I.B. 3700-SU-1A

INSTALLATION • OPERATION • MAINTENANCE

INSTRUCTIONS

HIGH-SPEED GEAR DRIVES

Type SU

WESTINGHOUSE ELECTRIC CORPORATION

NUTTALL PLANT • GEARING DIVISION • PITTSBURGH 1, PA.

SUPERSEDES I.B. 3700-SU-1

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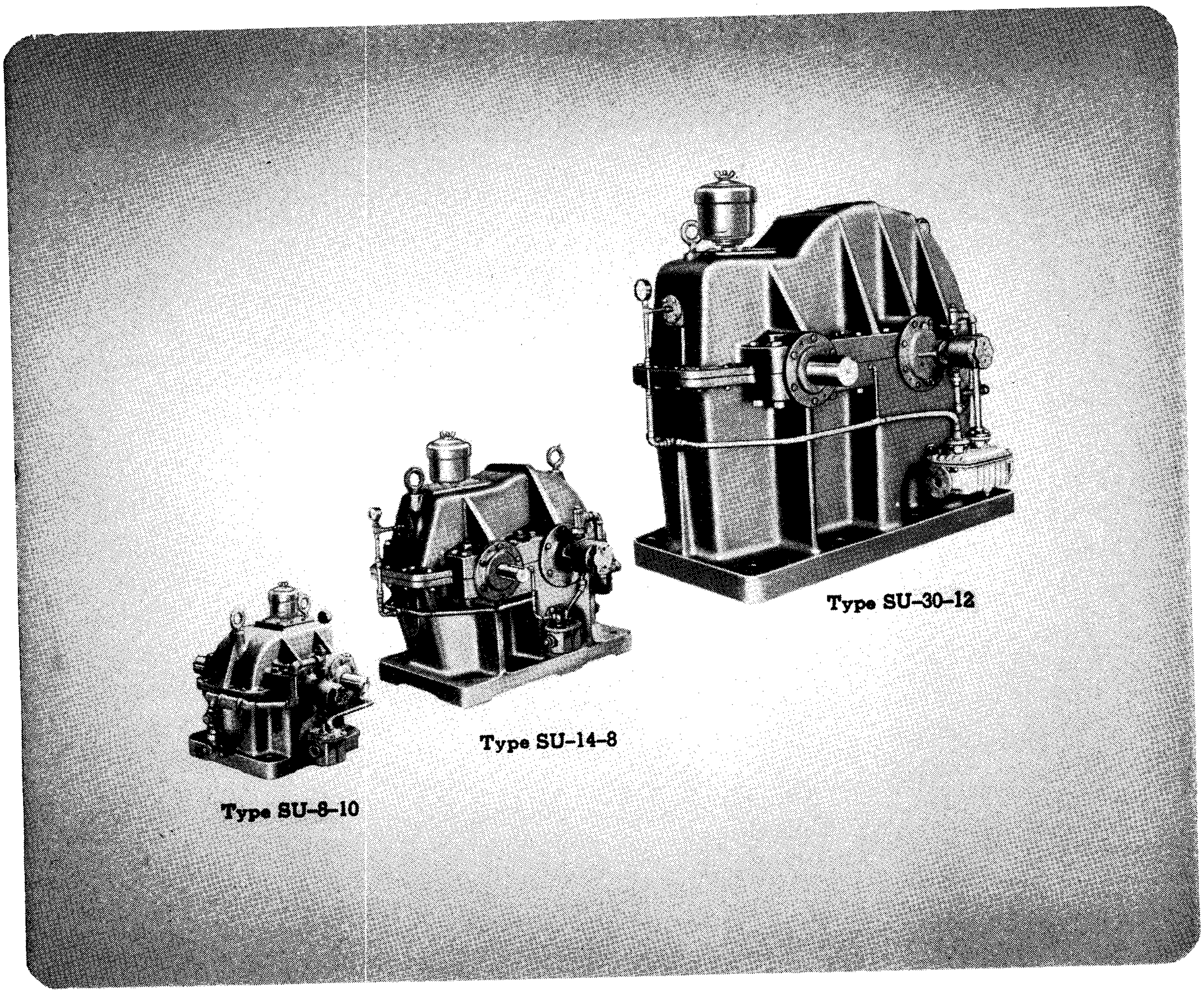


HIGH SPEED GEAR DRIVES Type SU are specifically designed to supply speeds in excess of those which can be obtained with economy and safety from ordinary prime movers. They are used wherever high-output speeds are required for driving pumps, compressors, blowers, generators, and similar equipment with maximum efficiency.

Type SU drives are precision-built in standard form for pinion speeds up to 10000 RPM, with resultant gearing pitch line velocities up to 10000 feet per minute. Modified and special design SU drives are also built for speeds up to about three times these speeds. High speed gear drives are manufactured to close tolerances. They must therefore be considered as precision machines and handled accordingly.

Note: The continuous efficient operation of high-speed, totally enclosed gear drives depends upon the following important factors as covered in this book: (1) Adequate mounting; (2) Proper alignment with prime mover and driven machine; (3) Proper lubrication; (4) Proper cooling; (5) Proper maintenance. The suggestions and instructions contained herein should be carefully followed.

INSTALLATION

Correct mounting and alignment are essential to prevent undue stresses on the shafts, bearings, and case. Solid cast bases supporting both unit and driven machine are highly recommended. Direct mounting of Type SU drives on concrete foundations of ample proportions is also satisfactory as the heavy supporting feet or mounting flanges of the cases readily permit such mounting.

Where it is necessary to mount the drive on a fabricated structural base or foundation, care should be taken to design and construct the base with sufficient rigidity through the use of ample sections, to prevent "weaving" or "flexing". Gusset plates and anchors should be provided to break up any otherwise unsupported spans in the structural members.

Where low sound level is of paramount importance, it may be necessary to install the connected apparatus on floating foundations, or insulate the drives by the use of sound absorbing material. Air-conditioning installations in public buildings are typical of this class of application.

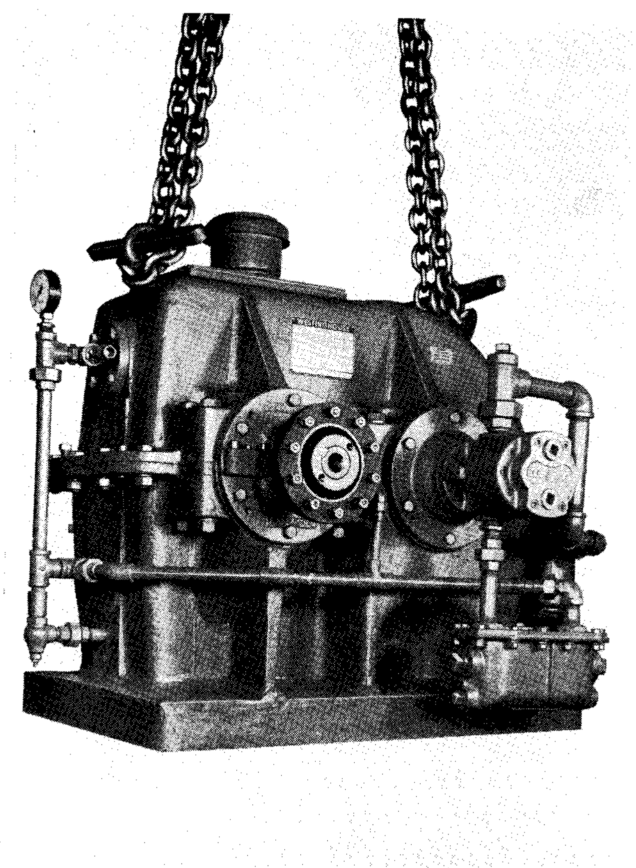


FIG. 1. Correct Method of Hoisting High-Speed Gear Drive

Handling. When moving the gear drive for purposes of installation, it is particularly important that care be taken not to damage the piping, shafts and bearings. It is therefore recommended that the eye bolts provided for that purpose be utilized in the manner shown in Fig. 1.

When setting the drive on its foundation or bedplate, care should be taken to set the drive down gently to avoid turning up burrs on the machined surfaces of the feet. Burrs on these surfaces will prevent the gearcase from seating properly. If such burrs are developed, they should be removed prior to attempting to align the gear drive with its driving and driven equipment.

ALIGNMENT

The use of flexible couplings should not be considered as a means of compensating for poor alignment, as the initial alignment for this type of coupling should be equally accurate to that of a solid coupling. Flexible couplings are generally applied to absorb and prevent the transmittal of critical vibrations, permit small lateral movement without imposing undue stress to connected apparatus, and to a certain degree, compensate for settling in foundation, etc.

Frequently the cause of bearing failures, shaft breakage, overheating, and noisy operation of the equipment, has been directly traceable to insufficient consideration having been given to correct mounting and alignment. Misalignment of the gear drive with the connected apparatus may cause premature bearing failures, as the bearings become subjected to localized stresses. This may cause breakdown of the oil film with the consequent metal-to-metal contact and result in possible scoring of the bearings.

When aligning the gear drive with the prime mover, particularly where the prime mover is an electric motor, care must be taken to insure that the motor is not prevented from operating with its rotor on magnetic center. Therefore, the coupling used should permit sufficient end movement of the motor shaft so that it may operate on true magnetic

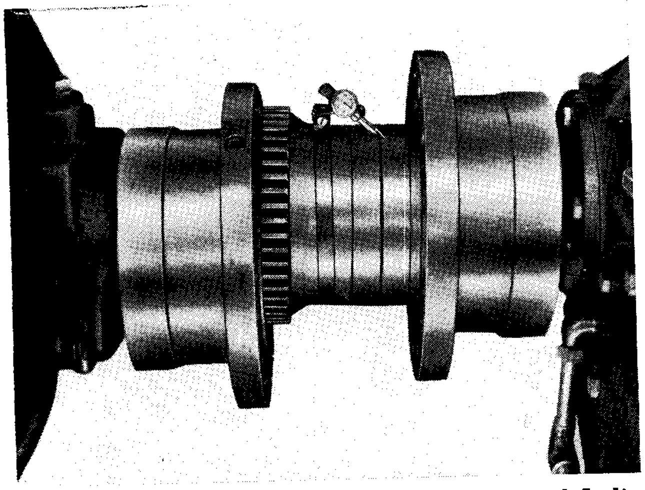


FIG. 2. Checking Parallel Alignment with Dial Indicator on Outside Diameter of Hub

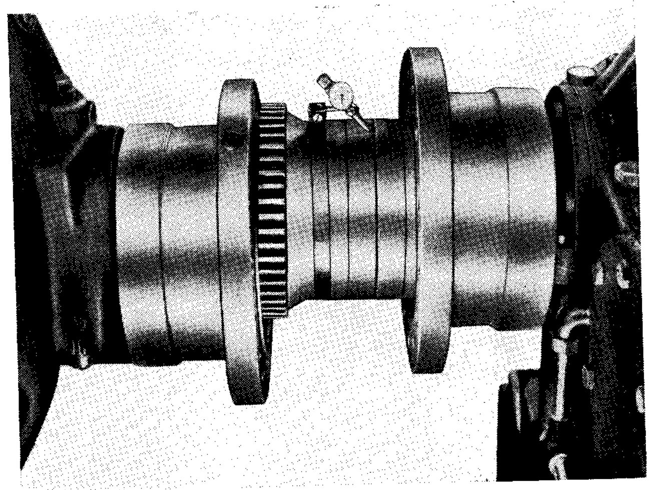


FIG. 3. Checking Angular Alignment with Dial Indicator on Face of Hub

centers. The gap which is set up between shaft ends should be set up with the motor shaft in its proper operating position and with the gear shaft centrally located with respect to its end movement.

Couplings should be aligned by means of an indicator as illustrated in Figs. 2 and 3. The indicator is clamped to one of the coupling halves, and this half is rotated slowly while the other half remains stationary. To check for parallel misalignment, the indicator is placed on the outside diameter of the machined surface as shown in Fig. 2 and the variation in the pointer noted as the coupling half is rotated. The difference in indicator readings between the two extremities in both the horizontal and vertical planes represents twice the error in parallel offset, and the couplings may be brought into alignment by moving both horizontally and vertically the required amount. For angular alignment check, the indicator is placed on the machined face of the coupling hub as illustrated in Fig. 3 and alignment made as previously described.

When aligning the gear drive to the connected equipment, it is important to make both a "hot" and a "cold" alignment check. The cold alignment check is made at room temperature as previously described. After this has been made, and the drive has been operated as described in paragraph 7, page 6, "Placing Drive in Operation", and temperatures have leveled off, the apparatus should be stopped and an accurate alignment check made while the equipment is still hot. There may be considerable differential in expansion between the driving and the driven equipment, and a readjustment in alignment should be made to suit the "hot" or running conditions. If this difference is not compensated for, operational difficulties may well be expected. It is well to remember that steel or iron will expand approximately .001 inch in each 10 inches of length (or diameter) for each 15 degrees F. rise in temperature.

PLACING DRIVE IN OPERATION

After the drive has been properly installed and alignment checked in "cold" conditions, it should be placed in operation as follows:

1. Run the motor or engine with the coupling disconnected to be sure that the direction of rotation of the motor or engine is the same as indicated by the Direction of Rotation Arrow located on the gear case. This is important as the pumps generally supplied with high-speed gear drives are uni-directional, that is, they may be run in one direction only, and if reversed, the suction and discharge ports will also be reversed. ***When gear drives are run in the direction opposite to that for which they are piped, no lubricant is supplied to the bearings and gear mesh, and failures would take place after very short periods of operation.*** For special application where reversing is required, lubrication may be furnished either by a reversible type pump (one which will maintain the same suction and discharge ports regardless of direction of rotation), a separately motor-driven pump, or a special scheme of piping and check valves which will cause oil to flow in the same direction regardless of the suction and discharge ports of the pump.

2. Connect the coupling and check the strainer basket to see that it is clean and free of foreign matter.

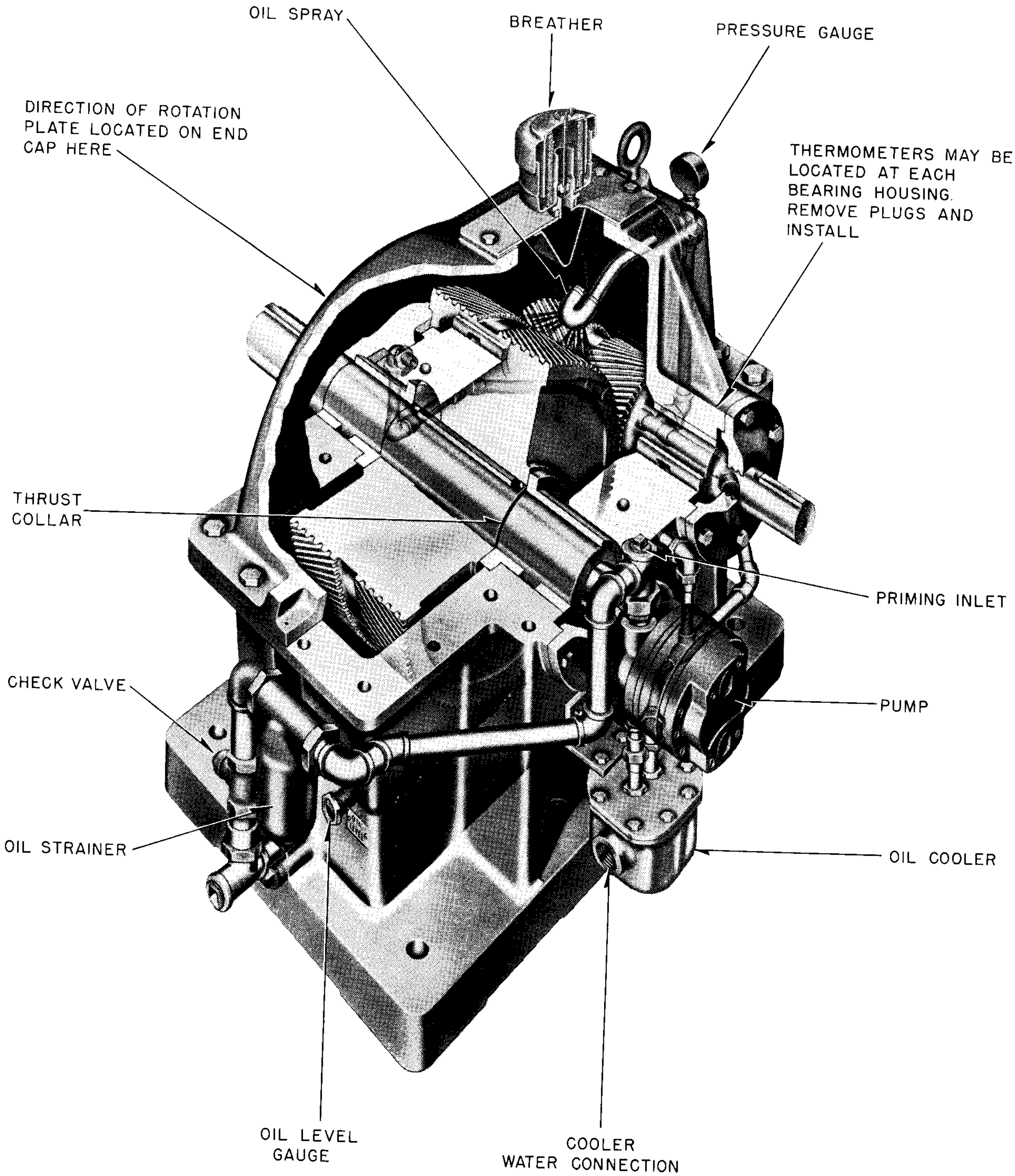


FIG. 4. Cutaway View of Type SU High-Speed Gear Drive

3. Fill the reservoir in the case to the proper oil level with the recommended grade of lubricant for the particular operating condition. (Refer to recommendations given under "Lubrication"). The proper oil level is indicated by the oil level nameplate located at the end of the gear case, beside the oil sight gauge. The proper level is maintained when the oil height is up to the center of the sight gauge, with the gear drive at standstill.

4. Prime the oil pump to avoid delay in the delivery of oil to the bearings and gear mesh. The priming inlet is shown in Fig. 4. In cases where a thermometer is installed at this point, it may be removed to permit priming and then replaced afterward. Ordinarily the pump does not require manual priming, but in case of long shutdowns it is considered good practice to prime the pump before starting the unit. The priming inlet is supplied with each drive.

5. Connect the cooling water to the cooler and supply the proper quantity of water, which is marked on the outline drawing and is generally based on a water supply temperature of 85 degrees F. Insofar as the rate of heat transfer is dependent upon the temperature difference between the water and the liquid to be cooled (oil, in this case), it is obvious that corrections should be made in cases where the water supply temperature is other than 85 degrees F. These correction factors appear in Table No. 1. The water quantity indicated on the outline drawing is to be multiplied by the correction factor for the actual water supply temperature in order to obtain the corrected water quantity based on the actual water temperature.

Table No. 1
WATER SUPPLY TEMPERATURE CORRECTION FACTORS

WATER TEMPERATURE (Degrees F.)	MULTIPLYING FACTOR
35	.70
50	.74
70	.83
85	1.00
100	1.25
120	2.00

6. The shaft extensions of the gear unit are given a rust preventive finish at the factory. This finish may be removed by dissolving it in common solvent or lubrication oil.

7. The gear drive is now ready to operate. Start the drive at a light load and allow it to run at this load for at least one hour, until the temperatures of the bearings become stable. Then increase the load in successive steps of approximately 25 percent until the full load condition is obtained. The bearing temperatures should be leveled off and stabilized at each step before the next load increment is made. High-speed gear drives may be operated with bearing temperatures as high as 175 degrees F., as measured with well-type thermometers inserted in the bearing hubs. After temperatures have stabilized under full-load (or near full-load) conditions, the "hot" alignment check and adjustment should be made, as previously described under "Alignment".

LUBRICATION

Type SU high-speed gear drives have a simplified lubrication system wherein the bearings and gears are lubricated with the same oil. This is accomplished by a centralized forced feed system incorporated as an integral part of the drive.

For uni-directional drives, the lubricating pump (see Fig. 4) is generally mounted on the low-speed end cap and is connected to the low-speed shaft by means of a pin type coupling (see Fig. 5) at the end of the low-speed shaft opposite the extension. The pump may be directly connected to the low-speed shaft or it may be connected through a set of gears (see Fig. 8) to obtain proper pump operating speeds.

The oil in a high-speed gear drive serves two purposes. In addition to its action as a lubricant, it also serves as a cooling medium in removing the heat from the gears and bearings. An oil circulating pump and heat exchanger therefore become important parts of a combined lubricating and cooling system.

Oil spray regulating valves are provided in all Westinghouse high-speed drives. These serve the purpose of proportioning the oil between the bearings and the gear spray. They are properly set at the factory test floor for best operating conditions, during the test run of the drive. Close to the spray regulating valve is a pressure gauge which is so

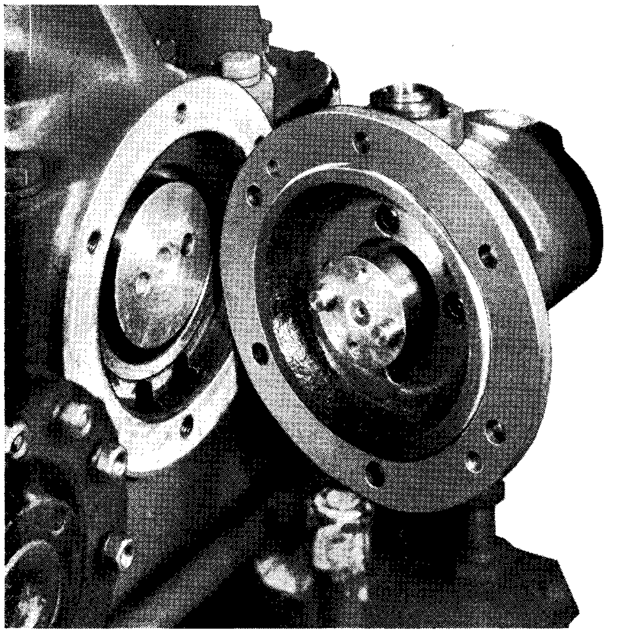


FIG. 5. Pin Type Coupling of Pump to Low-Speed Shaft

located as to indicate the pressure of the oil in the line feeding the bearings. In general, a reading at this gauge between 3 and 10 pounds will provide satisfactory operation. The arrangement of spray valves and pressure gauges is shown in Figs. 6 and 7.

Since the pitch line velocities in these high-speed gear drives are relatively high, air currents are set up, tending to "beat" air into the oil especially at the mesh of the gearing where the oil ejected from the spray head is forced into the gear mesh.

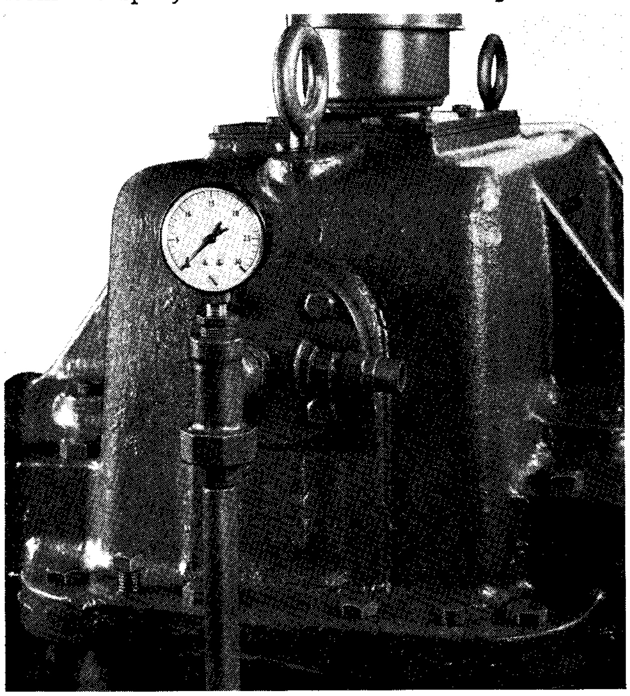


FIG. 6. Arrangement of Spray Valve and Pressure Gauge

Beating air into the oil will tend to oxidize the oil more rapidly. It is therefore important that the lubricating oils are of high-grade, high-quality, well refined petroleum oils. They must not be corrosive to gears or sleeve bearings; they must be neutral in reaction; free from grit or abrasives; have good defoaming properties with good resistance to oxidation; have high demulsibility factor and viscosity index not less than 60; the viscosity must be within the range specified in Table No. 2 for recommended lubricants. For refiners oils meeting AGMA requirements refer to Lubricant List I.L. 7460.

Table No. 2

RECOMMENDED LUBRICANTS FOR TYPE SU HIGH-SPEED GEAR DRIVES

VISCOSITY RANGE	S.U.V. SECONDS	FOR AMBIENT TEMPERATURE USE LUBRICANT		
LUBRICANT AGMA NO.	AT 100°F	0 TO 40°F.	41 TO 100°F.	101 TO 150°F.
1	180-240	AGMA 1	AGMA 2	AGMA 3
2	280-360			
3	490-700			

Note: For the lower temperatures it is important that the oil selected has a pour point at least 10 degrees F. below the lowest ambient temperature expected, or that suitable arrangements be made to provide an ambient to compensate for the pour point.

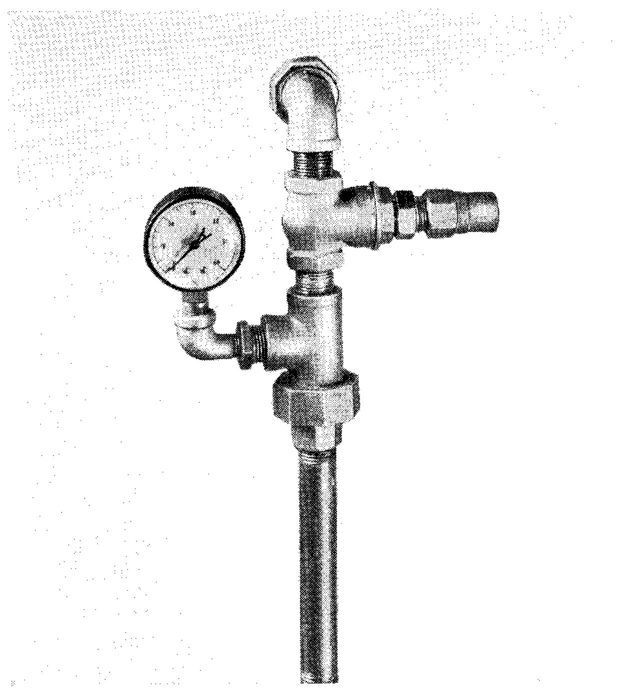


FIG. 7. Alternate Arrangement of Spray Valve and Pressure Gauge

Oils classified by SAE numbers may be selected providing they meet the above specifications. As a guide their viscosity range is listed below:

SAE No.	S.U.V. Seconds at 100°F.
10	160-230
20	230-400
30	400-570
40	570-750

Application requirements should dictate the selection of the oil. For high starting loads or where cyclic loading occurs during normal operation the heavier oils should be used.

For combined gear drive and driven equipment lubrication systems, where light starting and uniform operating loads are involved it is sometimes desirable to use a very light approximately SAE 10 oil. This is permissible providing a high-grade, high-quality oil is used having a viscosity in the range of 140-170 S.U.V. at 100°F. with a minimum viscosity index of 80. When using this oil with the unit in a high ambient its operating temperature should be carefully checked.

It is recommended that the gear drive be operated with the initial supply of oil for approximately 2 weeks. The oil should then be changed or filtered. After this first change, it is advisable to change the oil approximately every six months or every 2500 hours of operation whichever occurs first.

To meet customers special requirements a different type of oil pump, cooler, or strainer may be supplied located different than shown in Figure #4. The oil level and drains will vary to suit the lubrication system.

Specific lubricant recommendations by refiner's trade names will be furnished upon request. To obtain specific recommendations, the following information should be furnished:

1. Preferred lubricant supplier.

2. Expected maximum and minimum ambient temperatures.

3. Approximate temperature of cooling water to be used in oil cooler.

4. Prime mover (whether diesel, gas, or electric drive).

COOLING SYSTEM

The importance of the cooling system on the proper functioning of a high-speed gear drive cannot be too greatly emphasized. Because of the high speeds involved, the thermal radiating capacity of the gear case is insufficient to maintain safe operating temperatures. Consequently, an auxiliary means of cooling the lubricating oil and the gear case is necessary. The coolers, as provided, have sufficient capacity in themselves to maintain safe operating temperatures. Whatever cooling is obtained through the natural radiation of the gear case provides an additional margin of safety.

The cooler is located on the pressure side of the pump resulting in the oil being cooled immediately before entering the bearings and gear mesh. Through its contact with gears, bearings, shafts, and gear case, the oil removes the heat from those parts and carries it into the cooler where it is transferred to the cooling water. The amount of heat removed by the oil depends upon the rate with which oil contacts the various hot surfaces and the temperature difference between the oil and the surface. The amount of heat extracted from the oil by the water in the cooler, depends upon the temperature difference between the two liquids, the cooling surface area, and the rate of circulation of the liquids. If too large a water quantity is used, the pressure drop in the cooler may be excessive, or a larger size cooler will be required to keep the pressure drop within reasonable limits. In addition to this, an excessive quantity of water is wasteful and expensive, as the water discharged from a cooler is frequently of no further use. If, on the other hand, too small a water quantity is used, the heat transfer rate will be lowered and consequently, an oversize cooler will be required. In general, it has been found that a water rate based on a water temperature rise of approximately 10 degrees F. in passing through the cooler is acceptable to the users of high-speed drives. In general, water pressure drops of 5 pounds per square inch and oil pressure drops of 8 pounds per square inch, through the cooler, have been found satisfactory, as maximum values. It is of particular importance to maintain low oil pressure drops as the power required for driving the lubricating pump will increase as the pressure against the pump increases, which increase affects the overall efficiency of the drive. The above pressures are well within safe working pressure for standard commercial industrial lubricating oil coolers as the majority of them are designed for working pressures of 75 to 150 pounds per square inch.

For applications where salt or sea water is used as the cooling agent, special marine type coolers are available which are provided with an electrode for centralizing electrolytic action of the salt water. Inasmuch as the reaction between the water and electrode is such as to slowly corrode the electrode, it is necessary to replace these periodically if damage to the cooler proper is to be prevented.

CLEANING OF COOLERS

Frequency of Cleaning. Coolers should be cleaned as frequently as necessary to provide unrestricted flow of water and oil. This will vary depending upon operating conditions. Within 30 days after installation, it is recommended that the cooler be removed for inspection. After one or two inspections of this nature, the operator will be able to determine the length of time necessary between regular periodic cleaning.

Note: In certain types of service, oil sludge and carbon formation is more rapid than others. Heavy deposits of this nature will cause an objectionable increase in pressure drop through the cooler and a decrease in cooling efficiency will be observed. Cleaning at regular intervals will preclude the above mentioned conditions, and will insure maximum efficiency in operation at all times.

Method of Cleaning.

Important: In handling the core throughout cleaning operations, use care to prevent injury or damage.

Either the oil or water side of coolers can be cleaned with very little difficulty, when the operator has made it a policy to clean at regularly scheduled intervals, before excessive quantities of lime, rust, scale, oil sludge, and carbon have accumulated.

Note: It is recommended that both sides of the cooler be cleaned whenever the unit is disconnected for cleaning. It is suggested that the oil side be cleaned first, as surplus oil in the passages will mix with and weaken the solution used to clean the water side. To prevent hardening and drying of accumulated foreign substance, the core should be cleaned as soon as possible after removal from service.

Cleaning Oil Side of Coolers.

1. Circulate carbon tetrachloride or trichlorethylene through the oil passages with a hand or motor driven pump, in reverse direction from normal operating flow. This action should be continued until the unit is clean.

Caution: Cleaning should be done in the open air, or a well-ventilated room when carbon tetrachloride or any other toxic chemical is used for cleaning.

2. If a circulating pump is not available, cleaning can be accomplished by immersing the core in a container of carbon tetrachloride. After the unit has been allowed to stand in the solvent for a few minutes, force cleaner through the oil passages with a hand force pump, of the ordinary piston or plunger type.

3. An Oakite or Alkaline solution is recommended where the oil passages are badly clogged, and when used, this should be circulated through the passages. ***After cleaning, flush thoroughly with clean hot water.***

Note: Flush inside of oil passages with clean light oil, after both the oil and water sides of coolers have been cleaned.

Cleaning Water Side of Coolers.

1. Immerse the exposed core in a solution, composed of one-third muriatic acid and two-thirds water, to which has been added one-half pound of oxalic acid, to each two and one-half gallons of solution.

2. Remove core when foaming and bubbling stops. This usually takes from thirty to sixty seconds. ***Pressure flush thoroughly with clean hot water.***

3. Remove all foreign substance from inside cover and casing before reassembling. Clean all gasket surfaces thoroughly and use new gaskets wherever necessary.

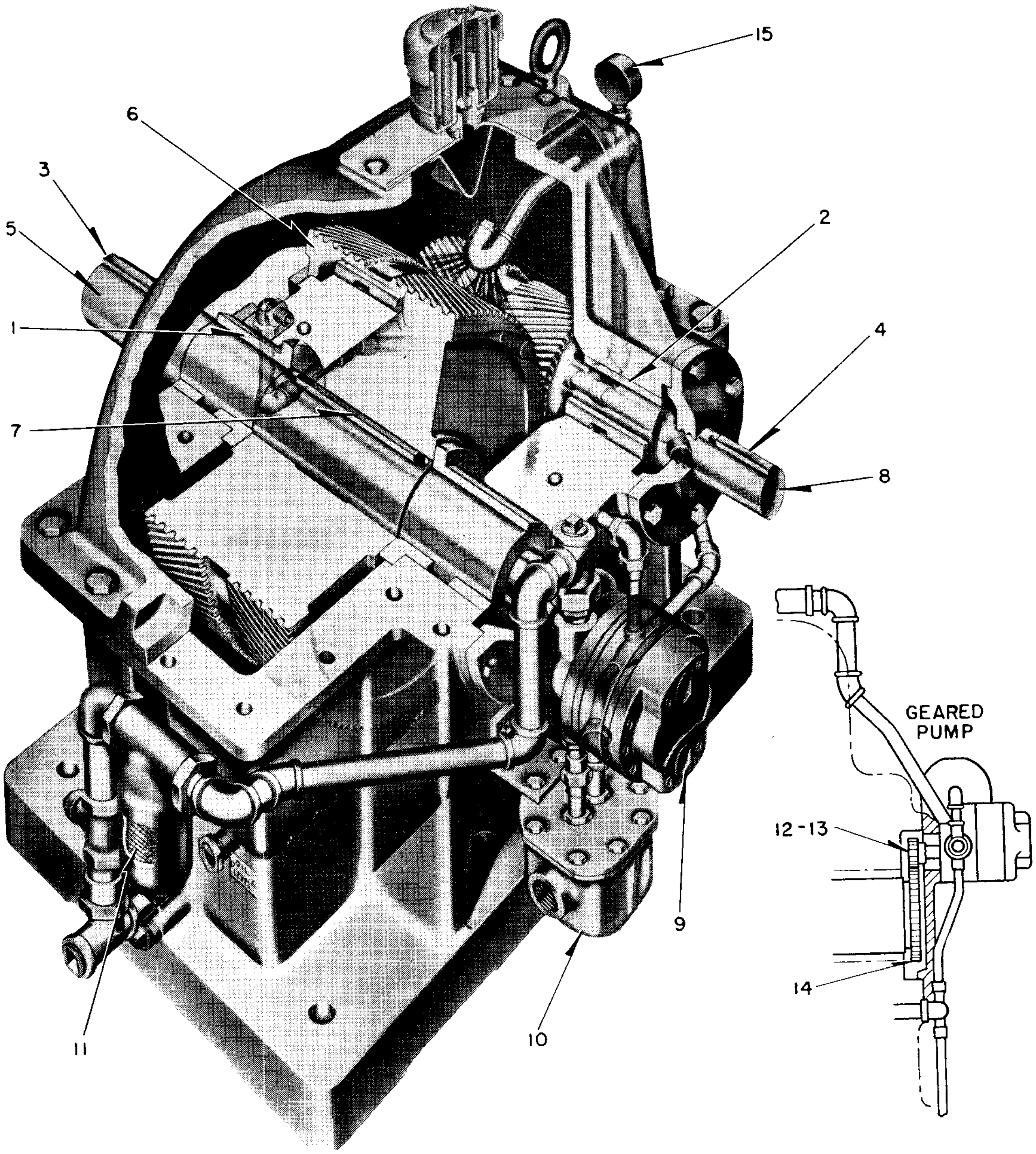
Note: In addition to the cleaners suggested in the preceding instructions, there are a number of other good cleaners and solvents on the market, manufactured by reputable concerns. Any such concerns will recommend cleaners to meet a particular need.

MAINTENANCE

After the drive has been installed and running for approximately one week, it is recommended that all bolts, nuts and oil line unions be checked and tightened if necessary. This operation should also be a part of the maintenance schedule for periodic checking.

The most common causes of bearing failures are as follows:

1. Lack of adequate lubrication. This may be caused by a clogged strainer, leaky oil line joints, a low oil level, or possibly due to loss of pressure in the oil pump. It is therefore important to check the strainer basket at frequent intervals, at least once a month, and clean it thoroughly in carbon tetrachloride, banana oil, gasoline, or kerosene. Compressed air should be used in the final clean-



LEGEND

1. LOW-SPEED BEARING
2. HIGH-SPEED BEARING
3. LOW-SPEED EXTENSION KEY
4. HIGH-SPEED EXTENSION KEY
*5. LOW-SPEED SHAFT
*6. LOW-SPEED GEAR
*7. GEAR KEY
*8. HIGH-SPEED PINION SHAFT
9. OIL PUMP
10. OIL COOLER
11. OIL STRAINER BASKET
12. OIL PUMP PINION
13. OIL PUMP PINION KEY
14. OIL PUMP GEAR
15. PRESSURE GAUGE

* ITEMS 5 TO 8 COMPRISE A UNIT AND ARE NOT FURNISHED SEPARATELY.

FIG. 8. Cutaway View of Type SU High-Speed Gear Drive Showing Component Parts, and Outline Sketch of Geared Pump (Furnished Only as Required or Specified).

ing operation to blow out any tiny particles which may have become lodged in the mesh screen, and also to remove traces of the cleaning medium. Check the oil level in the gear case. Too high an oil level may cause the gear to dip and result in excessive losses with a resultant increase in operating temperatures. If the oil level is too high, this will usually show up in the form of oil leakage, excessive foaming, or increased temperature. A poor grade of oil will foam excessively and create similar results. Always check the oil level when the drive is at standstill.

2. The strainer provided with the gear drive will exclude and prevent foreign bodies such as metallic chips, grit and dirt from entering the bearings. However, at times when the strainer is removed for cleaning or the oil line is disconnected or when the oil in the gear drive is being changed, it is possible for foreign bodies to enter the lubricating system and cause damage to the bearings. Be sure that the strainer is thoroughly clean and that all connections of the oil line are protected when dismantled.

To prevent the escape of oil vapor from the gear case, and still provide a means of maintaining a low pressure inside the gear case, a large breather of the Air Maze design is included with these drives. Oil vapor, which is developed by the heat inside the case, in attempting to pass out of the case into the atmosphere must follow a tortuous path through the breather. In so doing, it comes into contact with the large surface of the mesh wire screen in the breather and is thereby cooled and condensed. Drain-back holes may be provided in the breather in cases where excessive oil condensation is developed, to permit the oil to return to the gear case. These holes are not provided where the expected condensation is normal.

These breathers are clearly marked for an oil level, and it should be a part of the regular maintenance schedule to check the breathers to insure that a proper oil level is maintained. If too high an oil level is permitted in the breathers, the escaping vapors are forced to operate against this additional pressure. The vapors will of course follow the path of least resistance, and this might be along the shaft at the oil seal. Consequently, too high an oil level in the breather might cause leakage.

3. When starting up be sure that the unit has been in an ambient or room temperature of at least 20°F. above the pour point of its oil for about 2 hours. If the temperature of the oil in the unit is near its pour point and it is started, the time required for the oil to reach the bearings may be increased to the extent that the bearings may score due to the delayed oil flow.

4. All drives which are driven by diesel engines are equipped with a pressure relief valve loacted at the suction side of the pump ahead of the check valve. The function of the relief valve is to prevent damage to the piping in the event the engine should be turned over a few revolutions in the direction opposite that for which the gear drive is designed. It will in this case eject a stream of oil from the relief valve which should be a warning to the operator. If the gear drive should run often in the reverse direction its oil sump may eventually be emptied resulting in a gearing or bearing failure.

Table No. 3
COMPONENT PARTS OF TYPE SU HIGH-SPEED GEAR DRIVES

IDENTIFICATION AND DESCRIPTION (See Fig. 8)	NO. PER UNIT
1. Low-Speed Bearing	4 Halves
2. High-Speed Bearing	4 Halves
3. Low-Speed Extension Key	1
4. High-Speed Extension Key	1
* 5. Low-Speed Shaft	1
* 6. Low-Speed Gear	1
* 7. Gear Key	1
* 8. High-Speed Pinion Shaft	1
9. Oil Pump	1
10. Oil Cooler	1
11. Oil Strainer Basket	1
† 12. Oil Pump Pinion	1
† 13. Oil Pump Pinion Key	1
† 14. Oil Pump Gear	1
15. Pressure Gauge	..

* Not Furnished Separately. † Only as Required or Specified

BEARING REPLACEMENT PROCEDURE

To replace a bearing it will be necessary to dismantle the unit as follows. Unscrew pipe unions in inlet and outlet oil lines to lube oil pump and in oil line to gearing oil spray. Remove bolts holding pump support end cap to gearcase and remove cap and pump from unit. Remove bolts holding high speed end caps to unit and remove closed cap. Note that the recent design high and low speed shaft end caps are of the split design so that they can be removed from the shaft without removing the coupling if so desired. Take out bolts holding low speed end cap to gearcase. Remove bolts holding upper case to lower and by means of the jacking screws free upper case and remove it from lower case. The upper half high and low speed bearings can now be taken out. Lift out high speed pinion shaft to remove lower high speed bearings. To remove either the low speed shaft or the lower low speed bearings first lift up the shaft extension just high enough to pull up the bearing shell so it will clear the dowel pin and then rotate it 180 degrees to the top of the shaft to take it from the case. The low speed shaft should next be moved out axially from the other bearing and lifted out of the case. This will prevent the possibility of the thrust plates or gear hub and the bolts holding the plates from hitting and damaging the thrust surface on the low speed bearing collars.

Replacement bearings are available and manufactured to the same extreme accuracy as the original bearings furnished with the gear drive. Dismantle the unit as specified above to replace a bearing. When installing replacement bearings, the recommended practice is to first make sure that the bearing shell fits snugly in the case bore, that is, to make sure that no burrs or nicks are protruding from the bearing shell nor from the bore in the upper and lower halves of the gearcase which would prevent a good sliding fit. Place one half of the new bearing in the lower case bore. Blue the shaft journals sparingly with Prussian blue and place shaft carefully in lower half bearings. Then place the upper half of the bearing on top of the blued shaft. Roll the shaft in the bearing to obtain a contact marking. In order to get a good bearing contact surface all across the bearing, it may be necessary to scrape the babbitt at points shown by the bluing. Scraping of the babbitt should be kept to a minimum just enough to obtain an even contact not less than 10 degrees on either side of the vertical centerline.

Before reassembling the unit clean the old cement off all mating surfaces, bolt and pipe threads. When reassembling apply a coat of a good oil resisting cement such as Permatex #2, or equivalent to all mating surfaces, bolt and pipe threads being careful not to get any cement in the bearings nor bearing bores. Before the unit is completely reassembled the end play of the low speed shaft which is the clearance between the thrust plates or hub on the gear and the face of the low speed bearing thrust collars should be checked. Place a dial gauge indicator against the end of the low speed shaft and then by means of a block and lever between the coupling and the end cap shift the shaft to measure the shaft end play. The low speed shaft end play should be within the following limitations.

SU-619, 819, 1023,6,8,10 End Play .020″ minimum, .030″ maximum.

SU-12 to 30, Inclusive, End Play .20″ minimum, .050″ Maximum.

In some cases it may be necessary to dismantle the unit again, using the procedure above to take the low speed shaft and gear out of the case, remove a thrust plate from the hub of the gear being careful not to damage the bearing journal and install shims to limit end play.

The total diametral clearance between the bearings and the shaft should not be less than .0012 inches per inch of shaft diameter. This clearance can be measured between the top of the shaft and the bearing bore by means of a feeler gague.

The above general instructions apply for standard and slightly modified units. For highly modified units the assembly instructions will change accordingly to suit the special lubrication system involved. See specific drawings accompanying special instructions with the order.

Westinghouse

Type SU
High Speed Gear Units

(Refer also to Descriptive Data 3700-SU)

INSTRUCTIONS FOR CORRECT INSTALLATION, LUBRICATION AND MAINTENANCE

GENERAL

The continuous efficient operation of any totally enclosed gear drive depends on four very important factors—

1. Adequate Mounting.
2. Proper Alignment with Prime Mover and driven machine.
3. Proper Lubrication.
4. Maintenance.

It is obvious that the importance of these factors increase directly as the speeds are increased, tending to introduce added liability of possible damage from vibration, excessive heating, etc. Drives built for high speed service must therefore be manufactured to the closest of tolerances in all respects, and must be considered as a precision machine and handled accordingly.

Type SU High Speed Units are such a class of equipment, being precision-built for pinion speeds ranging from 2000 to 6000 RPM, with resultant gearing pitch line velocities up to 7500 feet per minute in their standard form, and approximately twice that under modified or special condition.

The suggestions and instructions in the following pages should therefore be followed carefully, to insure maximum service from your type SU Gear Drive.

INSTALLATION

Mounting and Alignment

Correct mounting and alignment are essential to prevent undue stresses on the shafts and bearings. Frequently the cause of bearing failures, shaft breakage, overheating, and noisy operation of the equipment, has been directly traceable to insufficient consideration having been given to these factors.

A thoroughly adequate foundation for mounting is a fundamental necessity. Solid cast bases supporting both unit and driven machine are highly recommended. Direct mounting of type SU Units on concrete foundation of ample proportions is also satisfactory as the units are constructed with heavy supporting feet, or mounting flange, thus readily permitting such mounting.

Where it is necessary to mount the drive on a fabricated structural base or foundation, care should be taken to design and construct such base with sufficient rigidness to prevent "weaving" or "flexing", through the use of ample sections. Gusset plates and anchors should be provided to break up any otherwise unsupported spans in the structural members.

Where low sound level is of paramount importance, it may be necessary to install the connected apparatus on floating foundations, or insulating the units by use of sound absorbing material. Air conditioning installations in public buildings are typical of this class of application.

After the unit has been installed and running for approximately one week, it is recommended that all bolts, nuts and oil line unions be checked and tightened if necessary. This tightening operation should also be part of the maintenance schedule for periodic checking.

The use of flexible couplings should not be considered as a means of compensating for poor alignment, as the initial aligment for this type of coupling should be equally accurate to that of a solid coupling. Flexible couplings are generally applied to absorb and prevent transmittal of critical vibrations, permit small lateral movement without imposing undue stress to connected apparatus, and, to a certain degree, compensate for settling in foundation, etc.

Misalignment of the gear unit with the connected apparatus is also frequently a cause for premature bearing failures, as the bearings become subjected to localized stresses, causing breakdown of the oil film with the consequent result of metal-to-metal contact and possible scoring of the bearings.

Lubrication

Type SU High Speed Gear Units are designed with as simple a lubrication system as is possible for the service conditions. The bearings and gears are lubricated with the same oil by a centralized forced feed system incorporated as an integral part of the unit.

The lubricating pump (see detail) is mounted on the low speed end cap and directly connected to the low speed shaft at the opposite end of the low speed shaft extension. The lubricant is conveyed from the amply proportioned oil reservoir in the gear case through an oil strainer (see detail) on the suction side of the pump and distributed to the bearings and gear mesh on the pump pressure side.

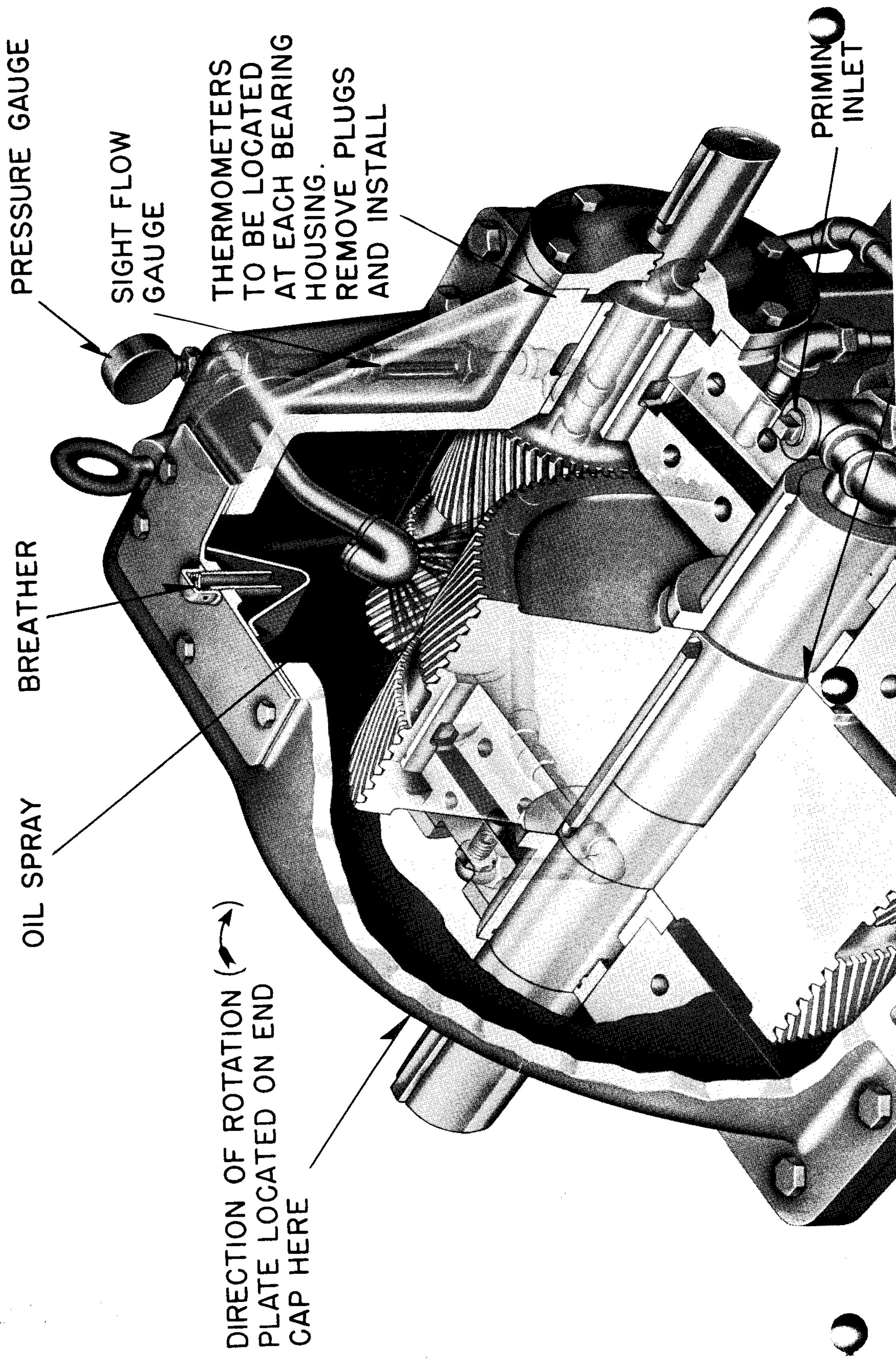
Before the oil enters the bearings and the gear mesh, it is cooled by means of a suitable oil cooler (see detail) which is installed in the oil circuit on the pressure side of the oil pump. The lubricant is cooled by means of water circulating around the outside of the lubricant conveying passages inside of the cooler body. The amount of cooling water necessary for the effective cooling of the lubricant is dependent on the ambient temperature, the temperature of the cooling water, the amount of oil being circulated and the desired bearing operating temperature.

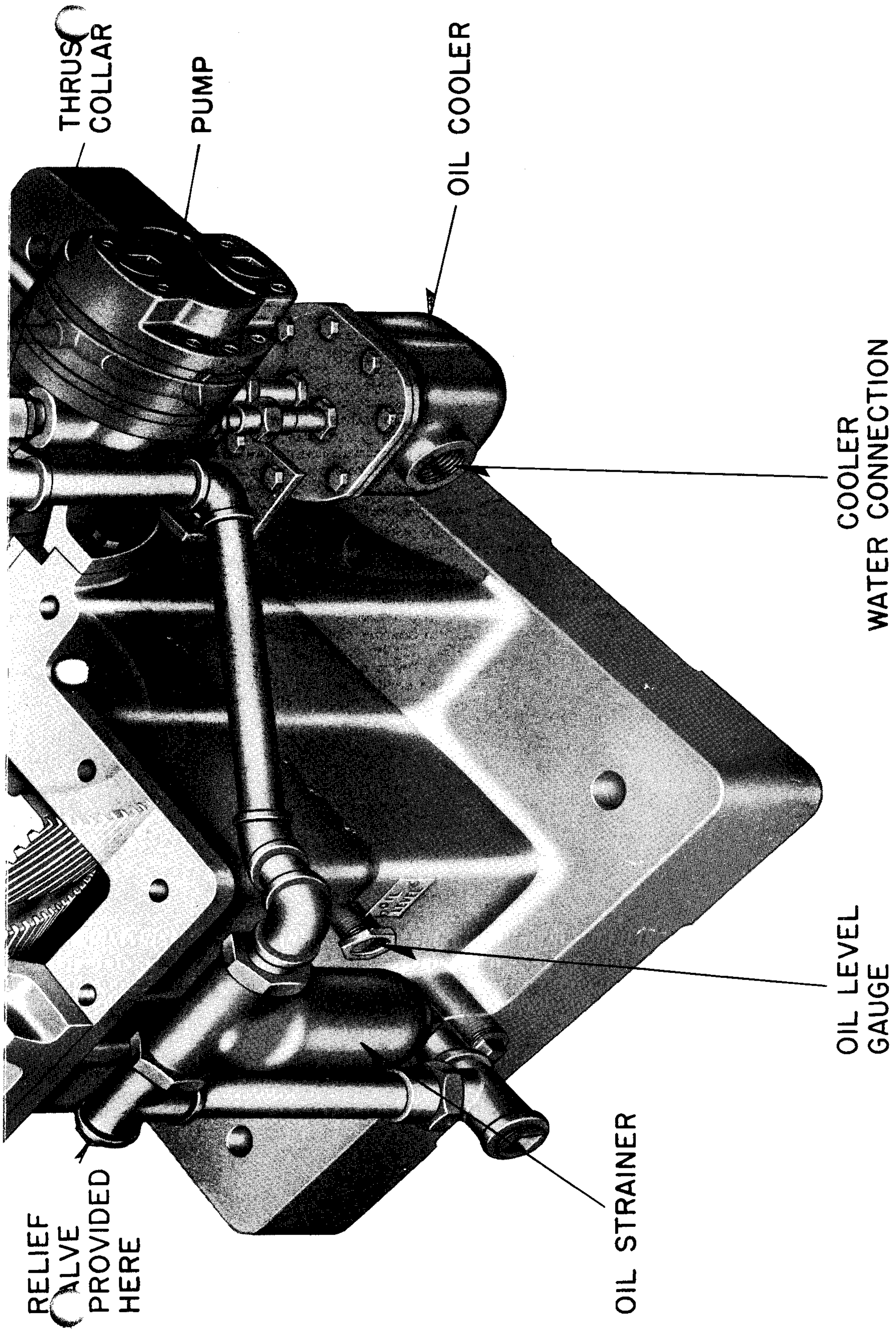
Since the pitch line velocities of the gears in these high speed gear units are relatively high, air currents are set up, tending to "beat" air into the oil, especially at the mesh of the gearing where the oil ejected from the spray head is forced into the gear mesh.

Beating the air into the oil will tend to oxidize the oil more rapidly; it is, therefore, important that the lubricant selected for this type of service should be of a HIGH GRADE, HIGH QUALITY, well-refined petroleum oil with good resistance to oxidation, high demulsibility factor, FILTERED and within the viscosity as noted below:

Viscosity Range	S.U.V. Seconds	For Ambient Temperature	
Lubricant No.	At 130° F.	0° to 70° F.	70° to 120°F.
1 2	140 to 185 185 to 225	Use Lubr. No. 1	Use Lubr. No. 2

For the lower temperatures it is important that the oil selected has a pour point of not less than the lowest ambient temperature expected for the application.


PRESSURE GAUGE
SIGHT FLOW GAUGE
THERMOMETERS TO BE LOCATED AT EACH BEARING HOUSING. REMOVE PLUGS AND INSTALL
PRIMING INLET
BREATHER
OIL SPRAY
DIRECTION OF ROTATION PLATE LOCATED ON END CAP HERE


THRUS
COLLAR
PUMP
OIL COOLER
COOLER
WATER CONNECTION
OIL LEVEL
GAUGE
OIL STRAINER
RELIEF
ALVE
PROVIDED
HERE

It is recommended that the gear unit be run with the initial supply of oil for approximately one month's time, then the oil should be changed or filtered. After the first oil change, it is advisable to change the oil approximately every six months.

Specific lubricant recommendations by Refiners' trade names will be furnished when requested. To obtain specific recommendations, the following information should be furnished:

1. Preferred lubricant supplier.
2. Expected maximum and minimum ambient temperature.
3. Aproximate temperature of cooling water to be used in oil cooler.
4. Prime Mover—Diesel, Gas or Electric Drive.

Preliminary Operating Instructions

The first procedure after a unit has been properly installed should be to run the motor or engine with the coupling disconnected to be sure that the direction of rotation is the same as indicated by the direction of rotation arrow located on the gear unit, then connect the coupling and check the strainer basket and oil lines to make sure that no dirt or foreign material is clogging the oil passages. Fill the oil reservoir in the case with the recommended grade of lubricant for the particular operating condition to the proper oil level, as indicated by the oil level name plate, located at the end of the gear case directly above the oil drain plug.

The second step should be to prime the oil pump in order to avoid any undue delay in the delivery of oil to the bearings and gear mesh. In general, the pump does not need manual priming, but in case of long shut downs, it is considered good practice to prime pump before starting unit. Priming inlet is supplied with each unit.

The gear unit is now ready to run. In order to obtain the utmost in performance, it is recommended that the unit be started at a light load and allowed to run at this load until the temperature of the bearings becomes stable for at least one hour, and then increase the load in successive steps of approximately 25% until the full load condition is obtained. The bearing temperatures in each case should be leveled off and stabilized before the next load increase is made.

General Maintenance Instructions

The most common causes for bearing failures are:

1. Lack of adequate lubrication. This may be caused by a clogged strainer, leaky oil line joints, or possibly, due to loss of pressure in the oil pump. It is therefore, important that the strainer basket be checked at frequent intervals and cleaned thoroughly in carbon-tetrachloride, banana oil, gasoline or kerosene, and compressed air used as the final cleaning medium. The oil pipe joints and unions should also be checked regularly to be sure that no leaks are apparent. If the oil level in the gear case is too high, this will generally show up in the form of air bubbles, and can readily be seen through the sight glass; however, a poor grade of oil will foam excessively and create the same impression. It is, therefore, advisable to check the oil level. (The oil level should never be checked while the unit is running).

2. Foreign bodies, such as metallic chips, sand or grit and dirt may enter the bearings. The strainer provided with the gear unit will exclude and prevent these foreign bodies from entering the bearings, but, at times, when the strainer is removed for cleaning, or the oil line disconnected, it may be possible for foreign bodies to enter the lubricating system and be carried to the bearings, and thus cause damage. It is, therefore, important to make sure that the strainer is thoroughly clean, and that all connections of the oil line when dismantled are properly protected. In locations where the atmosphere is dust laden, it may be possible that dust and dirt may enter the oil reservoir through the breather which is located at the top of the handhole cover, on the top half gear case. This breather, however, is filled with steel wool, and should not let through any foreign particles, unless through an error the steel wool compartment has been removed. It is, therefore, advisable to check that the breather is equipped with the steel wool partition.

3. If the room temperature is low (below or near the pour test of the oil) the time for the oil in the oil line to reach the bearings when the units are started is increased and the bearings may be scored due to the delayed flow of the oil to the bearings. It is, therefore, advisable to be sure when starting up that the room temperature is always at least 10° to 20° F. above the pour test of the oil used.

4. The larger size units and all units driven by Diesel engines are equipped with a relief valve located at the suction side of the pump ahead of the check valve. The function of this relief valve is to prevent damage to the piping in case the engine should be turned over a few revolutions in the direction opposite that for which the gear unit is designed, and in this case, will eject a stream of oil which should be a warning to the operator. If the gear unit should run for any length of time in the reversed direction, the bearings may run dry and cause bearing failures. It is important that the relief valve be checked for AIR leakage after an occurrence as described above; if air leak is present, the pump may not be capable of delivering the required amount of lubricant. This may readily be checked by placing a thin paper at the open end of the valve so if an air leak is present, the paper will be sucked towards the valve. To correct this condition, it is generally only required to compress the spring at the valve stem and turn the valve as, in all probability, a small piece of foreign material may have lodged between the valve stem and seat.

Bearing Replacement Procedure

Replacement bearings are available and manufactured to the same extreme accuracy as the original bearings furnished with the gear unit. When installing replacement bearings, the recommended practice is to first make sure that the bearing shell fits snugly in the case bearing bore, that is, to make sure that no burrs or nicks are protruding from the shell or gear case to interfere with a good sliding fit. Place the liner type bearing in the case bore, blue the shaft sparingly with Prussian Blue, and roll same in the bearing to determine that a good bearing surface is obtained.

In order to obtain a good contact surface all across the bearing, it may be necessary to scrape the babbitt at points shown by the bluing. The check on the top half of the bearing should follow the same procedure as for the bottom bearing, except that it will not be necessary to place same in the top half case. The thrust collar of the low speed bearing should be checked for clearance between the face of the bearing flange, and the face of the hub on the gear, with bearings and gear located in the lower half gear case. The clearance between the hub and the bearing flange should not be less than .010 inches.

The radial clearance of the bearings on the shaft should not be less than .001 inches per inch of shaft diameter. This clearance may be checked readily by the use of a feeler gauge.

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