Reduction Gear

General

Figure 1 shows the construction and assembly of the reduction gear unit for use with the smaller sizes of Westinghouse Turbines for Mechanical Drive. It consists of the housing base "26", housing cover "27", gear wheel "10", pinion "28" (integral with rotor shaft), bearings, oil pump and oil cooling coil. The pinion is overhung from the bearing "30" which is located in the gear case and which also serves to support one end of the turbine rotor shaft.

Bearings

The pinion bearing "30" consists of a cast shell, split horizontally to facilitate assembly and removal and lined with tin base babbitt.

In normal operation, the bearing is lubricated by a pressure circulating system. Oil is supplied by the gear oil pump and enters the bearing at the top, as shown in the illustration.

During the starting and stopping periods, when the pressure delivered by the main pump is not sufficient to supply the bearings, lubrication is provided by the conventional type of revolving ring shown as item "32". The bottom of the ring dips in oil in the cavity below the bearing and carries it to the top of the journal. The oil ring cavity is automatically kept full of oil from the pressure supply inlet after the unit has once been operated.

The gear wheel is carried in two standard ball bearings which, in addition to carrying the radial load, serve also as thrust bearings and maintain the correct axial position of the rotating element.

Housing

The housing is split in a horizontal plane through the axes of the pinion and gear, thus forming a base and cover. It is bolted solidly to and centered in a counterbore in the turbine cylinder. The entire unit (turbine and gear) is supported by three accurately machined pads (two on the turbine base and one on the gear base). This three point support arrangement, eliminates distortion of the housing when bolted down and greatly facilitates alignment.

Gear Wheel and Pinion

The gear wheel is made of forged steel and is pressed on and keyed to a steel shaft "3". The pinion and rotor shaft "28" are integral and are made of forged steel. Since the gear and pinion have only a single helix, the pinion thrust is taken by the main thrust bearing of the turbine while the ball bearings "8" which carry the gear are capable of taking the gear thrust. The axial position of the pinion can be adjusted by means of the turbine thrust bearing, and shims "5" are provided for adjusting the axial position of the gear.

Oil Pump

The oil pump is of the positive displacement, spur gear type and is driven directly from the gear wheel shaft "3" by a flexible coupling, formed by the pin "19" which engages a slot in the end of this shaft.

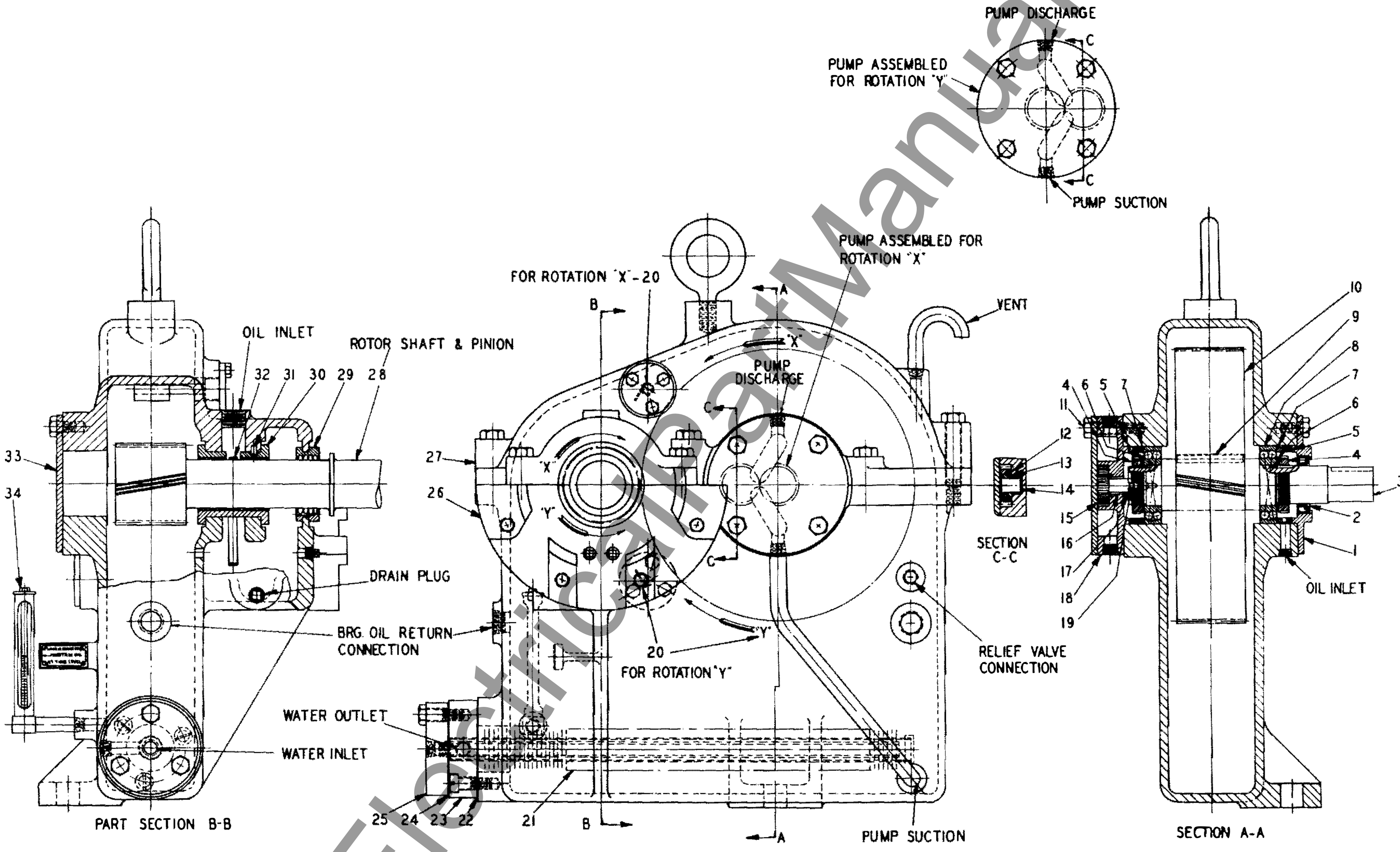

Fig. 1 - Gear Assembly

Provision for priming the pump has been made in the piping, but priming is necessary only when starting up for the first time or if the turbine has been out of service for a considerable length of time.

Lubricating Oil System

The gear case serves as an oil reservoir, and should be filled to the proper level with oil. Extreme care should be taken at all times to keep the oil system free of water. The oil pump takes the oil from a recess in the bottom of the gear case and discharges it directly to the bearing lines and to the spray "20" for lubrication of the gear teeth. A by-pass controlled by a relief valve is provided in case the oil lines become clogged. The oil should be maintained at the level of the oil level plate "34" on the side of the gear case. If oil is added above this level the gear wheel will dip in the oil and cause foaming and excessive heating of the oil, and perhaps gear tooth wear due to the oil breaking down. A drain is provided for emptying the oil from the gear case.

Since this gear is used for either clockwise or counter-clockwise rotation the position of the oil spray tube "20" and pump gear "12" will be for each rotation (shown by arrows "X" and "Y") as shown in the Figure.

Except as noted above, the gear requires no manipulation. It should, however, receive the usual attention from the operater such as:

1. Note oil level. Any increase in oil level (without addition of oil) indicates a leak in the oil cooling pipe.

2. Feel bearings occasionally to see that they are running at normal temperatures.

Oil Cooler

A cooling water pipe "23" with oil cooler tube nest "21" are submerged in the oil in the gear base and water is circulated through them for the purpose of keeping the oil temperature within the desired limits. The pipe should be connected to a water supply at a pressure not exceeding 50 pounds.

Installation and Alignment

When installing this type of unit, the driven apparatus should be set in its correct position and leveled first. Then the gear and turbine should be aligned to the driven apparatus. The housing should be set level in the transverse direction by using an ordinary type of level. In every other direction, the final position of the housing is determined by the alignment of the coupling flanges between the gear and the driven apparatus.

For satisfactory operation, it is of utmost importance to have the rotating shafts, which are coupled together, accurately aligned so that their axes are in the same straight line. There are several methods of obtaining correct alignment. The following procedure is recommended and is given here as a convenient guide.

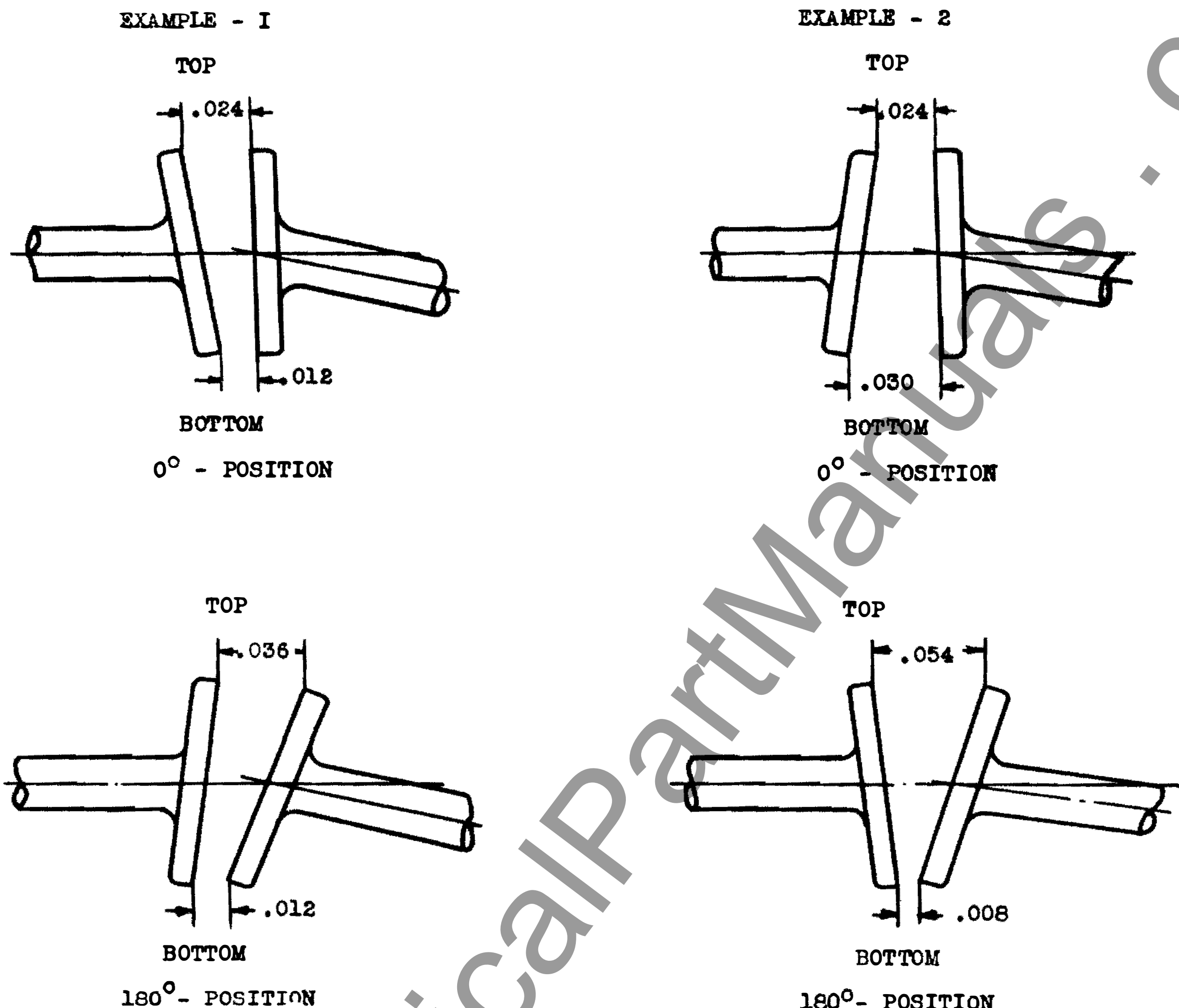

Fig. 2 - Coupling Alignment

COUPLING ALIGNMENT

Aligning for Parallelism of Rotor Axes

This is done by paralleling the faces of the coupling flanges. However, the flange faces may not be perfectly true with respect to the rotor axes. Therefore, the following rules should be followed which compensate for discrepancies in the faces and give accurate results.

Separate the flanges a convenient distance and measure the gap at the top, bottom and both sides. Then rotate both shafts 180° and take another set of readings.

Rule 1 - If the opening between coupling faces as indicated by two sets of readings taken 180° apart remains on the same side of the axes, the amounts of the openings should be added and the sum divided by two. The result is the amount that the coupling faces would be open if they were machined perfectly true with the axes.

Rule 2 - If the opening between coupling faces as indicated by two sets of readings taken 180° apart changes from one side of the axes to the other, the amounts of the openings should be subtracted and the difference divided by two. The result is the amount the coupling faces would be open if they were machined perfectly true with the axes.

The following examples explain these rules. (The discrepancies are, of course, greatly exaggerated to add clearness to the examples):

Example I; (Refer to Figure 2)

In the 0° position:

Top reading...........	.024
Bottom reading........	.012
Therefore faces show..	.012 opening at top.

With both coupling halves turned 180°

Top reading...........	.036
Bottom reading........	.012
Therefore faces show..	.024 opening at top.

Since the opening is at the top in both positions, Rule I applies. Therefore: $\frac{.012 + .024}{2} = .018$ actual opening across the diameter (or .009 across the radius) if the faces were perfectly true.

To put the coupling in correct alignment, raise the outboard end of one shaft so as to bring the faces .009 closer together at the top.

To check the accuracy of this work, take a set of readings in the 0° position and one in the 180° position. If the work is correct, the coupling faces will be open a certain amount at the top in one position and the same amount, but at the bottom, in the other position.

Example II: (Refer to Figure 2)

In the 0° Position:

Top reading...........	.024
Bottom reading........	.030
Therefore faces show..	.006 opening at bottom.

With both coupling halves turned 180°:

Top reading...........	.054
Bottom reading........	.008
Therefore faces show..	.046 opening at top.

Since the opening changes from bottom to top in the two positions, Rule 2 applies. Therefore: $\frac{.046 - .006}{2}$ = .020 actual opening across the diameter (or .010 across the radius) if the faces were perfectly true.

To put the coupling in correct alignment, raise the outboard end of one shaft so as to bring the faces .010 closer together at the top.

Of course, these examples show the alignment in the vertical plane only. By applying the same principle to the readings obtained at the two sides, the correct alignment is obtained in the horizontal plane.

Aligning for Concentricity of Rotor Axes

Fasten a truth indicator to one half of the coupling, allowing the indicator stem to ride on the other half. Roll both halves simultaneously through 360°, taking indicator readings at the top, bottom and both sides. These indicator readings will show the eccentricity of the two rotor axes. Move one unit so as to make the axes concentric. When making this adjustment, care must be taken to move both ends of the unit the same amount so that the alignment for parallelism, previously completed, will not be disturbed.

Inspection and Repair

Periodically (about once a year) the unit should be dismantled and thoroughly cleaned and inspected. Dismantling is very simple and requires only a small amount of work. After disconnecting the oil pipes, the oil pump can be removed as a unit by breaking the joint between the pump body "18" and the gear housing. The housing cover should be removed next which gives access to the bearings, gear wheel, pinion and oil cooling coil.

The bearings should be inspected and if worn excessively they should be renewed. The gear teeth should be examined to see that the contact markings are evenly distributed over both helices. If a feather edge should appear on the tips of the teeth, it should be removed by a fine oil stone. Any burrs or bruised spots should be dressed up with a scraper. Do not file these teeth under any circumstances.

If it should be necessary to renew the pinion bearing care must be taken to see that the bore and outer turn are concentric in order to maintain the correct center to center distance and give the proper amount of back lash in the gear teeth. This back lash can be determined most easily by measuring the axial movement (or end play) of the pinion relative to the gear wheel. With the gear wheel blocked against one set of thrust shims, the pinion should have from .015 to .050 inch axial movement. It is also important to see that the bearing shell fits correctly at the horizontal joint. Errors in these fits may cause oil leaks, thus decreasing the oil supply to the bearing.

When reassembling the housing cover and oil pump body, the joints should be made up with shellac and pulled together tightly before the shellac hardens.

The following list has been compiled to facilitate the ordering of spare or renewal parts by name and number, together with the serial number of the turbine:

Item No.	Name
1	Bearing Cap
2	Gear Wheel Shaft Oil Seal
3	Gear Wheel Shaft
4	Bearing Retaining Nut
5	Bearing Adjusting Shims
6	Bearing Retaining Nut Lock Washer
7	Bearing Spacer Ring
8	Bearing
9	Gear Key
10	Gear Wheel
11	Pump Case Cover
12	Pump Gear (Driven)
13	Pump Gear Hub (Driven)
14	Pump Gear Shaft (Driven)
15	Pump Gear (Driver)
16	Pump Gear Shaft Bushing (Driver)
17	Pump Gear Shaft (Driver)
18	Pump Gear Case
19	Pump Gear Shaft Coupling Pin
20	Gear Spray Complete
21	Oil Cooler Tube Nest
22	Gasket
23	Oil Cooler Inlet Pipe
24	Gasket
25	Oil Cooler Outer Flange
26	Gear Case Base
27	Gear Case Cover
28	Rotor Shaft and Pinion
29	Oil Ring
30	Bearing
31	Bearing Pin
32	Oil Ring
33	Gear Case End Cover
34	Oil Level Gauge

Printed in U.S.A.
(4-36)