocks are recommended if the unit has a heavy overhung load in a direction that would place the bolts in shear.

Torque values for bolting are as follows:

BOLT SIZE INCHES	APPROXIMATE TORQUE VALUE FOOT POUNDS
½	78
⅝	166
¾	210
⅞	320
1	472
1¼	864
1½	1460

After start-up (See Start-Up Instructions) the unit should be run until the operating temperatures stabilize. The alignment should be checked again and any necessary corrections made. **IT IS GOOD PRACTICE TO CHECK THE ALIGNMENT ONCE MORE AFTER OPERATING UNDER LOAD FOR TWO OR THREE WEEKS.**

CHECK ACCESSORIES—Those Philadelphia Gear units equipped with torque control, electric motor driven lube pumps, or electric control devices should be wired and checked for correct operation of those accessories.

Units with water cooled heat exchangers should be piped to the cooling water lines and correct flow of coolant observed.

For installations where lubrication is supplied from the customer's own central lubrication system, the unit should be piped to this system and before unit start-up, checked to insure that the system is furnishing oil in adequate volume and pressure to gearing and bearings.

RUST PREVENTION—When a Philadelphia Gear drive leaves the factory, the internal parts are protected with a film of polar type rust preventative which protects the unit during shipment. This film is soluble in a lubricant, and does not have to be flushed out before filling with the recommended lubricant. External machined surfaces are protected during shipment by an anti-rust compound. This can be removed by using solvents.

PROLONGED STORAGE—If installation of the gear unit and operation is to be delayed for more than one month after factory shipment, special rust preventative precautions should be taken. The precautions may be taken by the factory if full information concerning storage conditions is provided at the time of ordering or, alternately, by the user

in the field. The manufacturer's warranty on units held in prolonged storage should be covered by a special agreement reflecting the storage conditions.

If prolonged storage is necessary, it should be indoors, and preferably in a dry area having a relatively constant temperature.

When outdoor storage is unavoidable, units should be raised off the ground on skids and should be covered by a tarpaulin, or an equivalent protective covering. Also, where possible, units should be filled to the top with oil or, where this is not possible, the interior and exposed metal parts should be sprayed with a heavy duty rust preventative. Gear drives should be periodically rotated while in storage.

ADD GREASE — Reducers having bearings requiring grease are normally shipped from the Philadelphia Gear factory with grease in the bearings. Prior to prolonged storage or start-up, all grease lubricated bearings must be checked and grease added in accordance with instructions on page 10-11.

START-UP INSTRUCTIONS

(SEE GENERAL INSTRUCTIONS—PAGE 2)

■ When starting up any new piece of equipment, it is wise to proceed cautiously. Even though the best installation practices are followed, the possibilities of errors or omissions always exist. Therefore, we recommend that **before initial start-up** the following procedures be followed:

1. Has all accessory equipment such as: breathers, oil level indicators, pressure gauges, switches, etc., been mounted? Often it is necessary to box these items separately to prevent damage or loss to shipment.
2. Are mounting bolts tight? Check all external bolts, screws, accessories, etc., to make sure they have not loosened in shipping or handling.
3. Are all couplings, sprockets, pinions, etc., mounted on shaft extensions correctly with keys and fasteners in place?
4. Does high speed coupling allow adequate lateral float of worm shaft for units with torque control?
5. Have couplings, seals, and bearings been greased?
6. Have coupling connections been made and tightened properly? Have necessary guards and safety devices been installed at all hazardous locations?
7. **Fill with oil to indicated level. Before start-up all Philadelphia gear drives must be filled with the type and grade of oil specified on page 11 (Figure 6).**

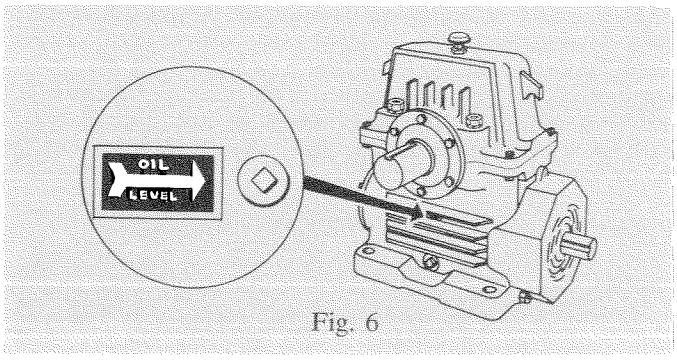


Fig. 6

8. Have all inspection covers on unit been closed and properly fastened?
9. Have required electrical connections been made? Units equipped with torque control should be wired in accordance with purchaser's wiring diagram.
10. Have required piping connections been made?
11. Tighten all pipe connections to make sure they have not loosened in shipment or handling.

Philadelphia Gear units are test-run at the factory; however, **during initial start-up** the following procedures are recommended:

1. If the reducer is equipped with heaters for cold temperature operation, turn on heaters and allow oil temperature to rise to at least 65° F.
2. If the unit is equipped with a separate motor driven oil pump, start pump motor and check visually through inspection covers that the lubrication is flowing to gearing and bearings and, also, that a pressure of 15 to 30 psi at operating temperature is indicated on pressure gauges. Motor driven oil pump starting equipment should be arranged to start pump before main gear drive.
3. Similarly, if unit is equipped with a pump driven by rotation of main gear train, the unit should be checked immediately on start-up through the full range of operating speeds to determine that lubricant is flowing to gearing and bearings, and that pressure of 15 to 30 psi is indicated on pressure gauge.
4. If the unit is equipped with a water cooled heat exchanger, make sure that clean cooling water is flowing to oil cooler. Cooling water should not exceed 80° F. on entry into cooler unless the cooler was selected by manufacturer to permit higher water temperature.
5. Start unit slowly under as light a load as possible. If rotation of the unit is limited to one direction only, a tag on the bearing block indicates direction of rotation. If necessary, reverse electrical leads on motor to make shaft rotation conform to those shown.
6. Prime Mover electrical starting equipment should be arranged to start unit slowly to avoid severe impact loads. Across the line starting of motors should be applied with caution to prevent instantaneous gear loads greatly in excess of rating.
7. As the unit is brought up to normal operating speed, it should be checked constantly for unusual sounds, excessive vibration, excessive heat, or oil leakage. If any of these develop, the unit should be shut-down, immediately and the cause determined and corrected. The operating temperature of the unit at the hottest point should normally not exceed 200° F.
8. If possible, the reducer should be operated under a light load (approximately half-load) for one or two days to allow final breaking-in of gears. After this period, the unit can be operated under normal load.
9. Check operation of torque control. The application of excess load should cause the torque control to operate and shut off motor.
10. If fan has been applied to unit, make sure that a flow of air is passing over the gear drive and that fan is not picking up dust or dirt and depositing it on the drive.

LUBRICATION INSTRUCTIONS

TYPE OF LUBRICANT—The recommended type of oil for use in Philadelphia worm gear units is a mineral oil with an additive of 3% to 10% of acidless tallow or similar animal fats. Specifications and recommended areas of application are shown on Page 11.

LOW TEMPERATURE OPERATION—The Philadelphia Gear factory should be fully advised of low temperature service conditions at the time an enclosed gear drive

is purchased, in order that special design considerations can be incorporated.

The oils recommended in the Selection Chart on Page 11 are not normally satisfactory for cold temperature starting. When ambient starting and operating temperatures range below the minimum specified in the following paragraph for low temperature environments, heaters or special oils must be used. Refer to the factory for recommendations.

The lubrication recommendations on Page 11 are suitable for splash systems starting and operating to 15° F. Whenever a pump is used in a spray lubrication system, these recommendations should only be applied to 65° F. When ambient temperatures fall below this level, either heaters or special lubricants must be used to assure adequate pump action.

GREASE LUBRICATION OF BEARINGS—Pressure fittings are supplied in Philadelphia units for the application of grease to bearings that are shielded from the oil. Although a film of grease over the rollers and races of the bearing is sufficient lubrication, Philadelphia Drives are designed with ample reservoirs at each grease point.

Grease chambers should be filled through pressure fittings until grease flows out of relief plugs (Figure 7).

Units shipped from the factory have grease applied; however, it is always advisable to add grease in the event the original grease might have been dissipated. Couplings, and all accessory equipment should be checked for adequate grease supply. (See Page 10).

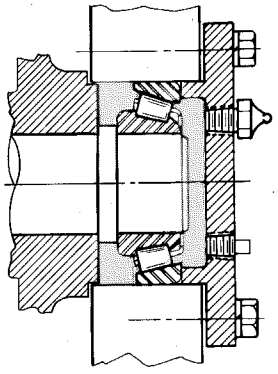


Fig. 7

Greased bearings should be lubricated at definite intervals. Usually one month intervals are satisfactory unless experience indicates that regreasing should occur at shorter or longer intervals.

OIL SEALS—Oil seals require a small amount of lubricant to prevent frictional heat and subsequent destruction when the shaft is rotating. Normally when a single seal is utilized, sufficient lubricant is provided by gear oil or bearing grease. Certain design or application requirements dictate that double seals be used at some sealing points. When this is the case, a grease fitting and relief plug are located in the seal retainer to provide lubricant to the outer seal. Grease must periodically be applied between the seals by pumping through fitting until overflow is noted at relief plug. The greases recommended for bearings may also be used for seals.

OIL CHANGES—After the initial two weeks of operation of a Philadelphia Gear unit, the first oil (see start-up Instructions, Page 9) should be changed. If desired, this oil may be strained and re-used. Do not use a strainer finer than 25 micro inches to avoid filtering out the additives. Very often, due to the wearing-in process, small metal particles will show up in the oil; this is not abnormal.

It is recommended that the gear case be thoroughly flushed-out after the original oil has been drained. Fill the case to the indicated level with SAE 10 straight mineral flushing oil which should not contain additives. Unit should be started, brought up to operating speed (preferably without load) and immediately shut down. Drain off flushing oil and refill with recommended operating lubricant to proper level. After the break-in procedure outlined above, it is recommended that oil be changed after each subsequent 2500 hours of operation or 6 months of normal operation, whichever occurs first.

Unusual environmental or load conditions sometimes necessitate replacement of oil as frequently as one to two month intervals—as determined by field inspection of oil. Special attention must be given to the inspection of lubricants when the following conditions exist:

1. High operating temperatures resulting from heavy intermittent loads, causing the temperature of the gear case to rise rapidly and then cool.
2. Ambient temperature conditions which might tend to cause sweating on the inside walls of the unit, thus contaminating oil and forming sludge.
3. Operating oil temperatures that remain constantly above 180° F.
4. When the unit is exposed to unusually moist atmosphere or vapors.

Precautions should be taken to prevent any foreign matter from entering the gear case. Dust, dirt, moisture, and chemical fumes form sludge which is the biggest enemy of proper and adequate lubrication. The Philadelphia Gear Corporation should be advised before manufacture of gear unit when unusual environmental conditions are anticipated.

PREVENTIVE MAINTENANCE

See Page 14 for Trouble-Shooting Chart.

The instructions for oil changes should be followed.

After the first 50 hours of operation all external housing and holddown bolts should be torqued to make certain they have not loosened. Piping connections should be checked and tightened if necessary.

It is good practice to recheck the alignment with connecting machinery after initially operating for two or three weeks under load.

At this time, also check the adjustment of the opposed taper bearings on the low speed and worm shafts using the method outlined in Assembly Instructions Page 13.

DAILY—The Philadelphia unit should be given a routine visual inspection for oil leaks or unusual sounds. If either occurs, unit should be shutdown at once and the cause determined. If the unit is equipped with pressure lubrication, the oil pressure should be checked. If any change from previous reading is noted, the cause should be immediately determined.

WEEKLY—Check oil level. Add oil if necessary.

MONTHLY—Add grease at all bearings, couplings, and seals. If the unit is equipped with pressure lubrication, clean the oil filters.

AT TWO MONTH INTERVALS—Check oil for contamination. Check grease for contamination. On units equipped with pressure lubrication systems, clean out oil filter by flushing out filter elements. Check operation of all gauges, alarm systems, controls, etc.

AT SIX MONTH or 2500 HOUR INTERVALS — Change oil, as outlined on Page 10. Change grease at bearings, couplings, and seals. Check condition of cooler tubes for build-up of sediment or other deposits from coolant water. Clean these members if necessary. The housings of fan cooled units should be cleaned to eliminate air flow obstructions and to avoid any thermal radiation loss.

EXTENDED SHUTDOWN PERIODS—If it becomes necessary to shutdown for a period longer than one week, the unit must be run for at least ten minutes during each week that it is idle. This periodic operation will keep the gears and bearings coated with oil and will prevent rusting due to condensation of moisture resulting from temperature changes.

AGMA OIL NUMBER SELECTION CHART FOR

PHILADELPHIA WORM GEAR DRIVES (SEE NOTE 1)
CONTACT YOUR SUPPLIER FOR TRADE NAME OF LUBRICANT MEETING THESE SPECIFICATIONS

Ambient Temperature Degrees Fahrenheit		15° to 60° F. (See Note 2)	50° to 125° F.
	Type of Oil	Compounded Mineral Oil	Compounded Mineral Oil
8" or less center distance.	AGMA No.	7 Comp.	8 Comp.
	Viscosity Range	125-150 SUV. @ 210° F.	150-190 SUV. @ 210° F.
Over 8" center distance—worm speed 700 RPM or less.	AGMA No.	7 Comp.	8 Comp.
	Viscosity Range	125-150 SUV. @ 210° F.	150-190 SUV. @ 210° F.
Over 8" center distance—worm speed over 700 RPM.	AGMA No.	7 Comp.	7 Comp.
	Viscosity Range	125-150 SUV. @ 210° F.	125-150 SUV. @ 210° F.

NOTE 1. THESE RECOMMENDATIONS ARE TO BE USED FOR NORMAL INDUSTRIAL SPEED RANGES (SHAFTS NOT EXCEEDING 1750 RPM OR PITCH LINE VELOCITIES NOT EXCEEDING 5000 FEET PER MINUTE). THESE RECOMMENDATIONS **ARE NOT TO BE** USED FOR GEAR DRIVES OPERATING AT HIGHER SPEEDS. CONSULT FACTORY FOR LUBRICATION RECOMMENDATIONS FOR HIGHER SPEEDS.

NOTE 2. For splash lubrication the oils listed above are suitable for start-up temperatures as low as 15° F. However, in units where a pump supplies forced feed lubrication, the above lubricants should only be used for start-up to 65° F. Below 65° F. heaters should be used to preheat oil before starting, or suitable special oil utilized. For other low temperature starting and operating recommendations, See Page 9.

TYPES OF LUBRICANT

The recommended type of oil for use in Philadelphia Worm Gear units is a compounded mineral oil with an additive of 3% to 10% of acidless tallow or similar animal fats. It should be a high grade well refined oil within the recommended viscosity range. It must be neutral in reaction and must not be corrosive to gears and ball or roller bearings. It should have good defoaming properties. For high operating temperatures good resistance to oxidation is needed.

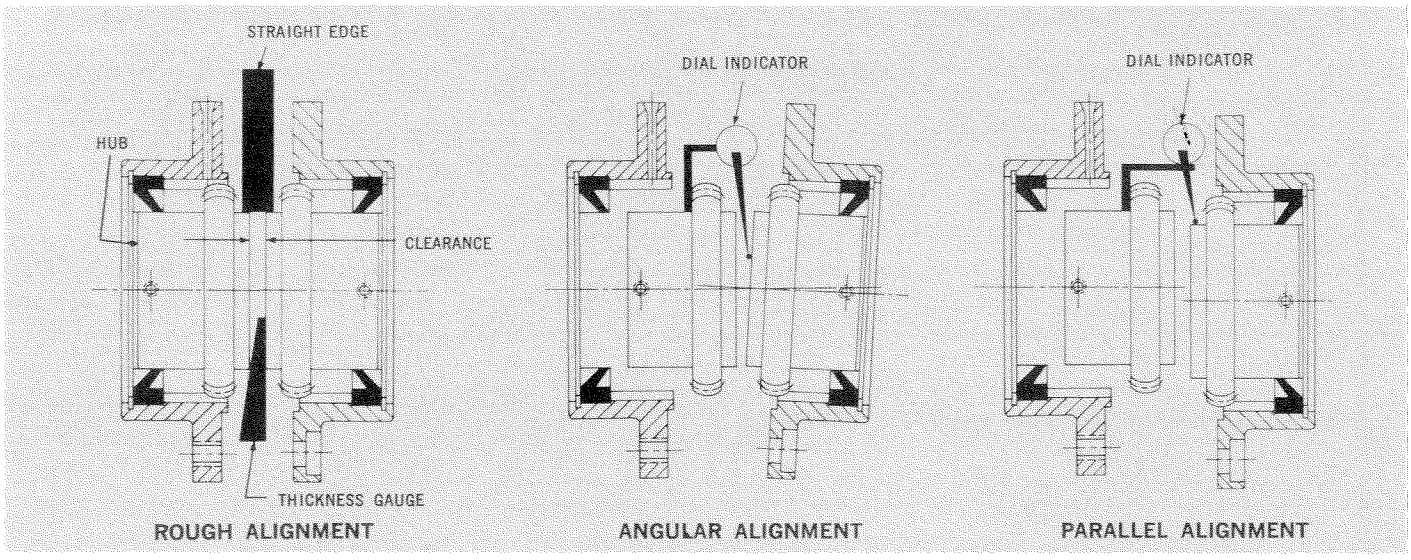
GREASE LUBRICATION

Lubricants should be high grade, non-separating, ball bearing grease suitable for operating temperatures to +180° F. Grease to be N.L.G.I. Number 2 consistency.

Grease lubricants must be non-corrosive to ball or roller bearings, and must be neutral in reaction. It should contain no grit, abrasive, or fillers; should not precipitate sediment; should not separate at temperatures up to 300° F.; and should have moisture resistant characteristics. The lubricant must also have good resistance to oxidation.

ALIGNMENT INSTRUCTIONS FOR COUPLINGS

1. Clean shaft coupling journals.
2. Fit keys to the coupling keyways to check for proper assembly.
3. Place keys into shaft keyway.
4. Place coupling housing on shaft keeping housing away from hub journal on shaft.
5. Mount coupling hubs on proper shaft extensions.
6. Move equipment into position; as near as possible to line-up the coupling.
7. Check coupling proof diameters for run-out of each hub.
8. Use a straight edge and a thickness gauge to make a quick rough alignment. Secure all bolts around base of unit.
9. Check **angular alignment** by mounting dial indicator on coupling hub with the indicator pin on the coupling face of the mating coupling. Rotate the shaft with the indicator and record readings at every 90° starting from the top. Move the unit as necessary until the indicator shows within .003" T. I. R. Relocate indicator on opposite coupling hub and recheck.
10. Check **parallel alignment** by placing the dial indicator pin on an O.D. of coupling. Rotate shaft with indicator and record dial indicator reading at every 90° starting from the top of the coupling. Move unit as necessary until the indicator shows within .003" T. I. R. Relocate indicator on opposite coupling hub and recheck.
11. Repeat steps 9 and 10 until both angular and parallel alignments are satisfied.
12. Lubricate coupling in accordance with Coupling Lubrication Instructions, and secure tightly with bolts.
13. Recheck coupling alignment after unit has run under normal temperature (Steps 9 and 10). (KNOWN AS HOT ALIGNMENT CHECK.)



TIPS FOR DISASSEMBLY:

■ Never perform any work on the gear unit or couplings until absolutely certain that the prime mover cannot be remotely or automatically started. Clean up area around unit before disassembly to keep parts clean and to keep them in proper order for reassembly. Keep in mind that parts usually go back together in reverse order of disassembly, and also note any match marks which might similarly affect reassembly. Provide wooden block or skids for storing machined parts in order to prevent damage to machined surfaces.

Before starting disassembly, carefully review typical parts list or assembly drawing of unit.

Disconnect unit completely from driving and driven machinery to avoid any possibility of accidental rotation.

Drain oil from housing by removing pipe plug at main drain.

Remove any exterior piping and gauges to avoid damage.

Remove caps, being careful to avoid damaging gaskets.

When removing caps having through shafts, tape shaft extension keyways and other sharp edges to avoid damaging oil seals.

Note arrangement of gearing for later reassembly.

TO DISASSEMBLE PHILADELPHIA GEAR UNITS WITH SPLIT HOUSING:

1. Unbolt caps and either completely remove, or move these caps at least ½" away from housing.
2. Remove all bolts holding upper housing to lower housing and to caps. Lift upper housing straight up and off.
3. Gear shaft assembly is now exposed and can be lifted out.
4. Worm shaft in single reduction units can now be removed.

If the unit is equipped with a single or double helical attachment, it is necessary to first remove the helical gear from the worm shaft extension. This can be done by removing the helical attachment cover and pulling off the helical gear. In some cases, it will be necessary to remove the mating helical pinion with the gear.

If the unit is equipped with a double worm attachment, it will be necessary to remove the first worm gear from the second worm shaft extension, before removing the second worm shaft. Remove the cover and caps on the attachment. Screw the first worm shaft in on the gear until the bearings disengage and the worm can be moved out of engagement with the gear. The worm gear can then be pulled off.

If the unit is equipped with a torque control, it is necessary to remove the control unit before removing the worm shaft. Always loosen the adjusting screw on the torque control to remove the load on the spring before starting to disassemble the control.

TO DISASSEMBLE PHILADELPHIA WORM UNITS WITH A ONE PIECE HOUSING:

Remove housing cover, disengage worm gear from worm shaft, and lift gear shaft assembly out.

Follow the same procedure as disassembly of split housings for removal of worm and attachment parts.

TIPS FOR ASSEMBLY

■ Clean all parts thoroughly before assembly. Examine components carefully for defects or signs of wear. Replace if necessary.

Make certain gearing is arranged in the same position as before disassembly. If gear has a chamfer on one end of bore only, this end must go against shaft shoulder. When pressing gear on shaft, check with indicator to determine that gear is square with shaft journals. Gear must be seated firmly against the shaft shoulder.

Bearings can easily be assembled on shafts if they are first heated to approximately 250° F. If bearings have bakelite ball or roller retainers, they should not be heated but, instead, should be pressed on shaft under ambient temperature conditions. Bearings must not be cocked and should be held against shaft shoulder while cooling. This can be readily accomplished by holding shaft vertically and dropping on bearing. After cooling, carefully tap inner race of bearing against shoulder with bar and hammer. Any bearing lock nuts or retainer plates should be taken up until snug against bearing.

Before replacing shaft assemblies on housing, check for clearance problems that would require one shaft assembly to be installed before the others. Bearing adjustments should be made as recommended in General Design Features, Page 6.

Correct bearing adjustment of single opposed tapered roller bearings can be obtained by the following procedure:

1. Position shaft assemblies in housing. If housing is split, bolt upper housing in place.
2. Mount bearing caps and tighten screws in cap until bearings are snug but turn freely.
3. Measure with feeler gauge the gap between cap flange and housing boss, and add the specified amount of lateral end play.
4. Insert shims of thickness equivalent to dimension obtained in Step 3.

Some Philadelphia Worm Gear units have two tapered roller bearings in an opposed mounting on one end of the worm shaft and a cylindrical roller bearing or ball bearing on the other end. In this arrangement, the two tapered roller bearings hold one end of the shaft and the other end is secured with the cylindrical roller or ball bearing which is free to float laterally. The tapered roller bearings are adjusted by following the same procedure described above, but only using the bearing cap on that end of the shaft. The bearing cap, on the side of the cylindrical roller or ball bearing, is not shimmed and can be tightened in place with the gasket.

When replacing the top half of housing on units with split housings, clean housing split surfaces thoroughly and apply a thin film of liquid sealing compound (Permatex No. 2 non-hardening type or equal is recommended). Before installing and fastening the upper to the lower housing, all dowel pin holes and oil lubrication holes must be correctly lined up.

Some units with one piece housings have gaskets between the housing and housing cover. However, some larger units are designed without a gasket. If no gasket was furnished originally, clean the flange surfaces thoroughly and apply a thin film of liquid sealing compound (Permatex No. 2 non-hardening type or equal) before replacing cover. Be certain that all dowel pin holes and lubrication holes are lined up correctly.

The worm gear must be adjusted to give a correct tooth pattern. See Page 16 for worm gear adjustment. If unit is equipped with torque control, see Page 18 for adjustment instructions.

Tape shaft extension keyways before installing oil seals to avoid damaging seals.

TROUBLE-SHOOTING TIPS

■ Your Philadelphia Gear drive will perform satisfactorily if the suggestions described in this booklet are carefully followed. It is estimated that approximately 98 percent of gear reduction failures can be attributed to improper lubrication, misapplication, and misalignment.

Improper lubrication causes a high percentage of gear reduction unit failures. Too frequently speed reducers are started up without any lubricant at all. Conversely, units are sometimes filled to a higher oil level than specified in the mistaken belief that better lubrication is obtained. This higher oil level usually results in more of the input power going into churning of the oil, creating excessive temperatures with detrimental results to the bearings and gearing. Insufficient lubrication causes the same results.

Gear failure due to overload is a broad and varied area of misapplication. The nature of load (input torque, output torque, duration of operating cycle, shocks, speed, acceleration, etc.) determines the gear unit sizing and other design criteria. Frequently, a gear drive must be larger than the torque output capability of the prime mover would indicate. An AGMA service factor compensates for varying severity of application conditions by providing a higher nominal horsepower which in effect increases the size of the gear unit. If there is any question in the user's mind that the actual service conditions may be more severe than originally anticipated it is recommended that this information be communicated to the gear manufacturer before start-up. Often there are remedies that can be suggested before a gear unit is damaged by overload, but none are effective after severe damage.

Motors and other prime movers should be analyzed while driving the gear unit under fully loaded conditions to determine that the prime mover is not overloaded and thus putting out more than rated torque. If it is determined that overload does exist, the unit should be stopped and steps taken to either remove the overload or contact the Philadelphia Gear Corporation to determine suitability of the gear drive under observed conditions.

TROUBLE SHOOTING CHART

TROUBLE	WHAT TO INSPECT	ACTION
Overheating	1. Unit overloaded.	Reduce the loading or replace with drive of sufficient capacity.
	2. Worm gear tooth contact.	**Adjust for correct tooth contact—See pages 16-17.**
	3. Has recommended oil level been exceeded or is level too low?	Check oil level indicator to see that housing is accurately filled with lubricant to the specified level.
	4. Are bearings properly adjusted?	Bearings must not be pinched. Adjustable tapered bearings must be set at proper bearing lateral clearance. All shafts should spin freely when disconnected from load.
	5. Oil seals or stuffing box.	Oil seals should be greased on those units having grease fitting for this purpose. Otherwise, apply small quantity of oil externally at the lip until the seal is run in. Stuffing box should be gradually tightened to avoid overheating. Packing should be a self-lubricating, braided asbestos type.
	6. Breather.	Breather should be open and clean. Clean breather regularly in a solvent.
	7. Grade of Oil.	Oil must be of grade specified in lubrication instructions. If it is not, clean unit and refill with correct grade.
	8. Condition of Oil.	Check to see if oil is oxidized, dirty, or of high sludge content, change oil and clean filter.
	9. Forced feed lubrication system.	Make sure oil pump is functioning. Check that oil passages are clear and permit free flow of lubricant. Inspect oil line pressure regulators, nozzles and filters to be sure they are free of obstructions. Make sure pump suction is not sucking air.
	10. Coupling Alignment.	Disconnect couplings and check alignment. Realign as required.
	11. Coupling lateral float.	Adjust spacing between drive motor, etc., to eliminate end pressure on shafts. Replace flexible coupling with type allowing required lateral float.
	12. Speed of unit excessive?	Reduce speed or replace with drive suitable for speed.
	13. Oil cooler operation.	Check coolant and oil flow. Vent system of air. Oil temperatures into unit should be approximately 110 degrees F. Check cooler internally for build up of deposits from coolant water.
Shaft Failure	1. Type of Coupling used.	Rigid couplings can cause shaft failure. Replace with coupling to provide required flexibility and lateral float.
	2. Coupling Alignment.	Realign equipment as required.
	3. Is overhung load excessive?	Reduce overhung load. Use outboard bearing or replace with unit having sufficient capacity.
	4. Is unit overloaded?	Reduce the loading or replace with drive of sufficient capacity.
	5. Is unit subjected to high energy loads or extreme repetitive shocks?	Apply couplings capable of absorbing shocks and if necessary, replace with drive of sufficient capacity to withstand shock loads.
	6. Torsional or lateral vibration condition.	These vibrations can occur through a particular speed range. Reduce speed to at least 25% below critical speed. System mass-elastic characteristics can be adjusted to control critical speed location. If necessary, adjust coupling weight, as well as shaft stiffness, length and diameter. For specific recommendations contact factory.
	7. Is outboard bearing properly aligned?	Realign bearing as required.
Bearing Failure	1. Is unit overloaded?	See—Overheating (Item I). Abnormal loading results in flaking, cracks and fractures of the bearing.
	2. Is overhung load excessive?	See—Shaft Failures (Item 3).
	3. Speed of bearing excessive?	See—Overheating (Item 12).
	4. Coupling alignment.	See—Overheating (Item 10).
	5. Coupling lateral float.	See—Overheating (Item 11).
	6. Are bearings properly adjusted?	See—Overheating (Item 4). If bearing is too free or not square with axis—erratic wear pattern will appear in bearing races.
	7. Are bearings properly lubricated?	**See—Overheating (Items 3, 7, 8, 9, 13). Improper lubrication causes excessive wear and discoloration of bearing.**
	8. Rust formation due to entrance of water or humidity.	Make necessary provisions to prevent entrance of water. Use lubricant with good rust inhibiting properties. Make sure bearings are covered with sufficient lubricant. Turn over gear unit more frequently during prolonged shut-down periods.

TROUBLE SHOOTING CHART

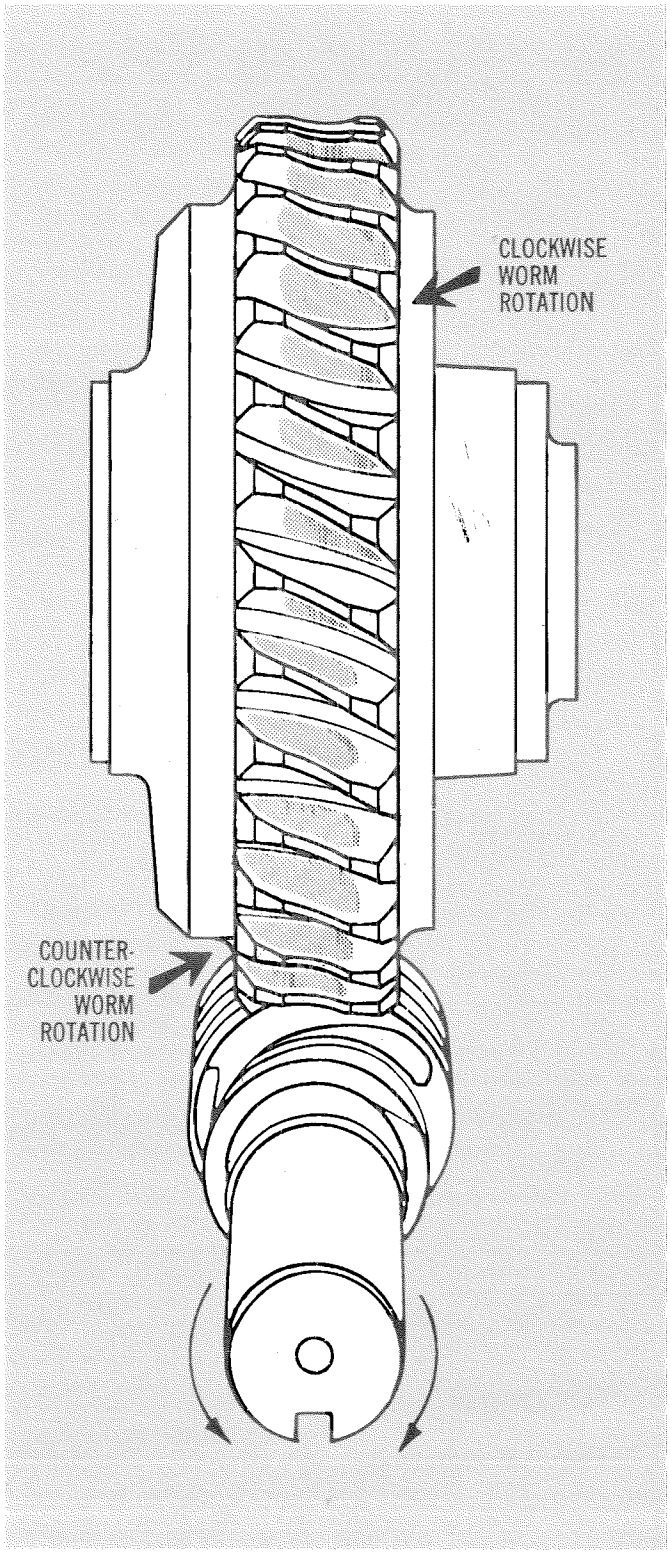
TROUBLE	WHAT TO INSPECT	ACTION
Bearing Failure (continued)	9. Is bearing exposed to an abrasive substance?	Abrasive substance will cause excessive wear, evidenced by dulled balls, rollers, and raceways. Make necessary provision to prevent entrance of abrasive substance. Clean and flush drive thoroughly and add new oil.
	10. Has unit been stored improperly or damaged by prolonged shut-down?	Prolonged periods of storage in moist, ambient temperatures will cause destructive rusting of bearings and gears. When these conditions are found to have existed, the unit must be disassembled, inspected, and damaged parts either thoroughly cleaned of rust, or replaced.
Oil Leakage	1. Has recommended oil level been exceeded?	Check through level indicator that oil level is accurately at level indicated on housing.
	2. Is breather open?	Breather should be open and clean.
	3. Are all oil drains open?	Check that all oil drain locations are clean and permit free flow. Drains are normally drilled in the housing between bearings and bearing cap where shafts extend through caps.
	4. Oil Seals	Check oil seals and replace if worn. Check condition of shaft under seal and polish if necessary. Slight leakage normal—required to minimize friction and heat.
	5. Stuffing boxes.	Adjust or replace packing. Tighten packing gradually to "break-in". Check condition of shaft and polish if necessary.
	6. Force feed lubrication to bearing excessive?	Reduce flow of lubricant to bearing by adjusting orifices. Refer to factory.
	7. Plugs at drains, levels, etc., and standard pipe fittings.	Apply Marseal pipe joint sealant, or equal, and tighten fittings.
	8. Compression type pipe fittings.	Tighten fitting or disassemble and check that collar is properly gripping tube.
	9. Housing and caps.	Tighten cap screws or bolts. If not entirely effective, remove housing cover and caps. Clean mating surfaces and apply new sealing compound (Permatex #2 or equal). Reassemble. Check compression joints by tightening fasteners firmly.
Gear Wear	1. Gear tooth wear and failure.	See Pages 18-19.
	2. Backlash.	Gear set must be adjusted to give proper backlash. Refer to factory.
	3. Worm Gear Tooth Contact.	See—Overheating (Item 2).
	4. Misalignment of Gears.	Check contact pattern to be over approximately 75% of face, preferably in center area. Check condition of bearings.
	5. Housing twisted or distorted?	Check shimming and stiffness of foundation.
	6. Is unit overloaded?	See—Overheating (Item 1).
	7. Has recommended oil level been maintained?	See—Overheating (Item 3).
	8. Are bearings properly adjusted?	See—Overheating (Item 4).
	9. Grade of Oil.	See—Overheating (Item 7).
	10. Condition of Oil.	See—Overheating (Item 8).
	11. Forced Feed Lubrication.	See—Overheating (Item 9).
	12. Coupling Alignment.	See—Overheating (Item 10).
	13. Coupling lateral float.	See—Overheating (Item 11).
	14. Excessive speeds.	See—Overheating (Item 12).
	15. Torsional or lateral vibration condition.	See—Shaft Failure (Item 6).
	16. Rust formation due to entrance of water or humidity.	See—Bearing Failure (Item 8).
	17. Gears exposed to an abrasive substance.	See—Bearing Failure (Item 9).
Noise	1. Unusual or increasing noise.	See—Gear Wear (Items 1 to 16) and Bearing Failure (Items 1 to 8).

WORM GEAR CONTACT

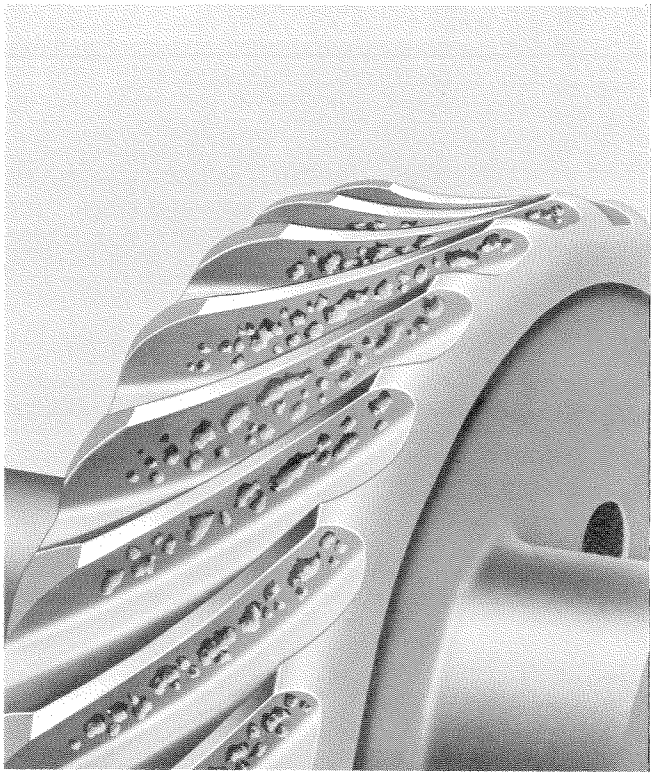
WORM GEAR ADJUSTMENT

■ In worm gear reducers the gear shaft is adjusted axially to give a proper tooth contact pattern on the worm gear. A proper tooth contact pattern is shown in the illustration. The gear should be adjusted so that the contact area is as large as possible in order to distribute the tooth load. The contact area should be located on the side of the tooth where the worm is leaving the mesh. In this way, the lubricating oil on the worm thread is fed into the tooth mesh. The contact area should never be located on the entering side of the gear tooth since this might result in scraping the oil off the worm thread.

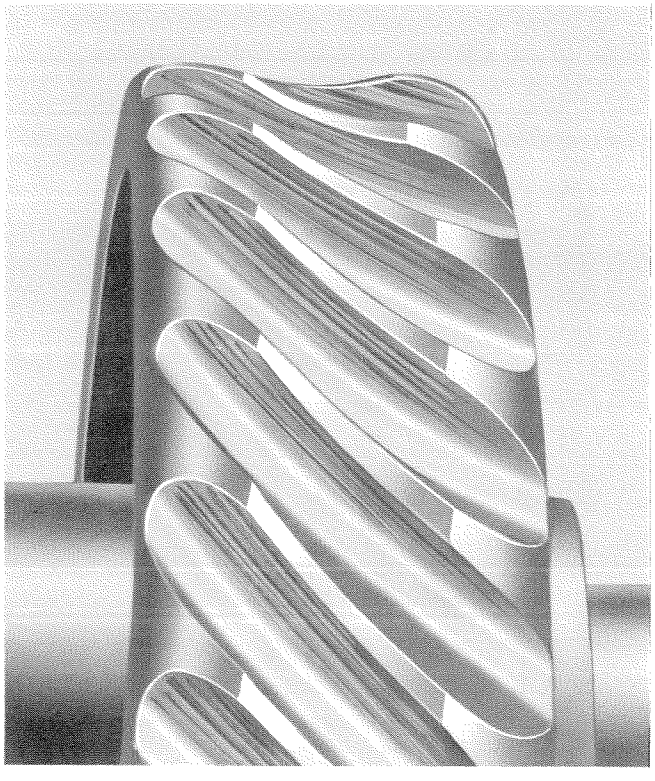
The low speed shaft assembly in a worm gear reducer is held in place by end caps or covers. Shims are located between the housing and the end caps or covers. The gear shaft assembly can be adjusted for proper tooth contact without disturbing the bearing adjustment by removing shims from one side and adding shims of equal thickness to the opposite side. The first worm gear in double reduction units is adjusted by the shim thickness between the worm attachment housing and the adapter in sizes up to and including the 775. In the larger sizes the first worm is adjusted by varying the shim thickness between the second worm shaft cartridge and the housing.



TOOTH CONTACT



SPALLING



GALLING

SPALLING AND GALLING — Spalling is caused by excessive loads which subject the tooth surface to stresses, causing subsurface fatigue. This causes cracks, which eventually lead to the falling out or removal of relatively large flakes of bronze. The spalling is often heaviest on the end of the tooth leaving the mesh. In some cases, localized spalling can be caused by misalignment.

Galling is caused by lubrication failure, that is, the failure of the oil film to carry the load. This is due to the use of unsuitable oil or to excessive load. Metal to metal contact occurs and the frictional heat causes welding of microscopic high spots, which are torn and dragged from the tooth surface. This usually results in excessive wear, leaving the tooth surface in a roughened condition.

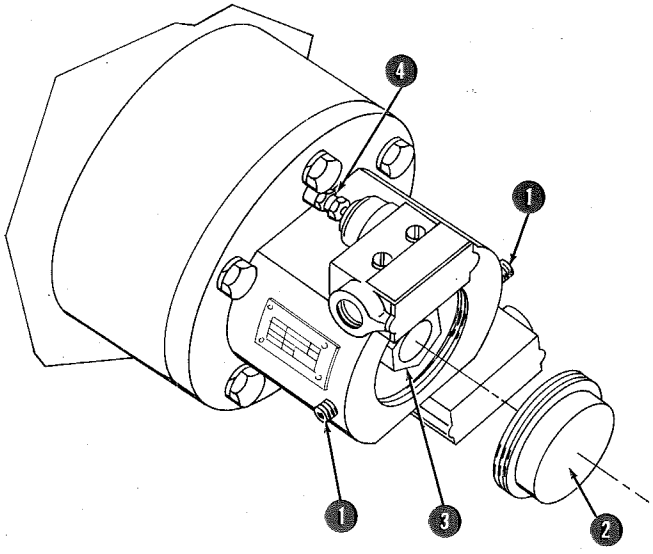
TORQUE CONTROL

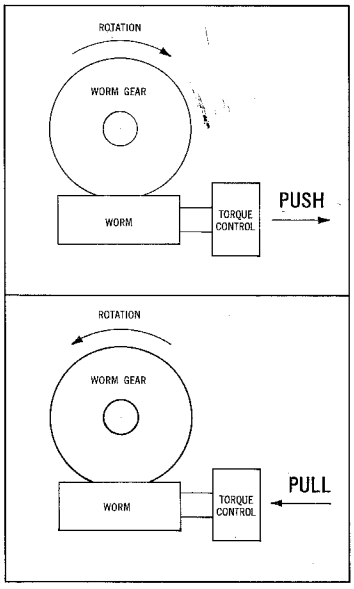
TORQUE CONTROL ADJUSTMENT—Units equipped with torque control are adjusted to the approximate rating at the factory. They can be adjusted in the field to suit the customer requirement.

The torque control can be adjusted to an approximate setting, by turning the spring adjusting nut the number of turns specified on the certified data sheet, or on the torque control nameplate. If closer adjustment or a different output torque rating is desired, the unit should be set up so that torque at the output shaft can be measured. The unit then can be adjusted as follows.

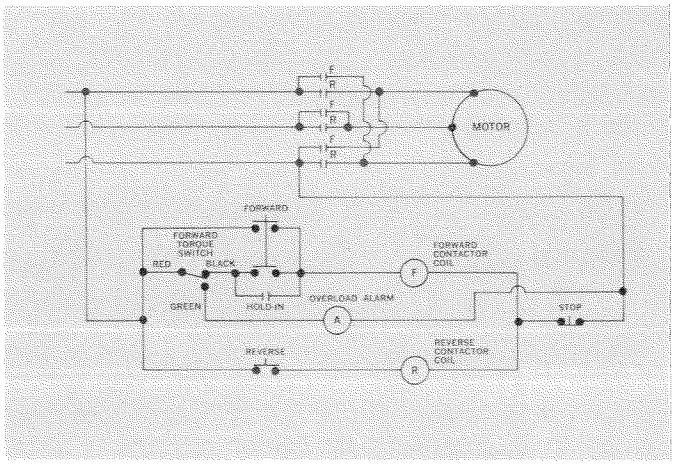
1. With no load on the unit, loosen set screws No. 1 and remove torque control cap No. 2.
2. Loosen adjusting nut No. 3. Tighten until it is finger tight. Then turn with a wrench the number of turns specified on data sheet or nameplate. Replace cap No. 2 and screw in until snug. Retighten set screws No. 1.
3. Remove cover and adjust micro switch adjusting screw No. 4 so that .005″ to .010″ movement will trip micro switch. The switch tripping point can be determined by wiring a test light to switch or by listening for audible click as switch trips.

   Push torque control switch should be adjusted so that movement of adjusting screw away from unit will trip switch. Pull torque control switch should be adjusted so that movement of adjusting screw towards unit will trip switch (see figure below). When switch is adjusted, lock micro switch adjusting screw No. 4 in place by tightening nut on adjusting screw.
4. Check unit under load. If torque control operates before desired load is reached, or does not operate at desired load, remove load and change setting on adjusting nut No. 3 by ¼ turn increments. Loosen to reduce operating load point. Tighten to increase operating load point. After each adjustment replace cap No. 2 and screw in until snug. Continue procedure until required rating is reached.
5. Lock setscrews No. 1 in position after replacing cap No. 2.

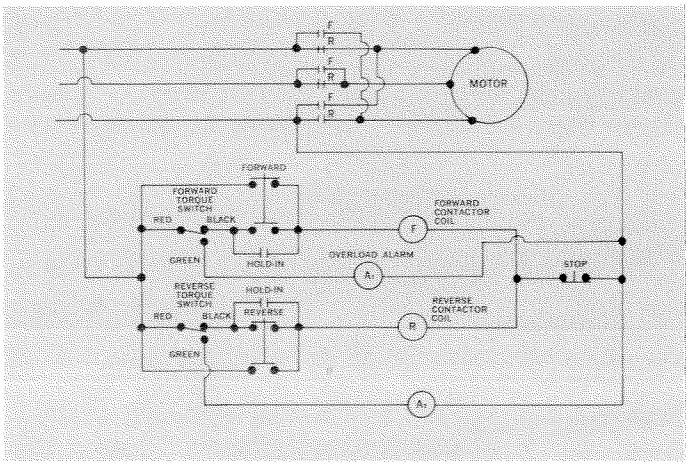




Typical Wiring Diagrams For Torque Control*—With Optional Alarm System



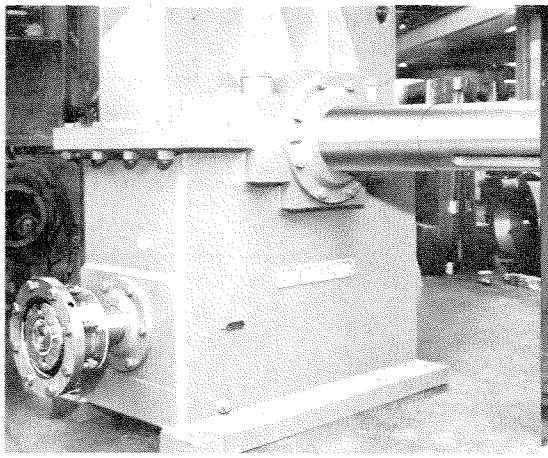
SINGLE WITH A.C. REVERSING MOTOR



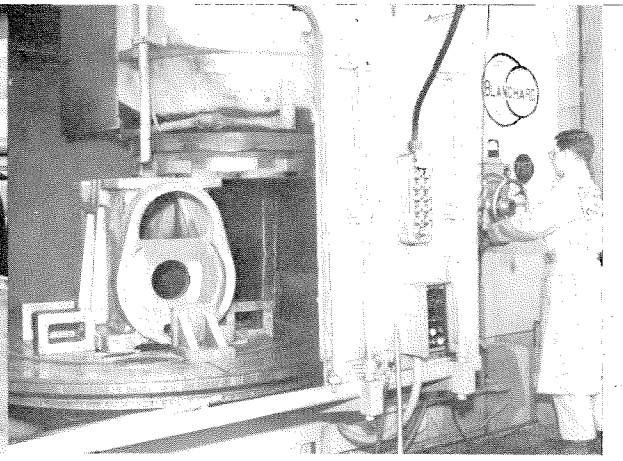
DOUBLE WITH A.C. REVERSING MOTOR

(NOTE: Color Coded Leads On Torque Switch)

*Due to the wide variety of wiring diagrams involved on various types and sizes of D.C. motors, consult factory for D.C. wiring diagrams to suit your equipment.



Finished worm gear reducer with fabricated steel housing.

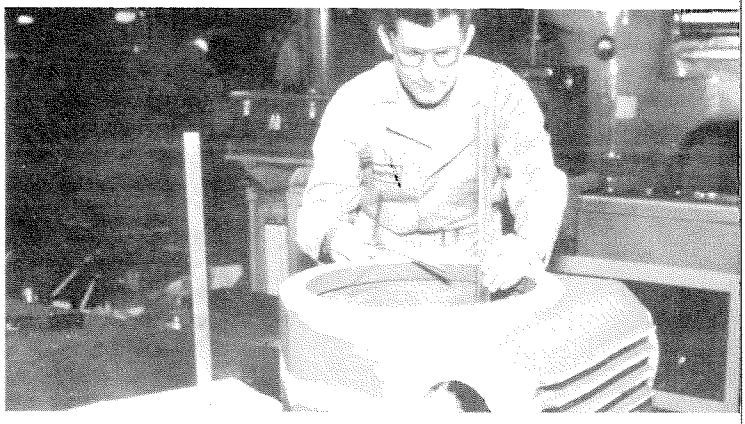


Worm gear housing on surface grinder.

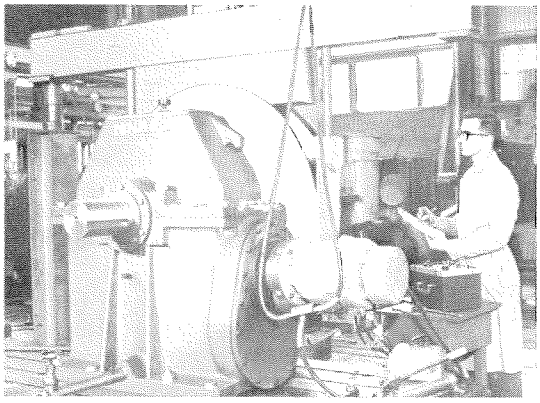
TECHNIQUES IN WORM GEAR DRIVE PRODUCTION

■ Philadelphia Gear Corporation manufactures worm gear drives with top performance in mind. We constantly try to improve tooling and manufacturing techniques and our new plant at King of Prussia has the most up-to-date equipment available.

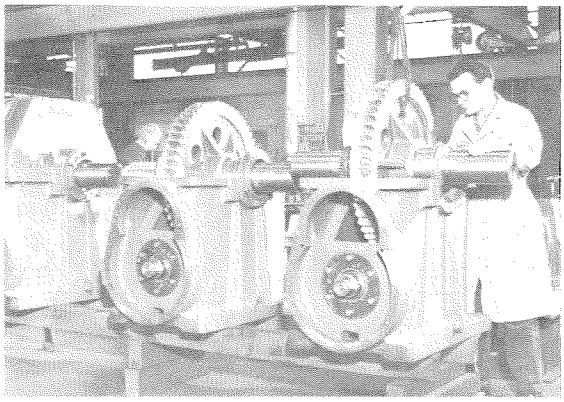
Experience in the manufacture of worm gear drives for almost every industrial application has enabled us to perfect their construction. Our units are operable under even the most severe conditions. Each step of manufacture, from the laying out and milling of the housing to the final stages of assembly and testing, is handled by craftsmen. You receive the benefits when your Philadelphia reducer is installed, and for many years afterward.



Housing casting at layout for checking.

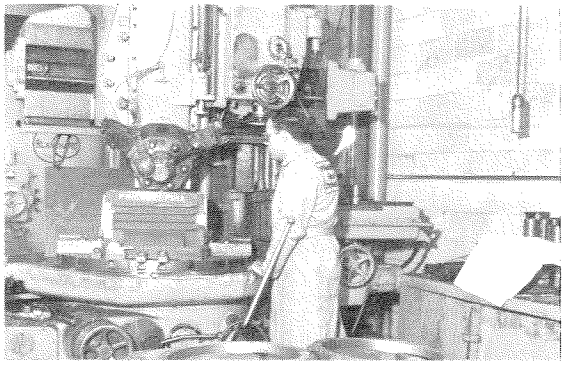


Special gate hoist drive tested on prony brake stand.



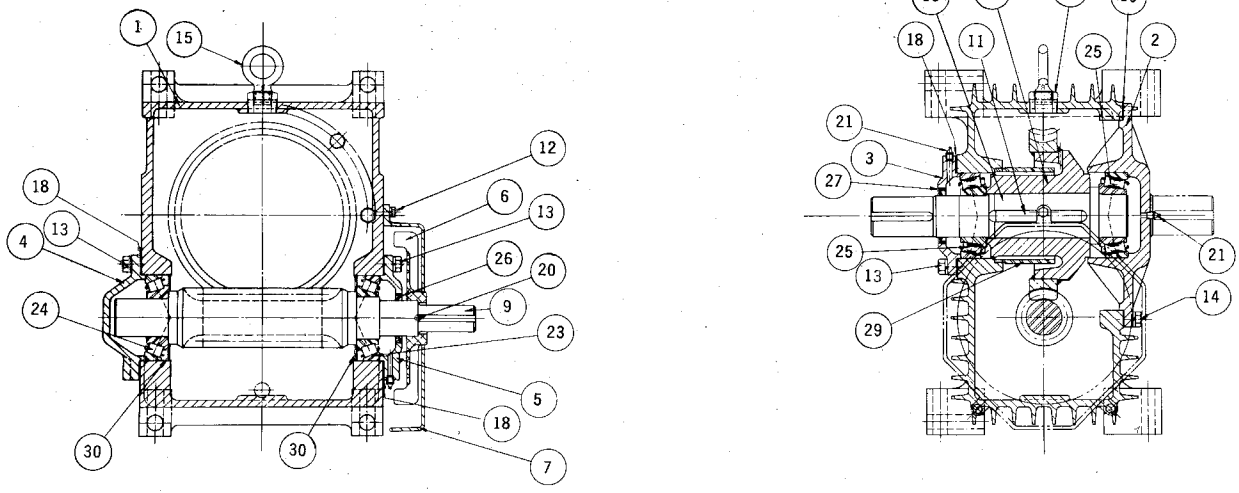
Gate hoist drives are inspected at each step of assembly.

Worm gear reducer on efficiency test in laboratory.



Vertical unit housings at first boring operation.

PARTS LIST

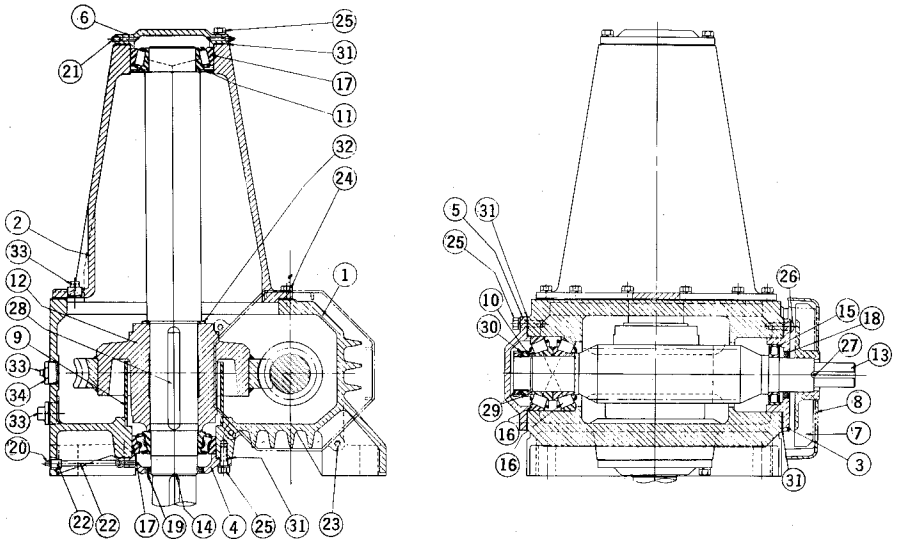


300-775 WORM GEAR REDUCER—TYPES A, R, U, V

ITEM NO	NO REQD	NAME	ITEM NO	NO REQD	NAME	ITEM NO	NO REQD	NAME
1	1	HOUSING	11	1	KEY	21	2	GREASE FITTING
2	1	HSG. COVER	12	3	HEX HD. BOLT & L.W.	22	2	RELIEF FITTING*
3	1	THRU CAP G.S.	13	18	HEX HD. BOLT & L.W.	23	1	BEARING
4	1	BLIND CAP W.S.	14	8	HEX HD. BOLT & L.W.	24	1	BEARING
5	1	THRU CAP W.S.	15	1	EYEBOLT BREATHER	25	2	BEARING
6	1	FAN ‡	16	1	PIPE PLUG*	26	1	OIL SEAL
7	1	FAN COVER ‡	17	1	PIPE PLUG*	27	1	OIL SEAL
8	1	WORM GEAR	18	3	SHIM SETS	28	1	REDUCER
9	1	WORM SHAFT	19	1	GASKET	29	1	DRYWELL**
10	1	GEAR SHAFT	20	1	SET SCREW	30	2	GREASE BAFFLE***

*NOT SHOWN **USED IN "V" SHAFT DOWN UNITS ONLY ***USED IN "R" UNITS ONLY

‡Fans not furnished for low input speeds.

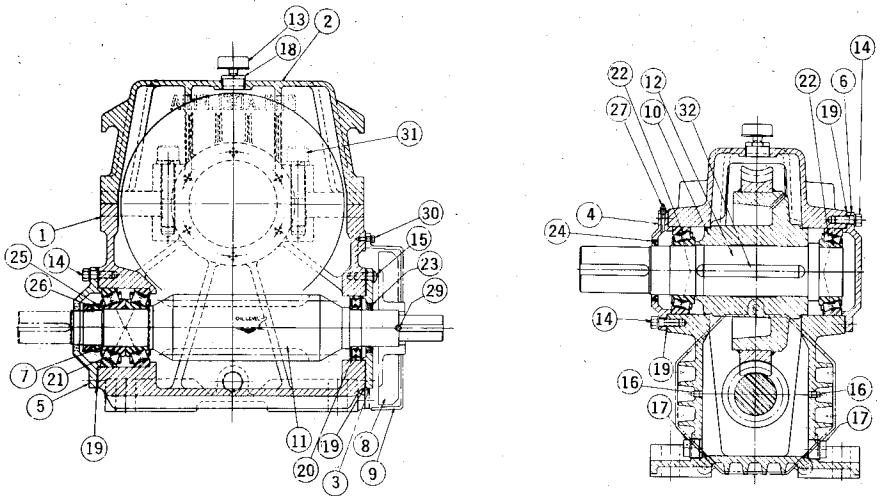


900-2100 WORM GEAR REDUCER—TYPE VS

ITEM NO	NO REQD	NAME	ITEM NO	NO REQD	NAME	ITEM NO	NO REQD	NAME
1	1	HOUSING	13	1	WORM SHAFT	25	18	HEX HD. BOLT & L.W.
2	1	STEEPLE	14	1	GEAR SHAFT	26	6	BUTTON HD. BOLTS
3	1	THRU PLUG	15	1	BEARING	27	1	SET SCREW
4	1	THRU CAP	16	2	BEARING	28	1	KEY
5	1	BLIND CAP	17	2	BEARING	29	2	LOCKNUTS
6	1	BLIND CAP	18	1	OIL SEAL	30	1	LOCKWASHER
7	1	FAN ‡	19	1	OIL SEAL	31	4	SHIM SETS
8	1	FAN COVER ‡	20	2	GREASE FITTING	32	1	GREASE BAFFLE
9	1	DRYWELL	21	2	RELIEF FITTING	33	3	PIPE PLUG
10	1	SPACER	22	2	PIPE NIP. & COUPLING	34	1	REDUCER
11	1	GREASE BAFFLE	23	3	HEX HD. BOLT & L.W.			
12	1	WORM GEAR	24	12	HEX HD. BOLT & L.W.			

*NOT SHOWN

‡Fans not furnished for low input speeds.

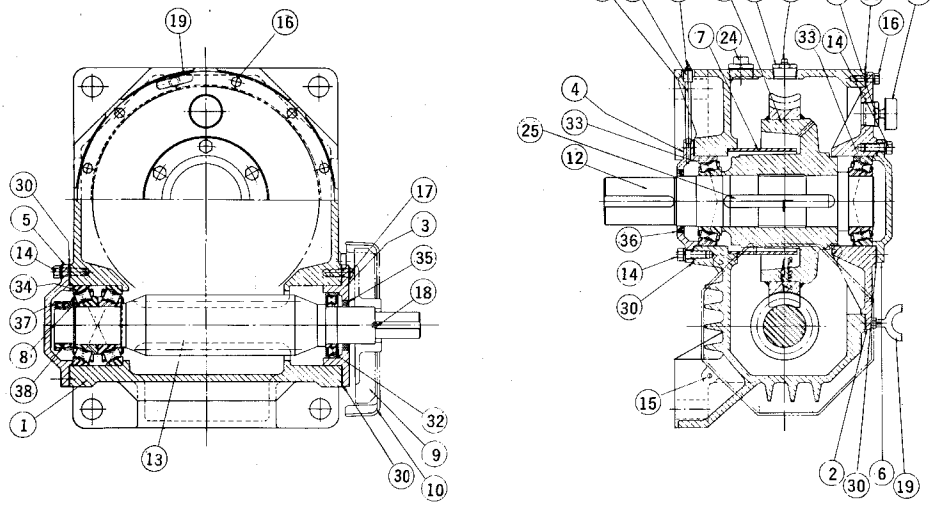


900-2100 WORM GEAR REDUCER—TYPE A

ITEM NO	NO REQD	NAME	ITEM NO	NO REQD	NAME	ITEM NO	NO REQD	NAME
1	1	HOUSING LOWER	12	1	GEAR SHAFT	23	1	OIL SEAL
2	1	HOUSING UPPER	13	1	BREATHER	24	1	OIL SEAL
3	1	THRU CAP W.S.	14	18	HEX BOLT & L.W.	25	2	LOCK NUT
4	1	THRU CAP G.S.	15	6	BUTTON HD. BOLT	26	1	LOCK WASHER
5	1	BLIND CAP W.S.	16	2	PIPE PLUG	27	2	GREASE FITTING
6	1	BLIND CAP G.S.	17	2	PIPE PLUG	28	2	RELIEF FITTING*
7	1	SPACER	18	1	REDUCER	29	1	SET SCREW
8	1	FAN ‡	19	4	SHIM SETS	30	3	HEX HD. BOLT & L.W.
9	1	FAN COVER ‡	20	1	BEARING	31	4	SOCK. HD. BOLT & L.W.
10	1	WORM GEAR	21	2	BEARING	32	1	KEY
11	1	WORM SHAFT	22	2	BEARING			

*NOT SHOWN

‡Fans not furnished for low input speeds.

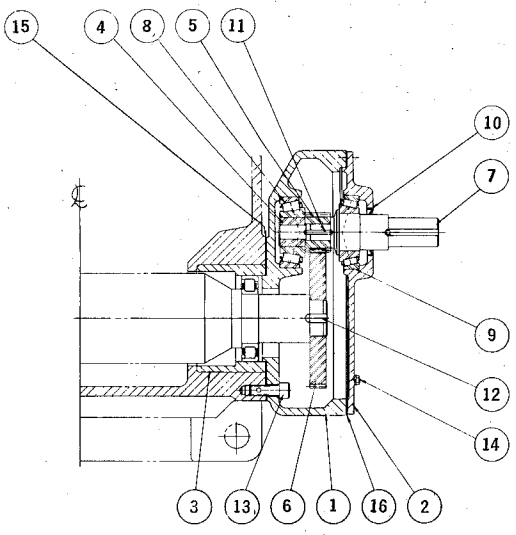


900-2100 WORM GEAR REDUCER—TYPES U, V

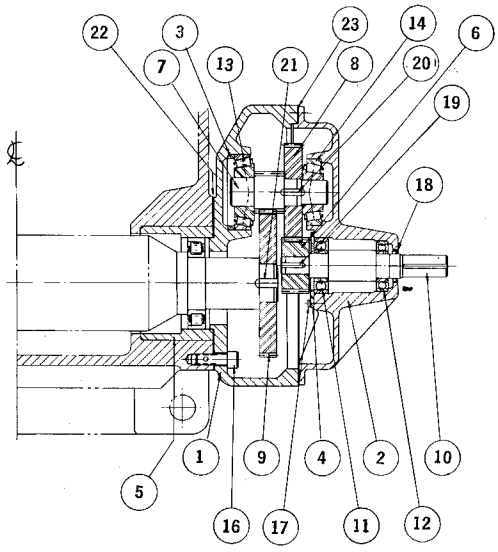
ITEM NO	NO REQD	NAME	ITEM NO	NO REQD	NAME	ITEM NO	NO REQD	NAME
1	1	HOUSING	14	18	HEX BOLT & L.W.	27	2	RELIEF FITTING*
2	1	HOUSING COVER	15	3	HEX BOLT & L.W.	28	2	COUPLING
3	1	THRU PLUG W.S.	16	10	HEX BOLT & L.W.	29	2	PIPE NIPPLE
4	1	THRU CAP G.S.	17	6	BUTTON HD. BOLT	30	4	SHIM SETS
5	1	BLIND CAP W.S.	18	1	SET SCREW	31	1	GASKET
6	1	BLIND CAP G.S.	19	2	EYEBOLT & NUT	32	1	BEARING
7	1	DRYWELL	20	1	BREATHER	33	2	BEARING
8	1	SPACER	21	1	REDUCER	34	2	BEARING
9	1	FAN ‡	22	1	REDUCER	35	1	OIL SEAL
10	1	FAN COVER ‡	23	1	PIPE PLUG	36	1	OIL SEAL
11	1	WORM GEAR	24	1	PIPE PLUG	37	2	LOCKNUTS
12	1	GEAR SHAFT	25	1	KEY	38	1	LOCKWASHER
13	1	WORM SHAFT	26	2	GREASE FITTING			

*NOT SHOWN

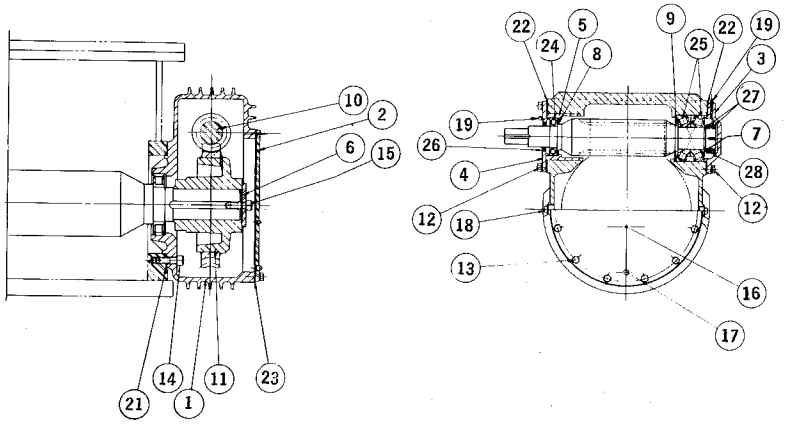
‡Fans not furnished for low input speeds.



900-2100 SINGLE HELICAL ATTACHMENT



900-2100 DOUBLE HELICAL ATTACHMENT



900-2100 DOUBLE WORM GEAR ATTACHMENT

PARTS LIST

ITEM NO	NO REQD	NAME
1	1	HELICAL HOUSING
2	1	HEL. HSG. COVER
3	1	ADAPTER SLEEVE*
4	1	BUSHING
5	1	PINION
6	1	GEAR
7	1	H.S. SHAFT
8	1	BEARING
9	1	BEARING
10	1	OIL SEAL
11	1	KEY
12	1	KEY
13	5	SOCKET HD. BOLTS
14	12	HEX. HD. BOLTS & L.W.
15	1	SHIM
16	1	GASKET

*USED ON VERTICAL UNITS ONLY

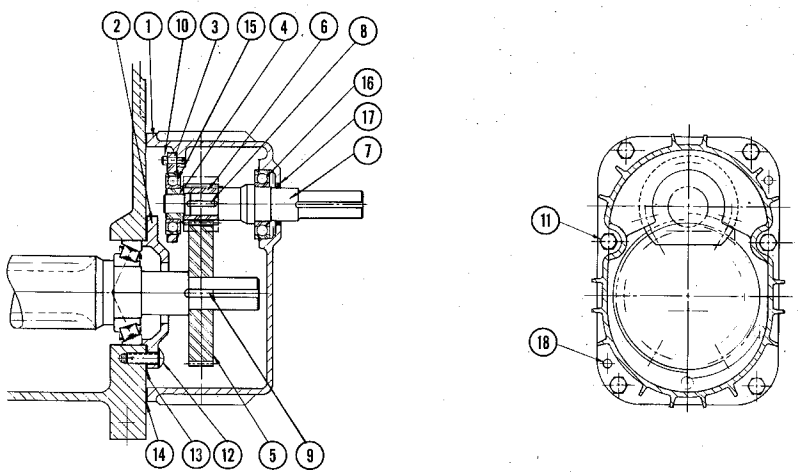
ITEM NO	NO REQD	NAME
1	1	HELICAL HOUSING
2	1	HEL. HSG. COVER
3	1	SPACER
4	1	RETAINER PLATE
5	1	ADAPTER SLEEVE**
6	1	PINION
7	1	HEL. PINION SHAFT
8	1	GEAR
9	1	GEAR
10	1	H.S. SHAFT
11	1	BEARING
12	1	BEARING
13	1	BEARING
14	1	BEARING
15	12	HEX HD. BOLT & L.W.*
16	5	SOCKET HD. BOLT
17	4	HEX HD. BOLT
18	1	OIL SEAL
19	1	KEY
20	1	KEY
21	1	KEY
22	1	SHIM SETS
23	1	GASKET

*NOT SHOWN
**NOTE—USE ON VERTICAL UNITS ONLY

ITEM NO	NO REQD	NAME
1	1	HOUSING (ATTACH)
2	1	HOUSING COVER
3	1	BLIND CAP W.S.
4	1	THRU CAP W.S.
5	1	ADAPTER SLEEVE
6	1	RETAINER PLATE
7	1	SPACER
8	1	GREASE BAFFLE
9	1	GREASE BAFFLE
10	1	WORM SHAFT
11	1	WORM GEAR
12	12	HEX HD. BOLT & L.W.
13	12	HEX HD. BOLT & L.W.
14	8	SOCKET HD. BOLT
15	1	SOCKET HD. BOLT
16	1	PIPE PLUG
17	1	PIPE PLUG
18	2	PIPE PLUG
19	2	GREASE FITTING
20	2	RELIEF FITTING*
21	1	SHIM SET
22	2	SHIM SET
23	1	GASKET
24	1	BEARING
25	2	BEARING
26	1	OIL SEAL
27	2	LOCKNUT
28	1	LOCKWASHER

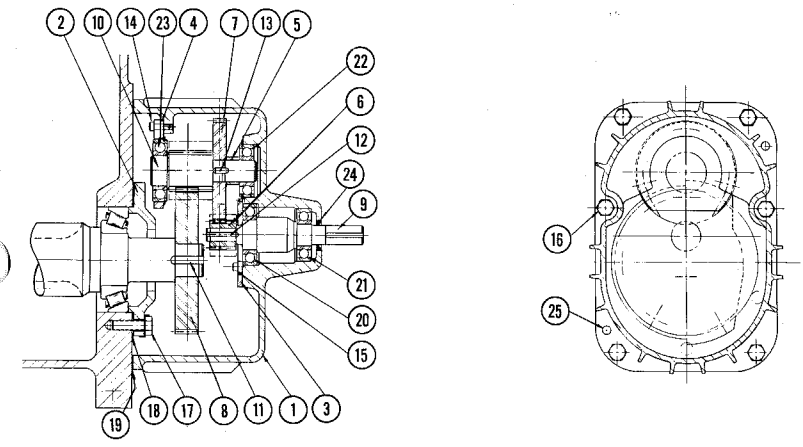
*NOT SHOWN

PARTS LIST



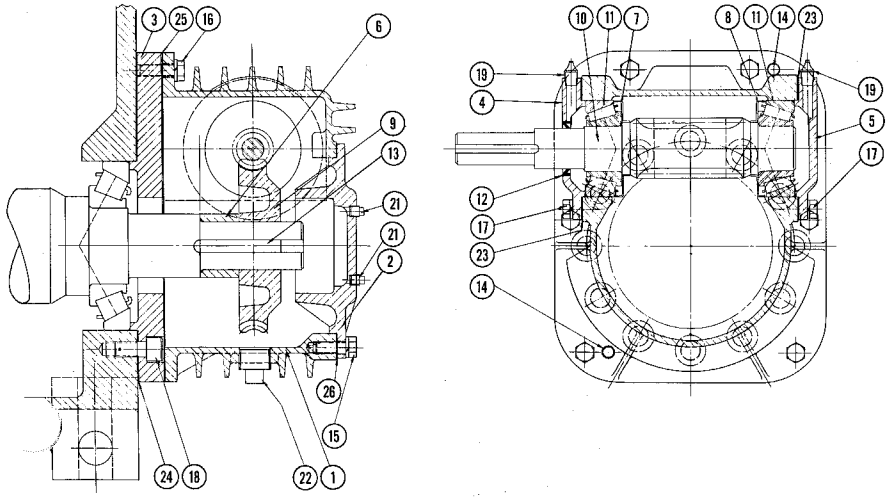
400-775 SINGLE HELICAL ATTACHMENT

ITEM NO.	DESCRIPTION
1	HELICAL HOUSING
2	THRU CAP
3	RETAINER PLATE
4	BUSHING
5	HELICAL GEAR
6	HELICAL PINION
7	H. S. SHAFT
8	KEY
9	KEY
10	HEX HEAD BOLT
11	HEX HEAD BOLT & L. W.
12	BUTTON HEAD BOLT
13	SHIM
14	GASKET
15	BEARING
16	BEARING
17	OIL SEAL
18	DOWEL PIN



400-775 DOUBLE HELICAL ATTACHMENT

ITEM NO.	DESCRIPTION
1	HOUSING
2	THRU CAP
3	BEARING RETAINER
4	BEARING RETAINER
5	SPACER
6	PINION
7	GEAR
8	L. S. GEAR
9	H. S. SHAFT
10	HELICAL PINION SHAFT
11	KEY
12	KEY
13	KEY
14*	SOCKET HEAD BOLT
15	SOCKET HEAD BOLT
16	HEX HEAD BOLT & L. W.
17	HEX HEAD W/TAB WASHER
18	SHIM SET
19	GASKET
20	BEARING
21	BEARING
22	BEARING
23	BEARING
24	OIL SEALS
25	DOWEL PINS



575-775 DOUBLE WORM GEAR ATTACHMENT

ITEM NO.	DESCRIPTION
1	HOUSING
2	HOUSING COVER
3	ADAPTER
4	THRU CAP
5	BLIND CAP
6	SPACER
7	GREASE BAFFLE
8	GREASE BAFFLE
9	WORM GEAR
10	WORM SHAFT
11	BEARING
12	OIL SEAL
13	KEY
14	DOWEL PINS
15	HEX HEAD BOLT & L. W.
16	HEX HEAD BOLT & L. W.
17	HEX HEAD BOLT & L. W.
18	SOCKET HEAD BOLT
19	GREASE FITTING
20*	RELIEF FITTING
21	PIPE PLUG
22	PIPE PLUG
23	SHIMS
24	SHIMS
25	SHIMS
26	GASKET

*NOT SHOWN

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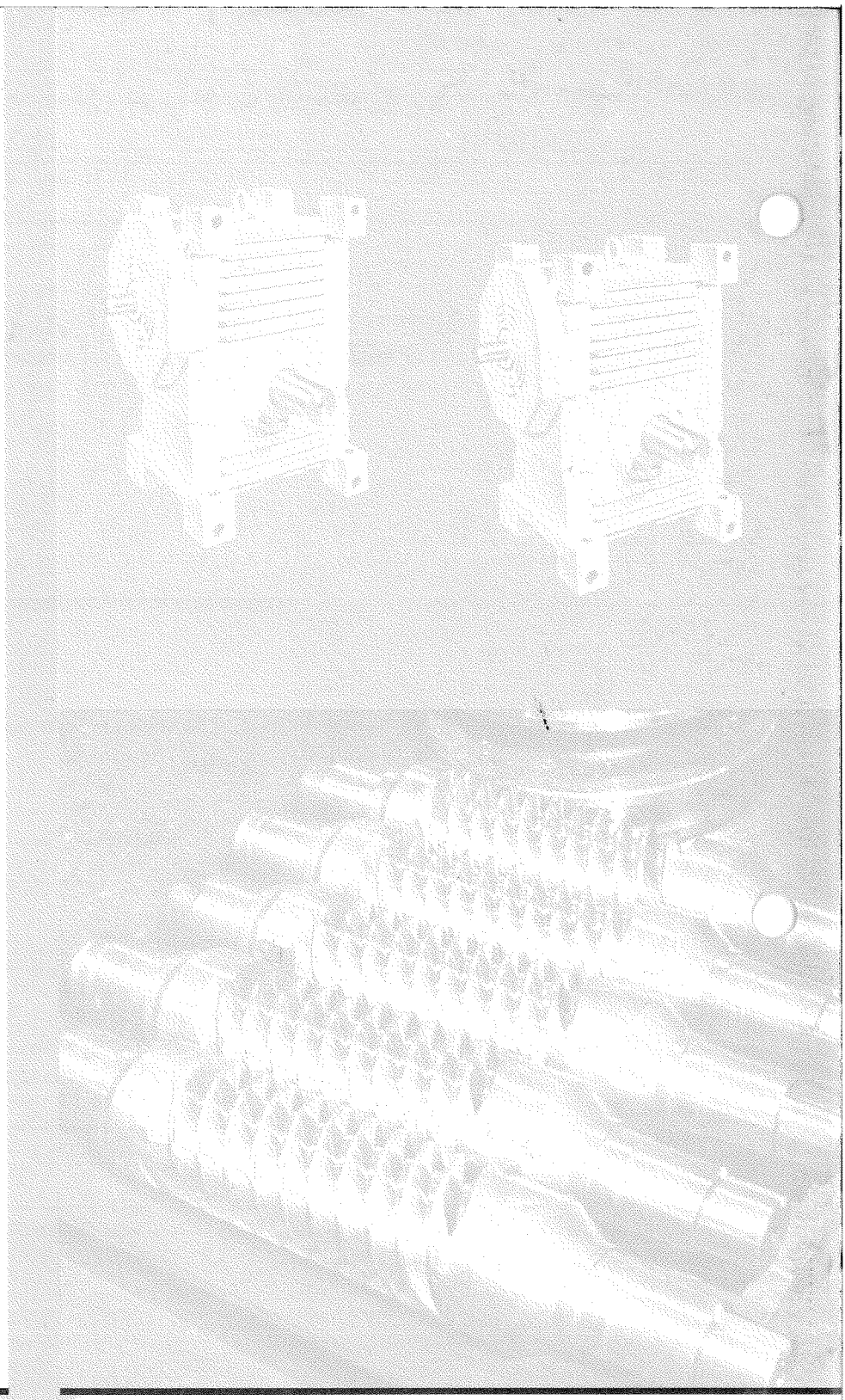

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