‘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″ pitch 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.

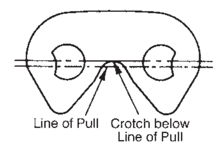
‘HV’ Chain Design

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 - 3/4″, 1″, 1½″ 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 ½″ 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.

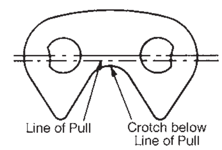
Fig. 1



Type 61-115

Chain Pitches 11/2 and 2 inch plus 3/4 and 1 inch for replacement

Fig. 2



Type 63-139

Chain Pitches 3/8, 1/2, 3/4 and 1 inch

HV Chain Link Plates

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.

Fig. 3

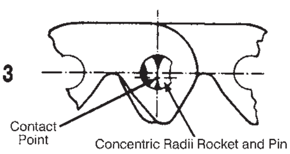
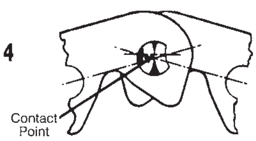


Fig. 4



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.

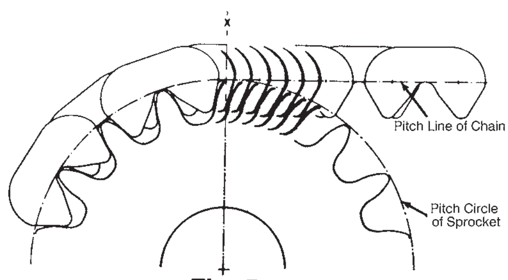


Fig. 5

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%.

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'HV' Chain - Selection

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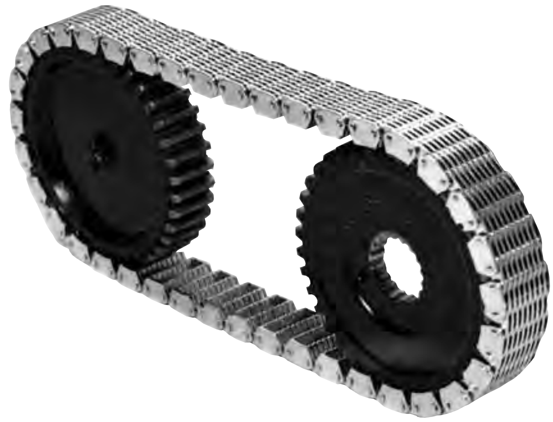
There are Seven good reasons to use HV in your design!

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.

Type of Load	Int. Comb. Eng. Hydraulic Drive	Electric Motor	Int. Comb. Eng. Mechanical Drive
Smooth	1.0	1.0	1.2
Moderate Shock	1.2	1.3	1.4
Heavy Shock	1.4	1.5	1.7

'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 $PCD \approx \frac{Zp}{\pi}$
   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:

   $$\frac{\text{RPM high speed shaft:}}{\text{RPM slow speed shaft:}} = \text{Ratio}$$

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 mechanite castings and induction 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.

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HV Chain - Selection Tables (kW)

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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.

3/8" Pitch - HV3
Chain Type 63-139

Stock Widths:
3/4″, 1″, 1 1/2″, 2″, 3″

No. Teeth	RPM														
	1500	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000	7500	8000	9000
21	19	25	31	37	42	48	53	58	62	66	70	73	76	78	80
23	21	27	34	40	46	52	57	62	66	70	74	77	79	80	81
25	22	29	36	43	50	56	61	66	70	74	77	79	80	81	
27	24	32	39	47	53	59	65	69	74	77	79	80	81		
29	26	34	42	50	56	62	68	72	76	79	80	81			
31	28	36	45	52	59	65	71	75	78	80	81				
35	31	41	50	58	65	71	76	79	80	81					
39	34	45	54	63	70	75	79	80							
45	39	51	61	69	76	80	81								

1/2" Pitch - HV4
Chain Type 63-139

Stock Widths:
1″, 1 1/2″, 2″, 3″, 4″

No. Teeth	RPM														
	1000	1250	1500	1750	2000	2500	3000	3500	4000	4500	5000	5500	6000	6500	7000
21	26	32	39	45	51	63	74	85	95	104	112	119	125	129	132
23	28	35	42	49	56	68	80	92	102	111	118	125	129	132	133
25	30	38	46	53	60	74	86	98	109	117	125	129	132	133	
27	33	41	49	57	65	79	92	104	114	122	128	132	133		
29	35	44	53	61	69	84	97	109	119	126	131	133			
31	38	47	56	65	74	89	103	115	124	130	133				
35	43	53	63	72	82	98	112	123	130	133					
39	48	59	70	80	89	106	120	129	133						
45	54	67	79	89	100	117	128	133							

3/4" Pitch - HV6
Chain Type 63-139

Stock Widths:
1 1/2″, 2″, 3″, 4″, 5″

No. Teeth	RPM														
	600	900	1200	1500	1800	2100	2400	2700	3000	3300	3600	3900	4200	4500	4800
21	33	48	64	79	94	107	120	132	143	153	161	168	172	176	177
23	36	53	70	86	101	116	129	142	152	161	168	174	177	177	176
25	39	57	75	93	110	125	138	150	160	168	174	177	177	175	170
27	42	62	81	100	117	132	146	157	166	173	176	177	175		
29	45	66	86	106	124	139	153	164	171	177	177	175			
31	48	71	92	113	130	146	160	169	175	177	175				
35	54	79	103	124	143	158	169	176	177	173					
39	60	87	113	136	154	168	176	177	172						
45	69	99	127	150	166	177	175								

1" Pitch - HV8
Chain Type 63-139

Stock Widths:
2″, 3″, 4″, 5″, 6″

No. Teeth	RPM														
	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3300	3600
21	54	72	89	105	121	136	150	163	174	185	195	202	208	214	215
23	59	78	96	114	130	146	161	174	186	195	203	210	214	215	212
25	64	84	104	123	140	156	171	184	195	204	210	214	215	212	200
27	69	91	112	131	150	166	180	193	203	210	214	215	213	203	
29	74	97	119	139	159	175	189	200	209	214	215	213	206		
31	79	104	127	148	167	183	197	207	213	215	213	206			
35	89	116	140	163	182	197	208	214	215	210					
39	98	127	154	176	195	207	214	215	208						
45	112	145	171	193	208	215	213	200							

1 1/2" Pitch - HV12
Chain Type 61-115

Stock Widths:
3″, 4″, 5″, 6″

No. Teeth	RPM														
	200	400	600	800	1000	1200	1400	1500	1600	1800	2000	2100	2200	2400	2500
21	29	58	85	111	135	155	172	179	185	193	196	195	195	184	142
23	32	63	93	121	144	165	181	187	191	196	194	190	183	151	
25	35	68	100	129	154	174	188	192	195	194	186	172			
27	37	73	107	138	162	182	193	195	196	189					
29	40	79	115	146	171	188	196	195	193	173					
31	43	84	121	153	177	193	196	192	186						
35	48	94	135	167	188	196	188	172							
39	53	104	147	178	195	192									
45	62	117	163	191	194										

2" Pitch - HV16
Chain Type 61-115

Stock Widths:
3″, 4″, 5″, 6″

No. Teeth	RPM														
	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1500	1700	1800
21	47	70	92	114	134	153	170	186	199	210	219	224	226	215	203
23	51	77	101	124	145	165	181	197	210	219	225	227	219	194	
25	56	83	109	134	155	175	193	207	218	225	227	225	205		
27	60	90	117	143	166	186	202	215	224	227	225	217	182		
29	65	95	124	151	175	195	210	222	227	226	219	204			
31	69	102	132	160	183	203	217	225	227	221	207				
35	78	114	147	175	199	216	225	227	218	198					
39	86	125	160	189	211	224	227	217	195						
45	98	142	179	207	224	227	213	182							

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.

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HV Chain Dimensions

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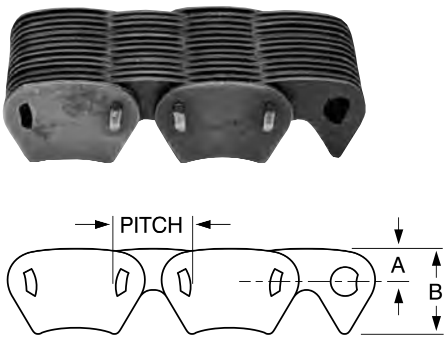
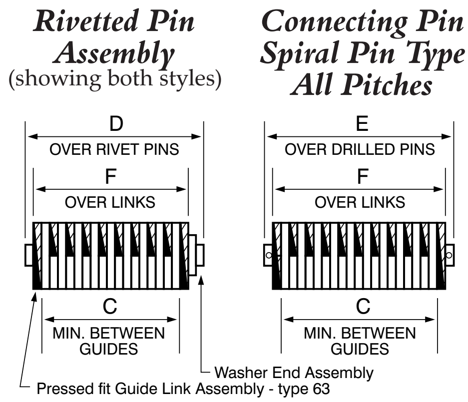
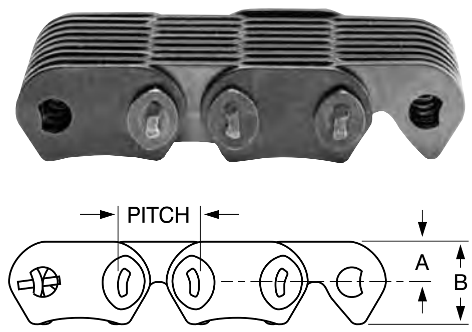


³/₈″, ½″, ¾″ and 1″ Pitch 'HV' Type 63
(Press Fit Guide Links)





¾″, 1″, 1½″ and 2″ Pitch 'HV' Type 61
(Press Fit Washers)

Chain Dimensions - Imperial Widths

'HV' Chain Designation	Nominal Width Inches	Chain Pitch ins (mm)	Chain Height above Spkt. PCD A mm	Chain Height B mm	Min Width between Guides C mm	Width over Links F mm	Width over Rivet Pin D mm	Width over Drilled Pins E mm	Average U.T.S. kN	Ave. Weight per Metre kg
3/8" PITCH 63 type HV										
HV-303	3/4	3/8" (9.525)	4.3	10.9	17.4	20.6	22.7	26.1	25	1.0
HV-304	1				23.8	26.9	29.1	32.5	33	1.3
HV-305	1.1/4				30.2	33.5	35.5	38.9	42	1.6
HV-306	1.1/2				36.6	39.7	41.9	45.3	50	1.9
HV-308	2				49.4	52.5	54.7	58.1	67	2.6
HV-312	3				74.8	77.9	80.1	83.5	100	3.9
1/2" PITCH 63 type HV										
HV-403	3/4	1/2" (12.70)	5.7	14.5	17.4	20.6	22.7	26.1	33	1.3
HV-404	1				23.8	26.9	29.1	32.5	44	1.7
HV-405	1.1/4				30.2	33.5	35.5	38.9	55	1.3
HV-406	1.1/2				36.6	39.7	41.9	45.3	67	2.6
HV-408	2				49.4	52.5	54.7	58.1	89	3.4
HV-410	2.1/2				62.1	65.3	67.4	70.8	111	4.3
HV-412	3				74.8	77.9	80.1	83.5	133	5.1
HV-416	4				100.2	103.4	105.5	108.9	178	6.8
3/4" PITCH 63 type HV										
HV-606/139	1.1/2	3/4" (19.05)	9.8	21.7	36.3	40.5	43.3	47.4	100	4.0
HV-608/139	2				49.0	53.2	56.0	60.1	133	5.3
HV-612/139	3				74.4	78.6	81.4	85.5	200	7.9
HV-616/139	4				99.8	104.0	106.8	110.9	267	10.5
HV-620/139	5				125.2	129.4	132.2	136.3	334	13.0
HV-624/139	6				150.6	154.8	156.6	161.7	400	15.6
1" PITCH 63 type HV										
HV-808/139	2	1" (25.40)	11.4	29.0	48.0	54.2	58.1	64.7	178	7.1
HV-812/139	3				73.4	79.6	83.5	90.1	267	10.5
HV-816/139	4				98.8	105.0	108.9	115.5	356	13.9
HV-820/139	5				124.2	130.4	134.3	140.9	445	17.4
HV-824/139	6				149.6	155.8	159.7	166.3	534	20.8
3/4" PITCH 61 type HV										
HV-606	1.1/2	3/4" (19.05)	10.3	20.9	31.7	35.9	43.2	43.4	100	3.9
HV-608	2				44.4	48.6	55.9	56.1	133	5.2
HV-612	3				69.8	74.0	81.3	81.5	200	7.7
HV-616	4				95.2	99.4	106.7	106.9	267	10.3
HV-620	5				120.6	124.8	132.1	132.3	334	12.8
HV-624	6				146.0	150.2	156.5	156.7	400	15.3
1" PITCH 61 type HV										
HV-808	2	1" (25.40)	13.7	27.8	41.2	47.4	56.8	57.7	178	6.8
HV-812	3				66.6	72.8	82.2	83.1	267	10.3
HV-816	4				92.0	98.2	107.6	108.5	356	13.7
HV-820	5				117.4	123.6	133.0	133.9	445	17.1
HV-824	6				142.8	149.0	158.4	159.3	534	20.5
1.1/2" PITCH 61 type HV										
HV-1212	3	1/1/2" (38.10)	20.6	41.8	66.6	72.8	89.2	85.2	400	15.5
HV-1216	4				92.0	98.2	109.6	110.6	534	20.5
HV-1220	5				117.4	123.6	135.0	136.0	667	25.7
HV-1224	6				142.8	149.0	160.4	161.4	801	30.8
HV-1232	8				168.2	174.4	185.8	186.8	1067	35.9
2" PITCH 61 type HV										
HV-1612	3	2" (50.80)	27.4	55.7	63.7	72.0	86.4	87.0	534	20.5
HV-1616	4				89.1	97.4	111.8	112.4	712	27.4
HV-1620	5				114.5	122.8	137.2	137.8	890	34.2
HV-1624	6				139.9	148.2	162.6	163.2	1068	41.1
HV-1632	8				190.7	199.0	213.4	214.0	1424	47.9

For notes see page 80

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