‘HV’ Inverted Tooth Chain Drives

For High Velocity, High Horsepower and High Efficiency Drives with smooth transmission of load in a compact space.

Morse HV Drives provide the Drive Designer with a new concept in the transmission of power for high speed, high load applications. Proven in a wide range of applications from high production automobiles to custom-designed flood control pumps, HV Drives offer opportunity for flexibility, compactness, weight saving and economy.

In the late 1940’s Morse Chain Engineers developed the original design of ‘HV’ to meet the high speed, high load requirements of Oil Well Drilling equipment. The first chain 2” Pitch x 12” Wide transmitted 1300kW at 650 r.p.m. on the slush pump of a drill rig. Success on this and similar applications led to the further development of a family of chains from 3/8” to 2” which have been successfully applied to a wider variety of industrial applications including Roll Grinders, Dynamometers, Pump Drives, Gas Turbine Starters, four Square Test Rig, and many Automotive Transmissions. Further development of HV chain enables drives over 2,500kW being accommodated with standard chain widths.

‘HV’ Chain Design

The Chain assembly consists of inverted tooth link plates, laced alternately and connected by two steel pins of the same cross sectional geometry, which form an articulating joint between the link sections.

‘HV’ Link Plate Design

The link design in the original HV pitches - 3/8”, 1”, 1 1/2” and 2” (Fig 1) had been tested and proven for many years. The link crotch is located slightly above the line of pull and all corners are rounded to minimise the possibility of stress risers and to ensure maximum performance on high load industrial applications. The 3/8” and 1/2” pitch chains (Fig. 2) have a new link contour for increased speed requirements, with the link crotch below the line of pull, and this design is now extended to include 3/4” and 1” pitches. Photo-elastic studies of various link shapes and aperture positions produced the design with the lowest level of stress concentration. Improved metallurgy, and development in design and pressure angle, achieve maximum load capacity with high speed performance. Carefully controlled shot-peening of the links gives them a uniform, matt grey finish and results in an improved level of link fatigue resistance.

Concentric Pin and Rocker Joint

The joint consists of a pin and rocker of identical cross section and contact radii. When chain engages the sprocket teeth the curved surfaces roll on each other eliminating sliding friction, and joint galling. The radii of the pins is selected to give almost perfect pitch compensation to minimise chordal* action. Before engagement with the sprocket the contact point of pin and rocker is below pitch line (Fig. 3). When chain engages with the sprocket teeth, the contact point moves upwards (Fig. 4) with slight elongation of the pitch to wrap the sprocket along the pitch line.

Chordal Action

The compatible design of HV links, joints and sprockets reduces the detrimental effects of chordal action to a minimum. The chordal action of conventional chain drives is the vibratory motion caused by the rise and fall of the chain as it engages sprocket teeth. This motion causes vibration and limits high speed load carrying capability. Of all types of chains, HV operates most efficiently at all speeds because chordal action is reduced to a minimum. Fig 5, shows how HV chain enters approximately tangent to the pitch circle of the sprocket and maintains this position as it travels around the sprocket. This smooth engagement permits high speed capabilities with efficiency and quietness.

Involute Tooth Sprocket

The third criteria for the success of HV is the mating sprockets. An involute tooth form, differing from the straight sided teeth of conventional silent chain sprockets is designed for smooth engagement of the chain with the sprocket teeth. All HV sprockets are top-hobbed and the teeth heat treated for tough wear resistant surface. Unlike the single tooth engagement of spur gears, many teeth share the load on a HV drive, resulting in low stresses, less wear, and long sprocket life.

You get more with ‘HV’

The features of ‘HV’ link design, compensating pin and rocker joint, with the involute hobbed sprockets means HV chain can transmit more power, at higher speeds, in less space than other transmission media, with smooth action and minimum of noise.

High Speed Performance Operating chain speeds range from 10 to 35 metres per sec. with higher speeds (to 55m/sec) on special applications.

High Power in Narrow Widths HV chain transmits more power per inch of width than any other chain or belt drive, with capacities up to 6000 kW.

Smooth Quiet Operation The rolling action of the chain joints combined with smooth sprocket engagement minimise induced vibrations. This enables HV chain to provide quiet drives on high speed applications.

High Efficiency Smooth operation, with minimal frictional losses, provide transmission efficiencies up to 99.7%.
‘HV’ Chain - Selection

There are Seven good reasons to use HV in your design!
HV transfer cases provide weight and cost savings because:

1. Fewer Shaft and Bearings are required.
2. Lighter Loads on Shaft Bearings.
3. Chain Bearing Loads are compressive, placing case in compression, unlike gear forces which are tensile.
4. HV Cases are Lighter as compressive loads mean thinner sections can be used.
5. Centre Distance is less Critical and more flexible than required by gear and belt drives.
6. Elasticity of HV Chain accommodates normal thermal expansion, and helps ‘cushion’ the drive.
7. Simplified Design results in a positive cost saving.

‘HV’ Drive Selection
Design of a ‘HV’ Chain Drive involves correct selection of chain and sprockets combined with correct casing design and lubrication system. The Power Rating tables opposite, giving power ratings per inch width of chain, enable selection of chain with drives operating under ideal conditions of smooth power source and load. To use these tables for other drives involving shock loads the Actual Power must be modified by a Service Factor to obtain the Design Power which can then be related to the tables.

Service Factors - S.F.

<table>
<thead>
<tr>
<th>Type of Load</th>
<th>Int. Comb. Eng. Hydraulic Drive</th>
<th>Electric Motor</th>
<th>Int. Comb. Eng. Mechanical Drive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smooth</td>
<td>1.0</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Moderate Shock</td>
<td>1.2</td>
<td>1.3</td>
<td>1.4</td>
</tr>
<tr>
<td>Heavy Shock</td>
<td>1.4</td>
<td>1.5</td>
<td>1.7</td>
</tr>
</tbody>
</table>

‘HV’ Drive Selection

1. Determine the R.P.M. and diameter of the high speed shaft.
2. Determine the total power to be transmitted.
3. From application detail determine proper service factor from table. Refer page 7 in Roller Chain Selection for machine types.
4. Establish Design Power by multiplying total Power to be transmitted by the service factor.
   Design Power kW = Motor Power × S.F.
5. Select the chain pitch and width and number of teeth in the small sprocket from the Power Rating Tables.
   a. For quiet and smooth drives use sprockets 25 teeth or more.
   b. Be sure the small sprocket will accommodate the high speed shaft diameter. As a guide with steel sprockets Pitch Circle Diameter should be minimum twice shaft diameter PCD – 2P.
   c. If the high speed shaft diameter exceeds the maximum bore in the selected small sprocket it will be necessary either to increase the number of teeth in the sprocket or select the next larger pitch chain.
6. Determine the required drive ratio:
   RPM high speed shaft:
   RPM slow speed shaft: = Ratio
7. Multiply the number of teeth in the small sprocket by the ratio to obtain the number of teeth in the large sprocket.
8. To determine chain length and centre distance refer to page 9. Centre distance and sprocket combination must always provide an even number of pitches of chain. For fixed centre drives it is recommended to use Centre Distance tables. HV drives should always be installed with a slight preload, and to provide this the actual centre distance is obtained by increasing the theoretical by 0.07%. Manufacturing tolerances should always be on the plus side. Further advice on centre distance requirements can be obtained from Cross+Morse Engineering.
9. As more than one pitch of chain could be selected for most applications consideration should be given that the shaft centre distance should never exceed 60 times pitch, and that large pitch, narrow width selections are better for shock loading and commercial considerations; however, small pitch chains operating on sprockets with high numbers of teeth give smoothest drives with minimum noise level. Whilst preliminary drive selection can be made from the tables it is recommended that all ‘HV’ Drives be referred to Cross+Morse Engineering Department for final approval.
10. The design and manufacture of the sprockets is critical for correct drive operation. General dimensional details are provided on page 81. Sprockets with 35 teeth or less are best manufactured from low carbon alloy steels with teeth carburised and hardened. Larger sprockets can be manufactured from medium carbon steels or mecanite castings and induct or flame hardened. Teeth must be generated to the special involute form for smooth drive operation.
   For 1:1 drives it is preferable to use even tooth sprockets for smooth drive, but on all reduction drives it is best to use odd number teeth in small sprocket for maximum drive life. Idler sprockets should never be used. Cross+Morse can offer the full range of ‘HV’ sprockets - manufactured to meet customers requirements. If not specified, through bore length, hub diameter and all manufacturing tolerances will be Morse Standards. Materials and Tooth hardness will always be to Morse Specification.
HV Chain - Selection Tables (kW)

The tables below provide power ratings in kW for chains of 1” width. To obtain capacity of other widths multiply width (inches) by rating obtained from table. Whilst tables cover sprockets from 21 teeth, it is recommended to use a minimum of 25 teeth for maximum chain performance and life. Preliminary selection can be made with these tables, but it is recommended that all selections should be confirmed with Cross & Morse Engineering prior to implementation. For applications with powers and/or speeds outside tables, consult Cross+Morse Engineering.

1/4” Pitch - HV3
Chain Type 63-139
Stock Widths: 3/4”, 1”, 1 1/2”, 2”, 3”

1/8” Pitch - HV4
Chain Type 63-139
Stock Widths: 1”, 1 1/2”, 2”, 3”, 4”

1/8” Pitch - HV6
Chain Type 63-139
Stock Widths: 1 1/2”, 2”, 3”, 4”, 5”

1” Pitch - HV8
Chain Type 63-139
Stock Widths: 2”, 3”, 4”, 5”, 6”

1/8” Pitch - HV12
Chain Type 61-115
Stock Widths: 3”, 4”, 5”, 6”

2” Pitch - HV16
Chain Type 61-115
Stock Widths: 3”, 4”, 5”, 6”

It is essential that drives selected in the area right of the tinted area are fitted with a pressure fed spray lubrication system. Other drives can operate in oil bath lubrication.

Note: Other widths of chain up to 8 times pitch can be supplied to order.
## HV Chain Dimensions

### Chain Dimensions - Imperial Widths

<table>
<thead>
<tr>
<th>'HV' Chain Designation</th>
<th>Nominal Width Inches</th>
<th>Chain Pitch Ins (mm)</th>
<th>Chain Height Above Spkt. PCD A mm</th>
<th>Chain Height B mm</th>
<th>Min Width between Guides C mm</th>
<th>Width over Rivet Pin F mm</th>
<th>Width over Drilled Pins E mm</th>
<th>Average U.T.S. kN</th>
<th>Ave. Weight per Metre kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>HV-303 3/4 type HV</td>
<td>3/4</td>
<td>20.6</td>
<td>22.7</td>
<td>26.1</td>
<td>25</td>
<td>1.0</td>
<td>33</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>HV-304 1</td>
<td>23.8</td>
<td>26.9</td>
<td>29.1</td>
<td>32.5</td>
<td>33</td>
<td>1.0</td>
<td>33</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>HV-305 1.1/4</td>
<td>30.2</td>
<td>33.5</td>
<td>35.5</td>
<td>38.9</td>
<td>42</td>
<td>1.6</td>
<td>42</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>HV-306 1.1/2</td>
<td>36.6</td>
<td>39.7</td>
<td>41.9</td>
<td>45.3</td>
<td>50</td>
<td>1.9</td>
<td>50</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>HV-308 2</td>
<td>49.4</td>
<td>52.5</td>
<td>54.7</td>
<td>58.1</td>
<td>67</td>
<td>2.6</td>
<td>67</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>HV-312 3</td>
<td>74.8</td>
<td>77.9</td>
<td>80.1</td>
<td>83.5</td>
<td>100</td>
<td>3.9</td>
<td>100</td>
<td>3.9</td>
<td></td>
</tr>
</tbody>
</table>

### Rivetted Pin Assembly (showing both styles)

- **Connecting Pin**
- **Spiral Pin Type**
- **All Pitches**

### Press Fit Guide Links

- 3/8", 1/2", 3/4" and 1" Pitch 'HV' Type 63
- 3/4", 1", 11/2" and 2" Pitch 'HV' Type 61

### Press Fit Washers

- 3/4", 1", 11/2" and 2" Pitch 'HV' Type 61

For notes see page 80

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**For questions or inquiries, please contact:**

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