

Design of Windlass Wildcats for Floating Offshore Structures

API BULLETIN 2S
SECOND EDITION, NOVEMBER 1995

REAFFIRMED, JANUARY 2001



AMERICAN PETROLEUM INSTITUTE

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FOREWORD

The purpose of this document for windlass wildcats is to provide major design considerations to ensure proper fit and function between wildcat and mooring chain. The formulation of the data is based on technology developed through historical design and application. It is recognized that various windlass wildcat designs, other than that shown in this document, do exist and are appropriate for mooring chain handling operations.

This document expresses the need for an intimate working relationship between the wildcat and chain manufacturers, because wildcats are castings and therefore dependent upon variable manufacturing tolerances.

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Suggested revisions are invited and should be submitted to the director of the Exploration and Production Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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Design of Windlass Wildcats for Floating Offshore Structures

1 Scope

1.1 This publication covers cast steel wildcats as used in windlass to haul in the pay-out anchor. An associated chain stopper is used to secure the chain while the vessel is anchored or the anchor is housed.

1.2 Wildcats are of the five-whelp type for use with stud-link anchor chain conforming to the classification society grades 1, 2 and 3, ORQ and Grade 4 chain. Wildcat dimensions are provided for chains in integral $\frac{1}{8}$ -in. (3-mm) steps, ranging in size from 2 in. to 4 in. (51 mm to 102 mm). Wildcat dimensions for chain in intermediate $\frac{1}{16}$ in. (1.5 mm) steps are not provided, but wildcats in these sizes are permitted within the scope of this publication. Wildcats designed in millimeters must be compatible with chain manufactured in millimeters. Wildcats designed in inches must be compatible with chain manufactured in inches.

CAUTION: Compatibility of wildcat and applicable chain standard is necessary.

1.3 Wildcats are configured to pass detachable links oriented parallel or perpendicular to the wildcat shaft centerline.

2 References

The following publications, specifications, and codes are cited herein:

ASTM¹

- A27 *Mid- to Medium-Strength Carbon-Steel Castings for General Application*
- A36 *Standard Specification for Structure Steel*
- A148 *High Strength Steel Castings for Structural Purposes*
- E10 *Standard Test Method for Brinell Hardness of Metallic Materials*

ABS²

American Bureau of Shipping Guide for the Certification of Offshore Mooring Chain

AWS³

American Welding Society Structural Welding Code, Chapter D1.1

¹ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428.

²American Bureau of Shipping, Two World Trade Center, 106th Floor, New York, NY 10048.

³American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

API

Spec 2F *Specification for Mooring Chain*

3 Definitions

A **detachable link** is used to join anchor chain lengths aboard ship and is manufactured in two types as follows:

- a. **Baldd type link:** a "C"-shaped link, closed by means of a pair of closing pieces and a taper pin.
- b. **Kenter link:** two "L" sections interacting to form a unit secured with a stud section and a taper pin.

4 Classification

4.1 The size of the wildcat is identified by the chain size.

4.2 Wildcats are furnished in two types as follows:

- a. Type I—cast from medium strength carbon steel castings to provide a surface hardness of approximately 150 Brinell.
- b. Type II—cast from high strength steel castings to provide a surface hardness of approximately 300 Brinell.

5 Ordering Information

Orders for wildcats recommended under this publication shall include the following information:

- a. Quantity (number).
- b. Size (chain size).
- c. API document designation and date of issue.
- d. Type (I, or II).
- e. Size, grade, and type of chain.
- f. Availability of assembled chain and detachable link to be furnished by the purchaser for test (see Section 9).
- g. As-cast or machined dimensions for wildcat, bore hub width, and outside boss diameter.
- h. Marking (shipping).

6 Materials and Manufacture

6.1 For wear and abrasion considerations, the type of material used for a wildcat shall be dependent upon the grade of chain used (minimum tensile strength) in the system.

- a. ORQ, API—93,000 psi (641 MPa).
- b. Grade 4—124,000 psi (860 MPa).

6.2 The manufacturer's name or identification mark, chain size, and pattern or drawing number shall be cast or stamped on the wildcat, using $\frac{3}{4}$ inch (19 mm) size characters as a

minimum. The marking shall not be on a wearing surface and shall be visible in an assembled windlass.

7 Dimensions

7.1 The wildcat must be fitted to the sample chain and detachable link (see Section 9). Principle dimensions of Type I and Type II wildcats for chain in steps of 1/8 inch (3 mm) are shown in Tables 1 and 2 for information only. “ A_1 ” dimension is the standard slot opening when a “C”-type detachable link is used. “ A_0 ” is the standard slot opening when a Kenter link is used.

7.2 The dimensions in Tables 1 and 2 are developed in accordance with 7.2.1 to 7.2.5. The “ R ” value shall be selected to suit applicable chain tolerance. The “ R_1 ” dimension will vary as the minimum and maximum of “ R ” to allow for clearance of chain link weld.

7.2.1 Bottom of chain pockets are relieved to clear enlargements occurring at centers of chain links manufactured.

7.2.2 Each face of the whelp is a partial frustrum of a cone so developed that each link whose plane is parallel to the wildcat shaft centerline will have end play as noted in Tables 1 and 2. This end play provides clearance between the non-bearing side of the whelp and the end of the next following link, whose centerline plane is parallel to the axis of the shaft.

7.2.3 The inner surfaces of the chain pockets, that form the flanges of the wildcat, are flat surfaces forming together the frustrums of pentagonal pyramids. The traces of the intersections of these flat surfaces or side of the frustrums, coincide with the centerline of the whelps.

7.2.4 The trace of the intersection of the plane at the bottom of the chain pocket and the side of the whelp forms a hyperbolic section of a cone and is therefore a curved line.

7.2.5 Wildcat radii are to be as follows (all dimensions in same units—refer to Figures 1 and 2):

R = a centerline radius representing a section view of a cylinder around which the pocketed links lie tangent.

$$R_{\min.} = 5.34d$$

$$R_{\max.} = 5.43d$$

$$R_1 = R - 0.05d$$

R_2 = a centerline radius representing the bottom of the groove around the center of the wildcat.
 $R_2 = 4.0d$ (approx.)

R_3 = mean effective radius, measured to the outside center of a link laying in the displaced position in a pocket.

L = overall length of link

g = link grip

$$\sin 18^\circ = 0.30902$$

$$\cos 18^\circ = 0.95106$$

$$R_3 = \frac{\sqrt{\left(\frac{g}{0.30902}\right)^2 + \left(\frac{d}{0.95106}\right)^2}}{2}$$

R_4 = a single arc blended with the contact plane of the whelp from the line of center.

$$R_4 = L - 3.36d \text{ or}$$

$$R_4 = 2.64d \text{ (approx.)}$$

R_5 = a radius fielded between the outer edge of the whelp flank and a projected line from the bottom contact plane of a link laying flat across the whelp.

8 Workmanship, Finish, and Appearance

8.1 Castings shall be smooth, of fine grain, and free of cracks, hot tears, and blow holes that are detrimental to end use.

8.2 Castings shall have all flash material, vents, and gates removed and ground flush to match the surrounding surface.

8.3 The outside faces of the wildcat flanges are to be machined to the extent necessary to rotate in true planes.

8.4 Pockets and whelps shall be symmetric inches. This refers to the wildcat's central plan.

8.5 Contact points between the chain and wildcat shall be smooth and symmetric.

9 Test

9.1 To test the fit of the sample chain on the wildcat, a nine-link sample shall be used, consisting of five joined common links, one detachable link, and three joined common links. The sample chain shall be uniform, representative of the chain to be used, and conform to regulating society standards.

9.2 The sample chain shall wrap tightly around the wildcat, starting with the first common link in a pocket. The link grip dimension of the closure (gap) shall not exceed the link grip length or be less than the link grip length minus 3/8 times the chain size (refer to Figure 3).

9.3 The dimensions of the wildcat may be reduced by chipping, grinding, or air-arc cutting for an acceptable fit. If

air-arc cutting is used, not less than the last $\frac{1}{8}$ in. (3 mm) of material shall be removed to a smooth contour by grinding. Flame cutting shall not be used.

9.4 By consent of the purchaser, weld cladding or hard surfacing may be used to build up chain contact surfaces for an acceptable chain fit. The Brinell hardness of the finished weld deposit shall be the same as that of the adjacent area of the base material.

10 Inspection

After cleaning by sand or shot blasting, the wildcat shall be visually inspected for surface discontinuities, workmanship, finish, and appearance.

11 Marking (Shipping)

Each wildcat, when furnished as a separate component, shall be marked with chain size standard designations, purchase order, and item number.

12 Packaging

Wildcats, when finished as separate components, shall be crated, skidded, or attached to a pallet in a manner acceptable for handling by a common carrier. When wildcats are furnished with machined bore and hub, machined surfaces will be protected against corrosion in open weather storage for periods of at least one year.

Table 1—Dimensions in Inches

Size of Chain	$R_{min.}$	$R_{max.}$	R_2	R_3	X	A_0	A_1	B	O	P	S	T	U	V	R_4	R_5	End Play of Link
2	10 $\frac{1}{16}$	10 $\frac{3}{16}$	7.50	12.99	5 $\frac{1}{4}$	3 $\frac{3}{16}$	3	8 $\frac{3}{4}$	1 $\frac{1}{4}$	3 $\frac{3}{16}$	4 $\frac{1}{2}$	7 $\frac{1}{4}$	2	$\frac{1}{2}$	5 $\frac{1}{4}$	3 $\frac{3}{4}$	1 $\frac{3}{4}$
2 $\frac{1}{2}$	11 $\frac{3}{8}$	11 $\frac{1}{2}$	8.00	13.80	5 $\frac{5}{16}$	3 $\frac{1}{2}$	3 $\frac{1}{2}$	8 $\frac{7}{8}$	1 $\frac{1}{2}$	3 $\frac{1}{2}$	4 $\frac{13}{32}$	7 $\frac{5}{8}$	2 $\frac{1}{2}$	$\frac{7}{32}$	5 $\frac{3}{8}$	4 $\frac{1}{4}$	1 $\frac{7}{8}$
2 $\frac{3}{4}$	12	12 $\frac{3}{8}$	8.75	14.62	5 $\frac{7}{8}$	3 $\frac{3}{4}$	3 $\frac{3}{4}$	9 $\frac{1}{4}$	1 $\frac{3}{4}$	3 $\frac{3}{4}$	4 $\frac{3}{4}$	7 $\frac{3}{2}$	2 $\frac{3}{4}$	$\frac{9}{16}$	5 $\frac{15}{16}$	4 $\frac{3}{4}$	1 $\frac{1}{2}$
2 $\frac{7}{8}$	12 $\frac{1}{2}$	12 $\frac{1}{2}$	9.25	15.42	6 $\frac{1}{8}$	3 $\frac{7}{8}$	3 $\frac{7}{8}$	9 $\frac{3}{4}$	1 $\frac{1}{2}$	4 $\frac{1}{4}$	5 $\frac{1}{16}$	8 $\frac{1}{8}$	2 $\frac{3}{4}$	$\frac{9}{32}$	6 $\frac{1}{4}$	4 $\frac{15}{16}$	1 $\frac{1}{2}$
2 $\frac{1}{2}$	13 $\frac{1}{2}$	13 $\frac{3}{8}$	10.00	16.24	6 $\frac{1}{2}$	4	3 $\frac{3}{4}$	10 $\frac{1}{4}$	1 $\frac{1}{2}$	4 $\frac{7}{16}$	5 $\frac{3}{8}$	8 $\frac{15}{16}$	2 $\frac{1}{2}$	$\frac{5}{8}$	6 $\frac{3}{8}$	5 $\frac{1}{4}$	1 $\frac{1}{8}$
2 $\frac{3}{4}$	14 $\frac{1}{2}$	14 $\frac{1}{4}$	10.50	17.05	6 $\frac{13}{16}$	4 $\frac{3}{16}$	3 $\frac{3}{4}$	10 $\frac{3}{4}$	1 $\frac{1}{2}$	4 $\frac{9}{32}$	5 $\frac{5}{8}$	9 $\frac{3}{8}$	2 $\frac{3}{4}$	$\frac{21}{32}$	6 $\frac{15}{16}$	5 $\frac{3}{8}$	1 $\frac{1}{8}$
2 $\frac{7}{8}$	14 $\frac{3}{4}$	14 $\frac{1}{2}$	11.00	17.86	7 $\frac{1}{8}$	4 $\frac{1}{4}$	4	11 $\frac{1}{4}$	1 $\frac{3}{4}$	4 $\frac{3}{8}$	6	9 $\frac{9}{16}$	2 $\frac{3}{4}$	$\frac{11}{16}$	7 $\frac{1}{4}$	5 $\frac{1}{4}$	1 $\frac{1}{16}$
2 $\frac{1}{2}$	15 $\frac{1}{2}$	15 $\frac{1}{8}$	11.50	18.67	7 $\frac{1}{4}$	4 $\frac{1}{2}$	4 $\frac{1}{4}$	11 $\frac{3}{4}$	1 $\frac{3}{4}$	5 $\frac{1}{16}$	6 $\frac{3}{16}$	10 $\frac{3}{8}$	2 $\frac{3}{4}$	$\frac{3}{2}$	7 $\frac{3}{8}$	5 $\frac{15}{16}$	1 $\frac{3}{4}$
3	16 $\frac{1}{2}$	16 $\frac{1}{4}$	12.00	19.48	7 $\frac{3}{4}$	4 $\frac{3}{4}$	4 $\frac{3}{4}$	12 $\frac{1}{4}$	1 $\frac{1}{2}$	5 $\frac{1}{4}$	6 $\frac{1}{2}$	10 $\frac{1}{2}$	3	$\frac{3}{4}$	7 $\frac{15}{16}$	6 $\frac{3}{16}$	1 $\frac{3}{8}$
3 $\frac{1}{8}$	16 $\frac{3}{4}$	16 $\frac{1}{8}$	12.50	20.30	8 $\frac{1}{8}$	5	4 $\frac{1}{2}$	12 $\frac{1}{2}$	1 $\frac{1}{2}$	5 $\frac{1}{8}$	6 $\frac{1}{4}$	11 $\frac{1}{8}$	3 $\frac{1}{4}$	$\frac{29}{32}$	8 $\frac{1}{4}$	6 $\frac{1}{4}$	1 $\frac{1}{8}$
3 $\frac{1}{4}$	17 $\frac{1}{2}$	17 $\frac{1}{8}$	13.00	21.10	8 $\frac{3}{8}$	5 $\frac{1}{8}$	4 $\frac{3}{4}$	13 $\frac{1}{4}$	1 $\frac{1}{2}$	5 $\frac{3}{8}$	7 $\frac{1}{8}$	11 $\frac{3}{8}$	3 $\frac{1}{4}$	$\frac{15}{16}$	8 $\frac{3}{8}$	6 $\frac{3}{8}$	2
3 $\frac{3}{8}$	18	18 $\frac{3}{8}$	13.50	21.92	8 $\frac{1}{2}$	5 $\frac{1}{4}$	5	13 $\frac{3}{4}$	2	6 $\frac{1}{2}$	7 $\frac{3}{16}$	12 $\frac{1}{8}$	3 $\frac{3}{8}$	$\frac{27}{32}$	8 $\frac{15}{16}$	7 $\frac{1}{8}$	2 $\frac{1}{8}$
3 $\frac{1}{2}$	18 $\frac{1}{2}$	19	14.00	22.73	9	5 $\frac{1}{2}$	5 $\frac{1}{4}$	14 $\frac{1}{4}$	2	6 $\frac{3}{8}$	7 $\frac{1}{8}$	12 $\frac{1}{4}$	3 $\frac{1}{2}$	$\frac{7}{4}$	9 $\frac{1}{4}$	7 $\frac{3}{8}$	2 $\frac{1}{4}$
3 $\frac{3}{4}$	19 $\frac{1}{2}$	19 $\frac{1}{8}$	14.50	23.54	9 $\frac{5}{8}$	5 $\frac{3}{4}$	5 $\frac{3}{4}$	14 $\frac{3}{4}$	2 $\frac{1}{2}$	6 $\frac{1}{2}$	7 $\frac{3}{8}$	13	3 $\frac{3}{4}$	$\frac{29}{32}$	9 $\frac{3}{8}$	7 $\frac{1}{2}$	2 $\frac{3}{8}$
3 $\frac{7}{8}$	20	20 $\frac{3}{8}$	15.00	24.35	9 $\frac{3}{4}$	6	5 $\frac{5}{8}$	15 $\frac{1}{4}$	2 $\frac{3}{4}$	6 $\frac{3}{4}$	8 $\frac{1}{4}$	13 $\frac{3}{8}$	3 $\frac{3}{4}$	$\frac{15}{16}$	9 $\frac{7}{8}$	8	2 $\frac{1}{4}$
3 $\frac{1}{2}$	20 $\frac{1}{8}$	21 $\frac{1}{2}$	15.50	25.17	9 $\frac{1}{2}$	6 $\frac{1}{8}$	5 $\frac{1}{2}$	15 $\frac{3}{4}$	2 $\frac{1}{2}$	6 $\frac{3}{8}$	8 $\frac{3}{8}$	13 $\frac{1}{4}$	3 $\frac{3}{4}$	$\frac{3}{2}$	10 $\frac{1}{4}$	8 $\frac{3}{8}$	2 $\frac{3}{8}$
4	21 $\frac{1}{2}$	21 $\frac{3}{4}$	16.00	25.92	10 $\frac{1}{4}$	6 $\frac{1}{2}$	6	16 $\frac{1}{4}$	2 $\frac{3}{4}$	7 $\frac{3}{8}$	8 $\frac{1}{8}$	14 $\frac{3}{8}$	4	1	10 $\frac{3}{8}$	8 $\frac{3}{8}$	2 $\frac{3}{4}$

A_0 — 1.6 × size of chain — max. "A" dim. when Kenter type detachable link is used.

A_1 — 1.48 × size of chain — max. "A" dim. when Baldt type detachable link is used.

Table 2—Dimensions in Millimeters

Size of Chain	$R_{min.}$	$R_{max.}$	R_2	R_3	X	A_0	A_1	B	O	P	S	T	U	V	R_4	R_5	End Play of Link
51	272.3	276.9	204	329.9	133.4	81.3	76.2	212.7	31.8	87.3	105.6	181.0	50.8	12.7	134.6	98.4	34.9
54	288.4	293.2	216	350.5	141.3	86.4	79.4	225.4	34.9	91.3	113.5	193.7	54.0	13.5	142.6	108.0	36.5
58	309.7	314.9	232	371.3	149.2	91.4	85.7	234.0	34.9	99.2	120.7	202.4	57.2	14.3	153.1	117.5	38.1
60	320.4	325.8	240	391.7	157.2	96.5	88.9	247.7	38.1	101.8	128.6	214.3	60.3	15.1	158.4	119.1	38.9
64	341.8	347.2	256	412.5	165.1	101.6	92.1	260.9	38.1	112.7	136.5	227.0	63.5	15.9	168.9	133.8	39.7
67	357.8	363.8	268	433.1	173.0	106.7	98.4	273.1	41.3	116.7	142.9	238.1	66.7	16.7	176.9	136.5	41.3
70	373.8	380.1	280	453.6	181.0	111.8	101.6	285.8	44.5	124.6	152.4	252.4	69.9	17.5	184.8	146.1	42.9
73	389.8	396.4	292	474.2	188.9	116.8	108.0	298.5	44.5	128.6	157.2	261.9	73.0	18.3	192.7	150.8	44.5
76	406.8	412.7	304	494.8	196.9	121.9	111.1	311.2	47.6	133.4	165.1	272.3	76.2	19.1	200.6	160.3	47.6
79	421.9	428.9	316	515.6	204.8	127.0	117.5	323.9	47.6	140.5	172.2	284.2	79.4	19.8	208.6	165.1	49.2
83	443.2	450.7	332	535.9	212.7	132.1	120.7	336.6	47.6	145.3	178.6	288.9	82.6	20.6	219.1	168.3	50.8
86	459.2	466.9	344	556.8	220.7	137.2	127.0	349.3	50.8	153.2	185.7	306.4	85.7	21.4	227.0	179.4	52.4
90	480.6	488.7	360	577.3	228.6	142.2	130.7	362.0	50.8	157.2	192.1	315.9	88.9	22.2	237.6	185.7	54.0
92	491.3	499.6	368	597.9	236.5	147.3	136.5	374.7	54.0	167.5	202.4	330.2	92.1	23.0	242.9	195.3	55.6
95	507.3	515.9	380	618.5	238.1	152.4	142.9	387.4	57.2	171.5	206.4	341.3	95.3	23.8	250.8	203.2	57.2
98	523.3	532.1	392	639.3	252.4	157.5	146.1	408.1	57.2	177.0	214.3	352.4	98.4	24.6	258.7	208.0	58.7
102	544.7	553.9	408	659.9	260.4	162.6	152.4	412.8	60.3	182.6	223.9	360.4	101.6	25.4	269.3	214.3	60.3

A_0 – 1.6 × size of chain – max. “A” dim. when Kenter type detachable link is used.

A_1 – 1.48 × size of chain – max. “A” dim. when Baldt type detachable link is used.

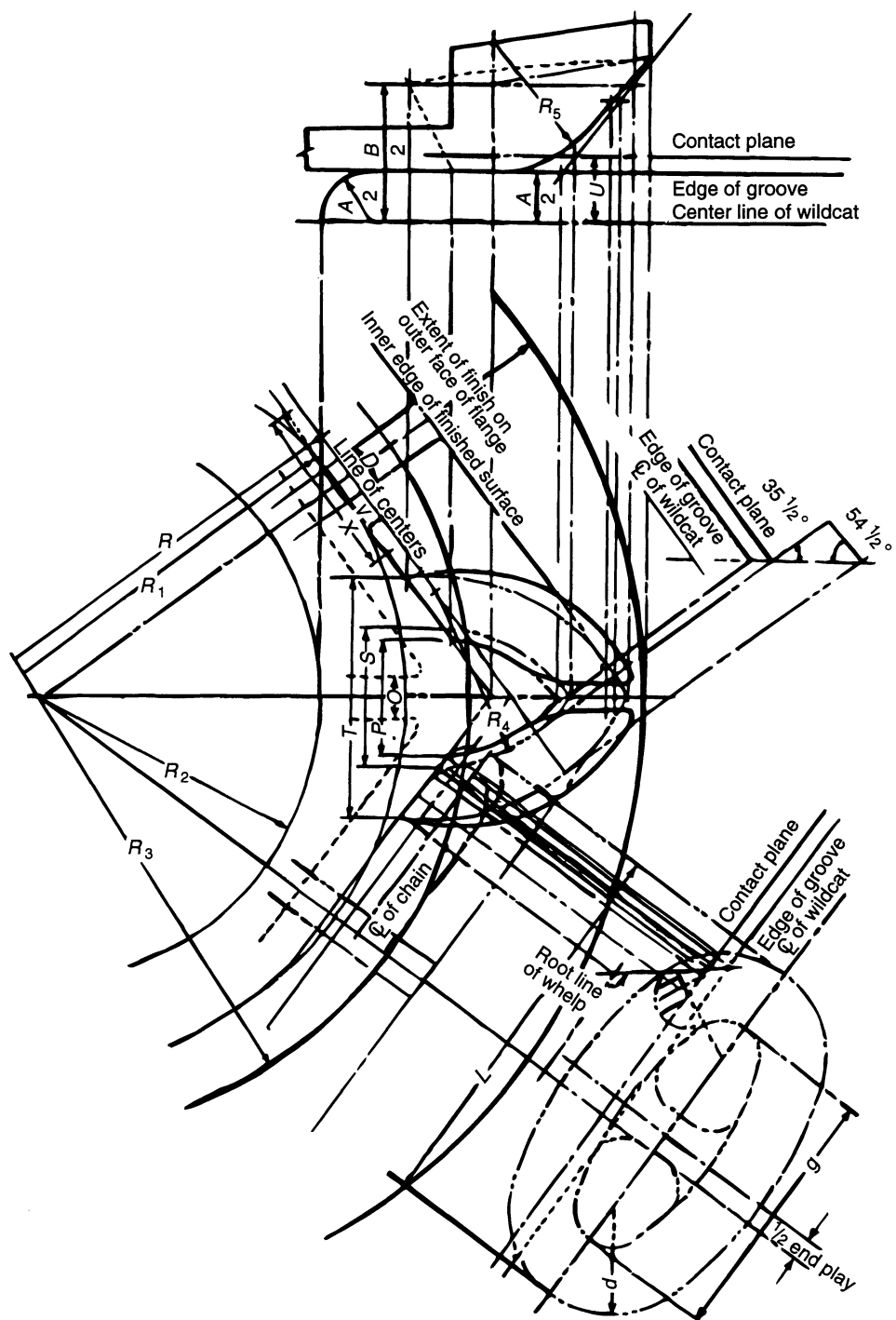


Figure 1—Wildcat Development

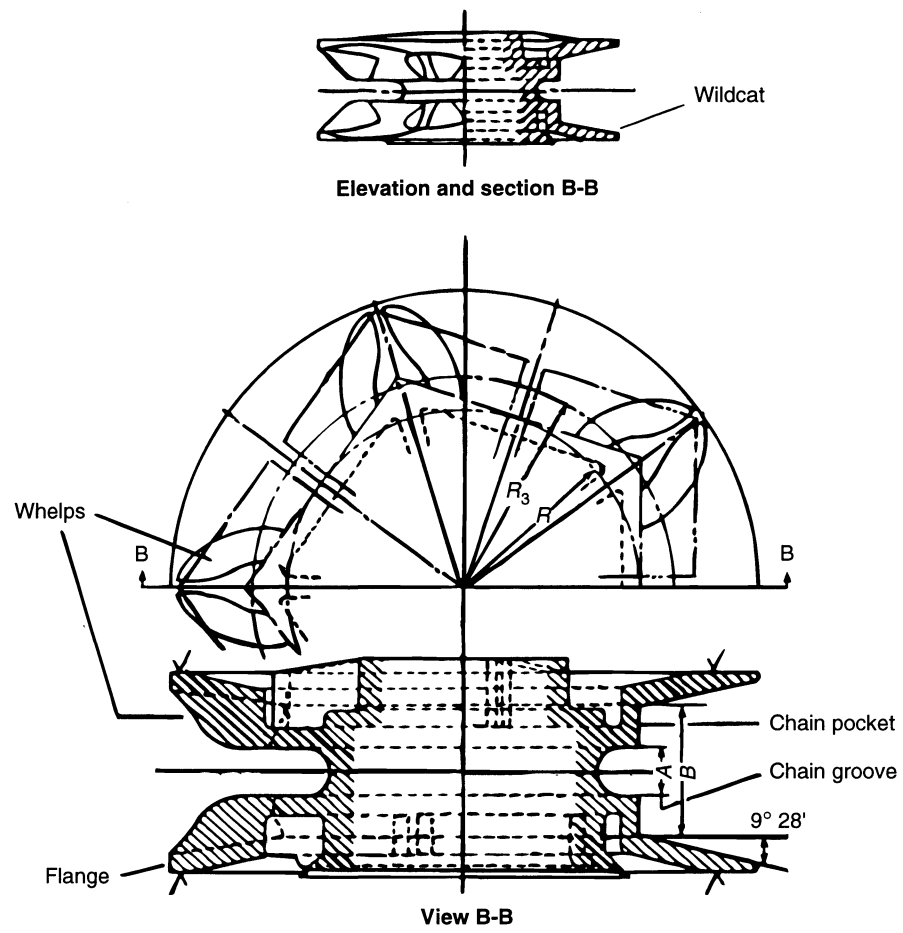


Figure 2—Wildcat Sections

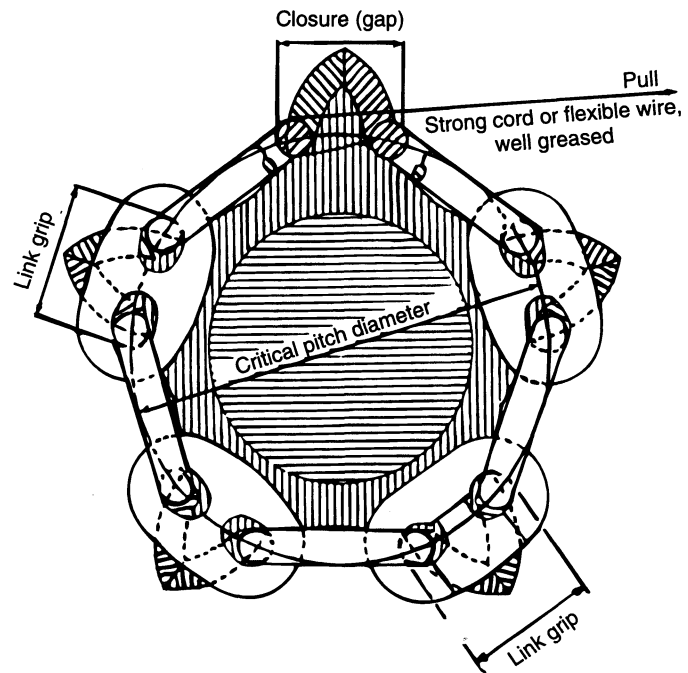


Figure 3—Chain Wrap Test

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