

Talking Points

The Chain Drive Transmission

One of the great success stories in fire pumps and accessories is the Waterous chain drive transmission. After two decades of experience, users have confirmed the design advantages and its reliability has been proven.

Before going into the advantages of the chain drive transmission let's get some background history that leads to the chain drive now in use. In the early 1950's the standard practice was to use spur gears in pump transmissions to transmit power from one shaft to another. Because of the distance between the truck drive shaft and impeller shaft, three gears were commonly used. Also, it was necessary to offer a selection of pump transmission ratios, which meant that the idler shaft had to be put in a different location for every ratio offered. Spur gears did an adequate job; however, they had some disadvantages in that they were very noisy (high pitched scream) and prolonged operation could actually cause fatigue in an operator standing alongside the pump.

Back then, the 750 gpm pump was the most popular pump, followed by the 500 and 1000. The power requirements of those pumps were not as great as they are for today's higher capacity pumps and generally a narrow tooth width gear was sufficient to transmit the required power. However, popularity grew for capacities of 1000 and 1250 gpm, the tooth width had to be increased (thicker gear). This pattern follows as you continue to transmit more and more power.

A partial solution for these problems came with the introduction of the CM pump in 1956. The then new "M" transmission used helical gearing which is much quieter than spur gearing. Because more teeth are engaged at any given time, a similar width gear had greater power handling capabilities. Also, the crown shaved teeth ensure that the load is carried on the center of each tooth, which is the tooth's strongest point.

Even though helical gearing provides greater power transmitting capabilities, the demand for larger capacity pumps with even greater power requirements is growing. The chain drive transmission is the answer to this demand. Since the chain wraps virtually half way around the sprockets, there are a greater number of teeth sharing the load, resulting in greater power transmitting capabilities and longer life. A smooth, quiet transfer

of power is provided by the chain drive transmission, which is a significant advantage over traditional drive methods.

Another inherent advantage of the chain drive as compared to the gear drive transmission is that this arrangement is perhaps the ideal method of transmitting power between parallel shafts running at high speeds, particularly if the shaft centers are spaced well apart. There is no need for an idler gear to fill the space between the drive gear and driven gear.

The chain we selected for the chain drive transmission is the Morse Hy-VO® chain, which is no ordinary silent chain. It is a very special, high strength, chain capable of operating at high speeds. Contrary to other chain designs and the old chain drive method, the Morse Hy-VO® chain has very little stretch.

In fact, both the chain and sprockets are machined with the utmost precision, allowing assembly that results in

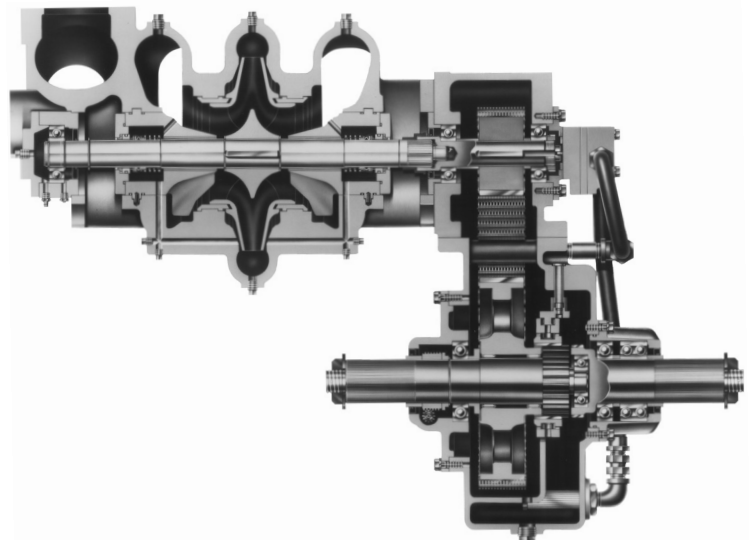
a predetermined, pre-load so that after break-in, proper backlash results. This is accomplished during the normal pump test break-in at the factory.

Even though the chain drive concept has been proven in other automotive applications, one just doesn't begin using it in the fire service without doing some testing first. Waterous installed two prototype chain drive transmissions on Model CM-1000 two-stage, series/parallel pumps in service in New York City. We asked the FDNY to select two companies that would give the chain cases a real workout.

They certainly did! The chain cases were installed on pumpers in service at Engine Companies 82 and 85. In March 1975, which marked one year's service, Engine Company 82 had responded to 6427 alarms and Engine Company 85 to approximately 6,000 alarms. Nearly ten years later these two vehicles continued to serve the largest fire department in the world.

When making a comparison to a relatively standard fire department that responds to approximately 300 alarms per year, and multiplying by 20 years, you come up with 6,000 alarms-only 427 alarms less than the number responded to by Engine Company 82 of the FDNY in just one year.

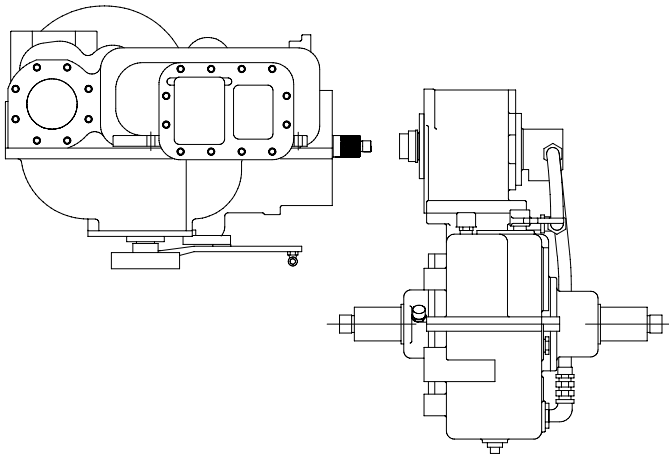
A cross sectional view of the chain drive transmission is shown below. This should give you a good idea of how the chain drive transmission operates.



Another development by Waterous is the separable impeller shaft feature. This two-piece impeller shaft allows separation of the transmission from the pump without having to disassemble either component. If repairs are necessary, the pump mechanic can service either the pump or transmission without having to disturb the other. This simplifies any repair procedure greatly, which ultimately results in less down time for your apparatus, and lower repair costs.

Power is transmitted by the spline and the shafts are held in precise alignment by the close fitting pilot. As with previous Waterous shaft designs, the two-piece impeller shaft is supported by deep groove ball bearings, which provide both radial and axial support.

The drawing below illustrates how the pump and transmission are separated.



With the increased use of large diesel engines and automatic transmissions by the fire service, has come the need for heavier driveline components in the pump transmission. Waterous now has available a 2.35 inch O.D. drive shaft with a 46 tooth spline. While this is not much larger than our 2-1/4 inch heavy duty shaft, the torque rating is greatly increased, due to the much larger root diameter (smaller, more shallow cut teeth). A split shaft pump transmission should have driveline components with a torque rating equal to or greater than the net engine torque multiplied by the torque converter ratios and first gear ratio. We have tested (no theoretical calculation here) this new shaft at more than 14,000 lb.-ft. of torque (equal to

more than 46 lbs. of force on a breaker bar as long as a football field). This shaft is capable of handling the full driveline torque of any engine/transmission combination currently available to the fire service.

Now for the Specifications

Housing: High-tensile gray iron, three piece, horizontally split.

Sprockets and Chain: Drive and driven sprockets are made of alloy steel with teeth of an involute form, and are carburized and hardened. The Morse Hy-VO® chain is a high strength, special tooth-form chain capable of operating at high speeds to provide smooth, extremely quiet transfer of power.

Shafts: Drive line shafts are made from alloy steel forgings, hardened and ground to size with precision. Drive line shafts are available in 1-3/4, 2 and 2.35-inch sizes, depending on the engine/transmission torque output.

Bearings: Deep groove, anti-friction ball bearings, oil splash lubricated throughout.

Lubrication: Primary lubrication for the bearings, sprockets and chain is accomplished by the same splash system used in Waterous gear cases and almost all other automotive gear cases, differentials, etc. A supplementary system is also used which includes a strainer, an oil circulation pump driven by the impeller shaft, and a spray bar inside the case which sprays oil on the inside of the chain before it goes over the driven sprockets. The P Series utilizes splash and a secondary passive lubrication system.

Note: The transmission housing incorporates a simple, yet effective, method of preventing transmission overheating during pump operation. This design eliminates the need for auxiliary cooling under normal operating conditions.

Ratio: For the best possible match of pump and engine, the following drive ratios are available:

1. **C10 Series Ratios** - 1.27, 1.41, 1.48, 1.58, 1.69, 1.79, 1.88, 1.97, 2.03, 2.27, 2.46, 2.73
2. **Y Series Ratios** - 1.14, 1.27, 1.41, 1.48, 1.50, 1.58, 1.69, 1.88, 1.97, 2.03, 2.27, 2.46 and 2.73.
3. **W Series Ratios** - 1.19, 1.29, 1.39, 1.52, 1.62, 1.74, 1.87, 2.04 and 2.57.
4. **P Series Ratios** - 1.71, 1.91, 2.05

Chain Drive Transmission

The Waterous chain drive transmission may be specified as follows: The pump drive transmission must be of latest design incorporating drive and driven sprockets made of alloy steel. Power transmission from drive to driven sprocket to be accomplished with a high strength, special tooth-form chain capable of operating at high speeds to provide smooth, quiet transfer of power.

C10 Series Chain Drive Transmission

Transmission case housing shall be high-strength aluminum, two-piece, horizontally-split

W Series Chain Drive Transmission

Transmission case housing shall be high tensile gray iron, two-piece, vertically split.

Heavy Duty Y Series Chain Drive Transmission

Transmission case housing shall be high tensile gray iron, three-piece, horizontally split.

P Series Chain Drive Transmission

Transmission case housing shall be light weight cast aluminum alloy, three-piece, horizontally split.