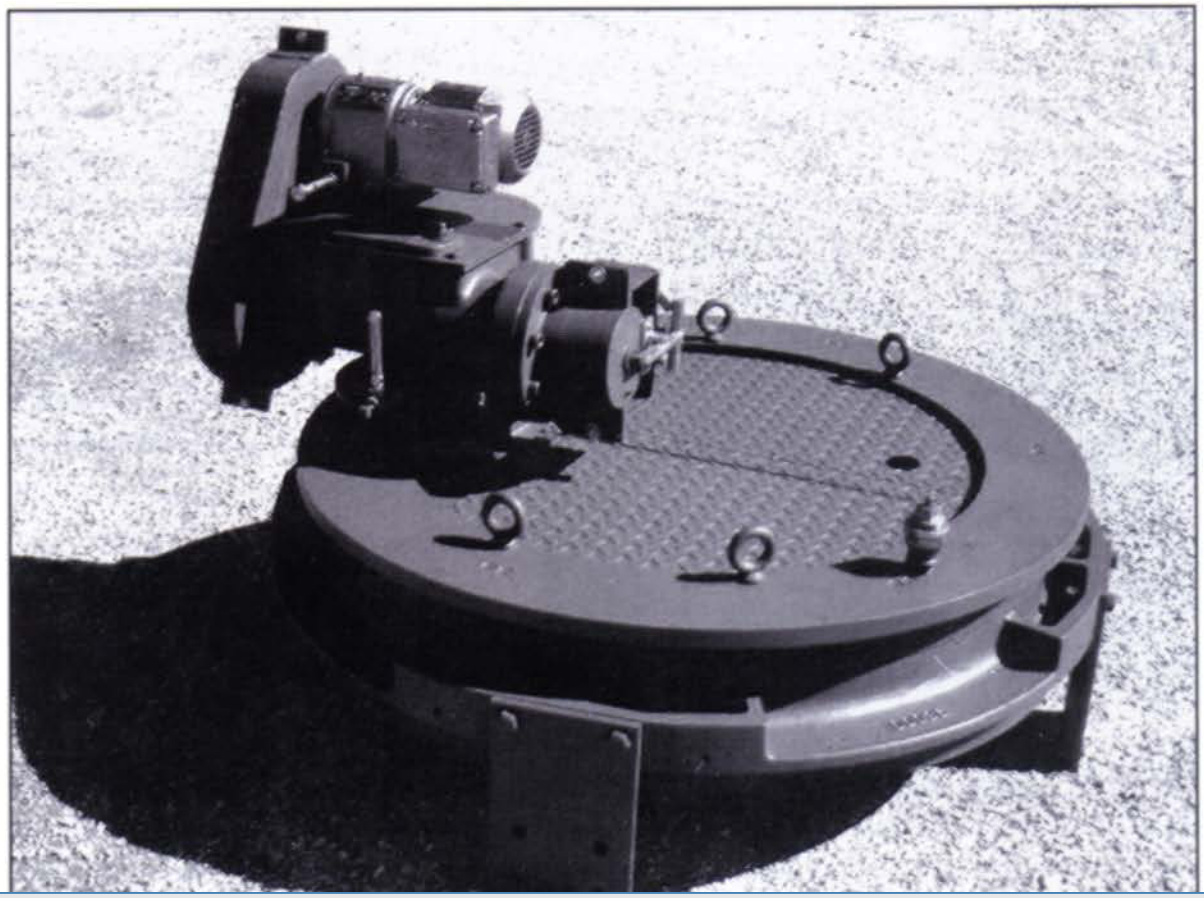
Drive Mechanisms for Circular Clarifiers

making the right choice for your project



AMWELL®
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Drive Mechanisms for Circular Clarifiers

We are pleased to introduce AMWELL as an Integrated Drive Manufacturer who has been a supplier of circular clarifier drives for almost fifty years. We have thousands of units in operation in every conceivable variation of temperature and environmental condition throughout North America and the world.

Integrated Manufacturers (as we have defined them) have invested millions of dollars in patterns, facilities and equipment to provide for the supply of drives that are designed for the specific needs of our industry. This level of investment and design selection is indicative of our commitment to our industry.

The principle design considerations that are specific to our industry and incorporated into our drives are:

- Low speed
- Combined high thrust and high radial loadings
- Continuous operation
- Ease of maintenance
- Rugged stability

The following major designs were made in keeping with the foregoing criteria:

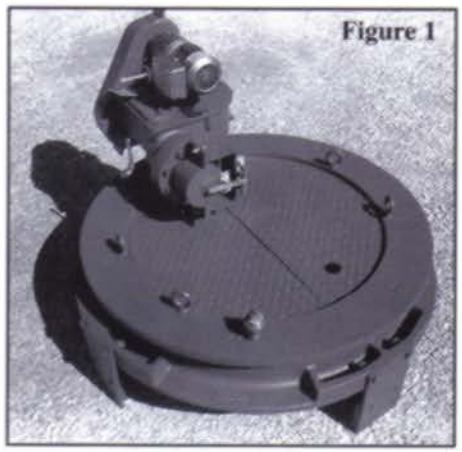
Figure 1

1) Rugged cast iron housings were selected to provide superior geometry for rigidity and support, superior dampening and corrosion resistance properties. This decision necessitated a major investment in patterns that is ongoing. The investment was felt to be merited for the foregoing reasons plus it eliminated dependency on weld quality.

2) To provide a worm drive specific for the application utilizing a dependable, simple combination of worm shaft, bronze worm gear, and alloy pinion that would provide for years of trouble-free operation and ease of maintenance in the field if and when required.

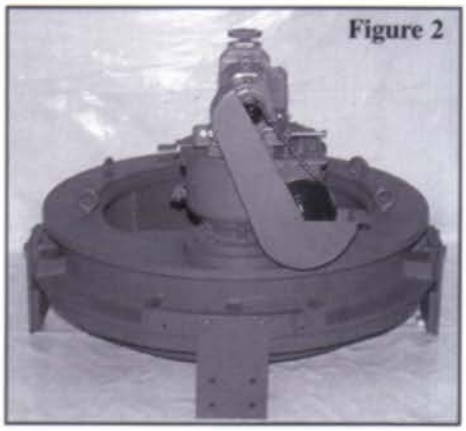
Figure 2

3) A specific bearing system was designed for the spur gear that met the needs of a high thrust, high radial load application and provided for the use of replaceable wear strips. The selected design also permitted the use of bearing balls without nonmetallic spacers resulting in approximately twice the number of bearing balls for a given diameter.

4) Split the spur gear in halves to permit ease of inspection, maintenance and cost effective replacement of parts in the field.

In achieving these specific design objectives, no commercial "off-the-shelf" major components were used. Only components that were designed specifically for the application are utilized. All components are stocked at AMWELL's facilities for fast delivery and service.

A typical AMWELL Drive Mechanism.

Figure 1 is a typical AMWELL Drive Mechanism showing the major components of a helical worm gear drive, a worm tower, the split internal tooth spur gear with its associated main gear housing.

In Figure 2 we removed the chain guard to clearly show the drive and driven sprockets with the associated roller chain and shear pin hub. This is the preferred design in that it provides for the capability for adjustment in the field, at any time, to different output speeds by changing the ratio of drive and driven sprocket and for ease of getting to the shear pin hub. Should the process

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change, or optimization of the results dictate a change in output speed of the clarifier it can be easily accommodated.

Figure 3 shows our worm tower assembly with the few major components that provide for rugged simplicity and ease of maintenance. Maintenance of this durable but simple assembly is well within the capability of plant maintenance personnel. Note that roller bearings are used throughout our drives including the torque input end of the worm shaft.

Figure 4 shows both a worm shaft and an alloy pinion. The significant feature is that in both instances they are a one-piece design. In neither case has the gear been keyed to a shaft for cost reduction purposes. All of the attributes that are claimed for a single piece pinion can also be applied to a single piece worm shaft. In both cases the bearings straddle the load.

Figure 5 shows a typical spur gear housing. The picture clearly shows the rugged mass of the casting and the unique geometry that is applied to provide stiffening in the appropriate places. The general attributes of cast iron have been adequately described earlier on. Please note that the AMWELL housing is a one-piece design. There is a full 360 degree support for the worm tower and there are no intermediate pieces that could create any misalignment between the lower pinion bearing location and the upper pinion bearing location that exists in the worm tower.

In Figure 6 we see a clear shot of the pinion lower bearing pocket which offers full 360 degree support for the bearing and provisions are made to directly withdraw all water and contamination from below the lower pinion bearing without depending on migration. In this picture you can also clearly see that the bearing balls have no non-metallic spacers and that they are riding on replaceable bearing liners. This not only provides for ease of maintenance but also, in the case where excessive wear has occurred, the cost of replacing the bearing balls and the bearing liners is minimal and can be done in the field.


Figure 5

In Figure 7 we see a typical AMWELL split spur gear with internal teeth. This spur gear utilizes the highest grades of ductile iron manufactured in accordance with the latest standards. Very few bolts are required to disassemble the spur gear though the joint geometry has been designed to comfortably handle momentary peak conditions. The gear has been configured to permit its removal, while the drive is installed, for inspection and if required, maintenance. Maintenance is very cost effective as it only requires the replacement of bearing liners and bearing balls.

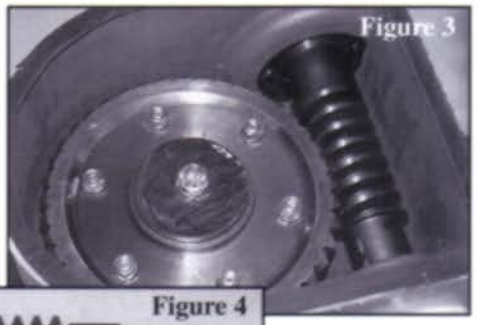
Figure 3


Figure 4

Main Bearing

The next part of our discussion deals with a comparison between "precision" four-point bearings and replaceable bearing liners.

The Anti-Friction Bearing Manufactures Association (AFBMA), Annular Bearing Engineers Committee (ABEC), has established tolerances for precision ball bearings. In order to truly be designated a precision bearing, the bearing must meet the criteria established by the AFBMA.

Not all bearings are covered by the AFBMA. The ball and bearing liners used by AMWELL and all of the major Integrated Drive Manufacturers in our industry are not covered by AFBMA. Neither

are the four-point Gothic arch bearings promoted by non-Integrated Drive Manufacturer's. A single four-point contact ball is commonly, but incorrectly, referred to as a precision bearing. These bearings do not meet the AFBMA criteria and as such technically cannot be called precision bearings. The major feature of the four-point bearing is its ability to resist an overturning moment. The overturning moment feature relates to the original applications of this type of bearing to machinary such as mobile cranes, cherry pickers, etc. Overturning moments are not a significant factor in the water and wastewater industry either municipal or industrial. The significant disadvantage of this design is that you cannot utilize replaceable bearing liners and you end up with approximately half the number of bearing balls for a given diameter.

Lubrication

AMWELL drive units typically operate at very slow speeds and accordingly operate in a condition where a boundary lubrication film exists. In this environment the depth of the oil level on the tooth is of little consequence and can vary from 20 to 80 percent of the tooth height since the meshes essentially have metal to metal contact with the system dynamics that are present. The high pressure meshing action of the gear tooth contact pumps the lubricant along the flanks of the gear teeth. The lubricant then cascades down over the flank of the adjacent teeth providing lubrication for the mesh. Recognizing the fact that the surfaces of the gear teeth have a small amount of surface roughness, a quantity of lubricant will be retained which adds to the formation of the boundary lubricant film. Experience has demonstrated this fact with nearly five decades of successful and reliable operation.

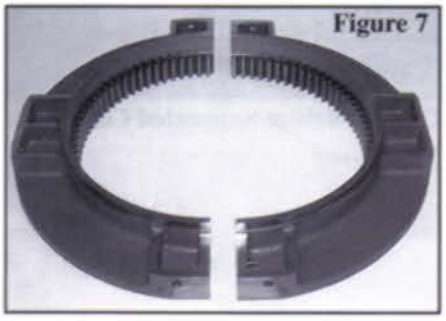
Figure 7

The condensation and contaminant build-up in the oil is removed from more than one location in the drive. By design there is positive removal of condensate from at least two locations in the spur gear housing, one of which is from the area below the lower pinion bearing pocket. In this case, the removal of the condensate and contaminant is not dependent on the possible migration of the condensate to a point of removal.

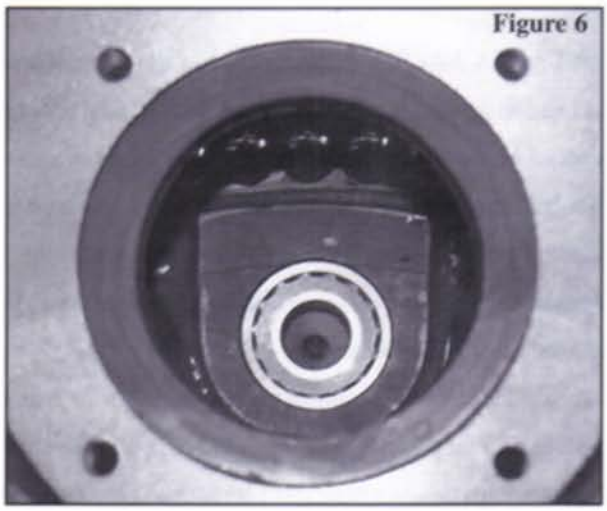
Figure 6

Drive Standards

For the last five years AMWELL has participated in a review, redesign and upgrade program of its entire drive line. The result is that we have realized many design improvements and achieved conformance with the latest ANSI/AGMA Standard 2001-B96 for spur gears and pinions and ANSI/AGMA 6034-B92 for worm sets. In achieving conformance with these new standards we were able to increase our torque ratings by taking the following steps:

A) Improving the spur gear material selection to a higher grade of ductile iron with a microstructure of fine tempered pearlite.

B) Complying with the new requirements for Class II material for gearing.

C) Instituting an upgrade in quality control from the foundry through to a shipped product in complete compliance with ASTM A536.

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D) Upgrading the manufacturing of:

1) Spur gears to an AGMA Class 6 or better

2) Pinions to an AGMA Class 8 or better

E) Improving our spur gear and pinion geometry which, combined with our traditional low aspect ratio design, allowed us to achieve exceptional load sharing capability.

Note

ANSI/AGMA 2001-BS8 continues to allow the empirical method of calculation for load distribution factors Km and Cm, but a test was added for the aspect ratio to insure mesh stiffness was adequate.

Aspect ratio is a slenderness ratio where the gear's face width is divided by the pitch diameter of the pinion. The smaller the gear face width for a specific pinion diameter, the better (lower) the aspect ratio that can be attained.

Some of our competitors utilize smaller diameters of gearing with large gear face widths. In spite of the possible economies of manufacture this design offers, this approach to gearing does not achieve the same level of load distribution as our design. Accordingly they are forced to use high values of Km and Cm.

"The better a gear set is designed for load distribution, the lower the load distribution factor that can be claimed."

F) Full conformance to the above standards for calculation of momentary peak which prohibits factors of greater than 75% of yield.

We believe that our concentrated design effort has produced the finest line of drives available in our industry today in terms of quality, metallurgy, geometry and features and should be considered the number one choice.

AMWELL, as an "Integrated Supplier," has not resorted to buying "off-the-shelf" commercially available major drive components. We have designed, and manufacture in-house, those items specific to our industry needs. This approach calls for a major investment, or entry fee, to become a participant in our industry.

It is our belief that the long term requirements of our market for specifically designed low speed, high thrust, high radial load drives, designed to the latest standards, can be best made by suppliers that have made a major financial commitment to produce these specifically designed drives and who will be around for the long term in order to realize return on their investment.

One Piece Pinion Shaft

For further information, please contact AMWELL at 630/898-6900, fax us at 630/898-1647 or email us at amwell@amwell-inc.com. We will be pleased to discuss your specific application with you to help select the correct drive mechanism and clarifier for your specific application.

Worm Gear Drive Unit for Bridge Supported Collector

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