

PENSTOCKS

HAMBAKER

FlowControl

PENSTOCKS



Business Philosophy

- Integrity in management
- Quality of product

HISTORY

HAM BAKER is a name most professionals in the water and wastewater industries will instinctively associate with high quality precision-engineered products. Established over 100



years ago the original company has undergone many changes over the last century and more recently changes of ownership.

The company is acknowledged as the world's leading designer and manufacturer of penstocks and flap valves. Penstocks and other flow control products manufactured by Ham Baker can be found operating in almost every country in the world.

The history of the company began in 1884 as a partnership between Frederick Ham, William Baker and Claude Sansom in London and began manufacturing penstocks in 1886, trading under the name of Ham Baker & Company Ltd. In 1902, Hartleys (Stoke-on-Trent) Ltd was founded as a family owned business in Stoke-on-Trent by William Hartley, who gained his early engineering training in the locomotive industry. Initially the company manufactured general engineering items and began specialising in the manufacture of equipment for the water and wastewater industries in 1904.



The two companies merged in 1998 to create a product range unrivalled throughout the world.

In 2002 the company was acquired by the WTB Group of Bristol and continues its proud 100 year history as a leading innovator in the fields of water and wastewater engineering.

The company now produces a range of products in cast iron, ductile iron, stainless steel and plastic to deal with every aspect of fluid control.

15 Reasons Why customers choose Ham Baker

1. Reputation

We hold an esteemed reputation globally, for well engineered, high quality equipment.

2. Service

Unsurpassed in service, our team of professionals will help you to find the most effective solution. All our personnel have e-mail contactability, even whilst away from the office. The business world is moving faster exponentially, and we aim always, to move with it.

3. People

We pride ourselves on building long-term, strong relationships with both suppliers and customers to enable us to better understand and meet customer needs.

4. Range

Unique size range with manufacturing capability up to 5m square penstocks.

5. Quality

Our products exceed the requirements of British and American Waterworks Association Standards and, indeed, exceed the quality of most of our competitors. All products are manufactured under a BS EN ISO 9001:2000 certified quality assurance system.

6. Delivery

No other company delivers any faster than us. Spares and Fastrack products are often delivered within hours.

7. Flexibility

One of the very few companies who cater for non-standard requirements. "You draw it... we'll build it".

8. Partnerships: Experienced in Framework Arrangements

We have worked with and continue to work with a number of Water and Sewage Companies in the UK who are committed to value for money when using Ham Baker. A sign of value for money and peace of mind.

9. One Stop Shop

Recognised as the only 'one-stop shop' in penstocks. Design, proposals, specification, supply, fix, repair, spares, aftercare, consultation. Why diversify your time, or multiply the risks with several suppliers, when you can have all the contacts under one roof?

10. Peace of Mind

Readily available library of technical information, built up over 100 years, gives you peace of mind regarding design and maintenance. We have penstocks still in practical working order after over 90 years of continuous service.

11. Brand Name

Ham Baker is a household name of stability, in the water treatment business. Most of our competition is unknown to the end user.

12. Continued Innovation

We are at the leading edge of design and development.

13. Unique

Coplastix Penstocks are the most cost effective penstocks available. Designed and built only by Ham Baker. More cost effective (i.e. lower cost of ownership) than stainless steel or cast iron.

14. Retro Engineering

Designs are on file from over 60 years, to enable parts to be re-engineered, to service older penstocks, meaning lower cost of manufacture, with exact specification.

15. Price

Our products are competitively priced and represent excellent over life-time value for money, when considering all aspects of ownership; cost, installation, maintenance, and long-term performance.

Penstocks



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Penstock / Sluice Gate

A penstock is used to control the flow or level of a liquid and consists of a sliding door controlled by a mechanically operated spindle, which moves over an aperture in a frame, which in turn is secured onto a structure.

'Sluice gate' is more descriptive of the product, and this term is used widely in specifications outside the UK.

The word 'penstock' originates from the days of water mills when it was not uncommon for a pond (stored or 'penned up' water), which was used to feed the water wheel or mill race to be referred to as the 'pen'. The timber stop logs used to control the flow onto the water wheel was called the 'stock'. Later, as the need to accurately control the velocity of the water wheel became more critical, a single sliding gate operated by a lifting mechanism replaced the stop logs with their individual sections. During the 17th century, the words 'pen' and 'stock' became combined into a single word - **PENSTOCK**.



Penstocks Selection Table

THIS INFORMATION IS BASED ON OUR STANDARD RANGE OF PENSTOCK PRODUCTS

Type	Model	Size Range (mm)	Maximum Head (Metres)		Application							Catalogue Page	MOUNTING			
			ON SEATING	OFF SEATING	SEWAGE TREATMENT	WATER TREATMENT	INDUSTRIAL	HYDRO POWER	DOCKYARD	HIGH GRIT CONTENT	REDUCED LEAKAGE		Channel	Wall	Pipe	Thimble
Light Duty Cast Iron Penstocks	SERIES 60	100mm to 1000mm dia.	Varies with Size	6M	x	x	x			x				x	x	
	SERIES 60/30	150mm x 150mm to 2000mm x 2000mm	6M	3M	x	x	x			x				x		x
Light Duty Fabricated Penstocks	PLASTIGATE SERIES 20/20	VARIABLE to 1000mm x 1000mm	2M	2M	x	x	x				x			x		
Light Duty Fabricated Channel Mtd Penstocks	PLASTIGATE SERIES 20/20	VARIABLE to 1000mm x 1000mm	Door Depth	Door Depth	x	x	x				x		x			
	COPLASTIX 20/20	VARIABLE to 2000mm x 2000mm	Door Depth	Door Depth	x	x	x				x		x			
	SERIES 2000 STAINLESS STEEL	VARIABLE to 2000mm x 2000mm	Door Depth	Door Depth	x	x	x				x		x			
Medium Duty Penstocks	SERIES 90/60	150mm x 150mm to 2000mm x 2000mm	9M	6M	x	x	x	x	x	x				x		x
	COPLASTIX SERIES 50/40	VARIABLE to 2000mm x 2000mm	5M	4M	x	x	x				x			x		
	SERIES 2000 STAINLESS STEEL	VARIABLE to 2000mm x 2000mm	10M varies with size	10M varies with size	x	x	x				x			x		
Heavy Duty Cast Iron Penstocks	SERIES 160/80	150mm x 150mm to 3000mm x 3000mm	16M	8M	x	x	x	x	x	x				x		x

FEATURES AND BENEFITS

Below is a list of benefits for the 5 main penstock product types illustrated in our catalogue.

Cast Iron Penstocks

- Robust construction
- High impact resistance
- For use with high grit content applications
- All sewage and water applications
- 50 year service life
- Metal to metal sealing faces

Coplastix® Penstocks

- Materials UV stabilised
- Adjustable pressure pads
- Leakage considerably less than approved standards
- Reduced operating loads
- Door having smooth clean face
- Side wall fixing (no rebate required)
- Non-standard aperture sizes
- Resilient seals

Stainless Steel Fabricated Penstocks

- Adjustable wedging application
- Reduced operating loads
- Leakage considerably less than approved standards
- Mechanically fixed
- Low maintenance seals fitted to door only
- Wall, channel or side wall fixing
- Non-standard aperture sizes can be accommodated
- Individually designed to suit each application
- Resilient seals

Specification for penstocks

Ham Baker has ISO EN 9001:2000 accreditation, and the capability to manufacture a full range of penstocks in accordance with BS7775 or AWWA C501

The terminology used in this brochure is that defined in BS7775. The corresponding terms used in AWWA 501 are given below for reference.

BS7775	AWWA 501
Penstock	Sluice Gate
Door	Slide
Spindle	Stem
Spindle Nut	Thrust Nut
Spindle	
Protection Table	Stem Cover
Metal Seal	Sealing Face
Resilient Seal	Seal
On-Seating Head	Seating Head
Off-Seating Head	Unseating Head
Head Measured from invert of aperture	Head Measured from centreline of aperture

An Introduction to Flow Control

Ham Baker can offer the most comprehensive range of flow control equipment in the world.

The traditional cast iron ranges have been the mainstay of the industry and the development of Ham Baker has created several standard ranges which cover a wide variety of types, sizes and operating conditions. However the wealth of experience gives Ham Baker the ability to design and manufacture penstocks for any duty or size.

Ham Baker in step with its continuous programme of research and development has developed a range of stainless steel fabricated penstocks using the latest technology. Low friction guide blocks are positioned on the frame sides to effect a clearance between the door and the resilient sealing faces attached to the frame upon immediate raising of the door, thus preventing seal drag and minimising wear.

With this comprehensive range of flow control products Ham Baker can help our customers solve all their flow control needs. Because of this extensive range we are not limited to specific duty ranges or technologies but can offer our customers not only a technically suitable solution but also the most cost effective solution.

Penstocks and other flow control products manufactured by Ham Baker can be found operating in almost every country in the world, thus endorsing the statement that Ham Baker is one of the leading penstock manufacturers in the world.

SELECTION

Introduction

The primary application of penstocks is the flow control and isolation of fluids associated with water, waste water, sewage treatment plants, power generation, irrigation schemes and process plants.

The modern penstock is designed to cater for a wide variety of duties from low seating to high off-seating heads in sizes from 150mm to 5000mm square. Selection of the correct penstock to suit the duty is important to satisfy the design criteria and provide the most cost effective solution. Operation of the penstock is governed generally by factors outside the control of the penstock manufacturer. However, the range of available operating equipment is extensive: from simple direct operation by handwheel to complex control systems for electrical, pneumatic or hydraulic actuation. The range of penstocks together with its associated operating equipment will cater for the most demanding specification and application.

This section is intended to assist users in the selection of the most suitable products to meet requirements.

Selection Considerations

When setting out to determine the unit most suited to a particular requirement, the following considerations have to be made:

1. *Size of gate required.*
2. *In which direction is the flow of the fluid to be controlled; will it force the door on to or off its sealing face?*
3. *What is the differential head in metres across the gate in each direction under:*
 - (a) *Static conditions.*
 - (b) *Opening and closing conditions.*
4. *Wall, channel, pipe or thimble mounting.*
5. *Method of operation.*
6. *It is now necessary to make a selection given:*
 - (a) *Basic types available.*
 - (b) *Direction of flow and invert sealing arrangement.*
 - (c) *Mounting position.*
 - (d) *Fixing details.*
 - (e) *Method of operation.*
 - (f) *Accessories.*

Having selected the basic frame type, it is then necessary to specify one of the following alternatives:-

- | | |
|-------------------------------|---|
| A. Is the gate to take | <ul style="list-style-type: none"> - on-seating head? - off-seating head? - on and off-seating head? |
| On-seating head | <ul style="list-style-type: none"> - Pressure forcing the door onto the frame. |
| Off-seating head | <ul style="list-style-type: none"> - Pressure forcing the door away from the frame. |

Modulating penstocks for flow control purposes, where gates may be frequently repositioned and utilise only a proportion of the full stroke, require special consideration and may necessitate:-

- larger than standard stems
- slow operating speeds
- continuously rated motors on actuators
- special heat absorbing drive sleeves

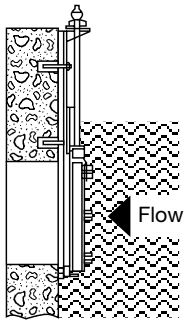
- | | |
|-------------------------------|---|
| B. Is the gate to have | <ul style="list-style-type: none"> - Chased/Rebated invert? - Flush invert? |
|-------------------------------|---|

Chased/Rebated Invert

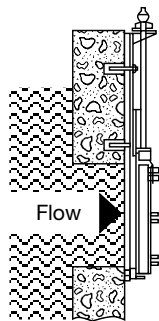
Standard inverts have bronze facings. Seating faces are very carefully bedded onto the door and frame surfaces, and secured with specially designed, long taper countersunk screws of the same material as the faces. They are finally mated to each other resulting in a tight seal.

Flush Inverts

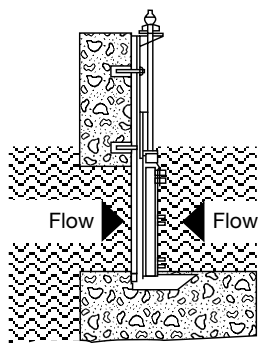
These are available with a resilient sealing strip to produce a laminar flow, improved hydraulics, efficiency and a non-fouling invert.



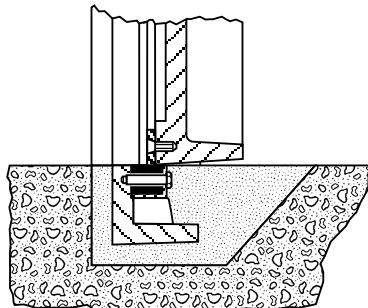
ON-SEATING HEAD



OFF-SEATING HEAD



ON-SEATING/OFF-SEATING CHASED/REBATED INVERT HEAD

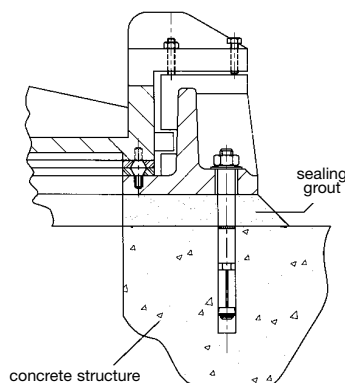


FLUSH INVERT

FIXING METHODS

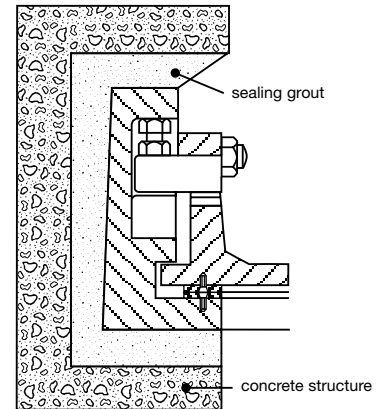
Wall Mounting

Wall mounted penstocks are fixed to vertical end walls of channels, chambers or similar structures by means of foundation bolts utilising a sand/cement non shrink grout to effect a seal between the wall and penstock frame. Foundation bolts can be supplied as an expanding type (as shown opposite), built-in type or chemical resin type.



Channel Mounting

Any of Ham Baker standard penstock units can be mounted in a channel. Channel mounted penstocks are fixed into preformed rebates in the sides and inverts of channels by means of a sand/cement non shrink grout, to effect a seal between the rebate and the penstock frame. Wall mounted penstocks can be installed with foundation bolts and grout, however, the rebate will need to be cast large enough to facilitate normal wall mounting procedures and wedge adjustment.



Wall Thimbles

When high off-seating pressure is specified, careful consideration must be given to the method of fixing the penstock to the structure. The most reliable method of attaching a penstock in such circumstances is by use of a wall thimble.

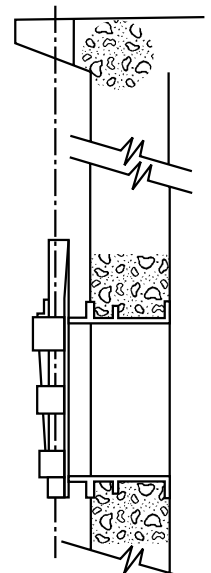
Wall thimble mounting offers the following advantages:-

1. Civil construction can proceed prior to delivery of penstock reducing costs.
2. Considerable keying/anchor area within the concrete structure.
3. Ease of penstock erection and removal for re-siting or cleaning etc.

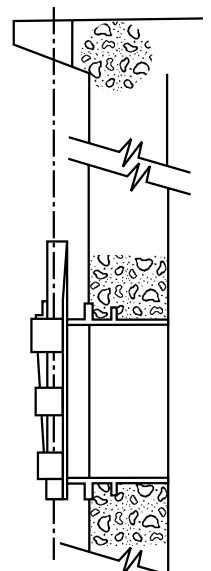
Iron wall thimbles can be supplied in either 'E' or 'F' section, suitable for circular or rectangular openings.

'E' Section for off-seating heads

'F' Section for on-seating heads



'E' SECTION THIMBLE



'F' SECTION THIMBLE

COUPLINGS

There are several methods of connecting sections of spindle together. The type selected will depend upon the application and the duty of the penstock. The most commonly used couplings are illustrated below.

Spindle Adaptor

Manufactured in cast iron, for jointing straight lengths of stem in line. For use with torsional loads only (non-rising stem applications).

Muff Couplings

Manufactured in the same material as the spindle for joining straight lengths of spindle in-line. For use with both axial and torsional loads (rising and non-rising spindle applications).

Two types of coupling are available:-

1. Plain muff coupling.
2. Screwed muff coupling.

The use of a particular type of coupling will depend upon the operating duty and/or the specification.

Universal Joint

Manufactured in mild steel or stainless steel, for joining two straight lengths of spindle in different planes. For transmission of torsional loads only (non-rising stem applications). Universal joints are supplied in pairs for a maximum working angle of 35°.

Protective neoprene gaiters can be supplied for the retention of lubricants in the joints.

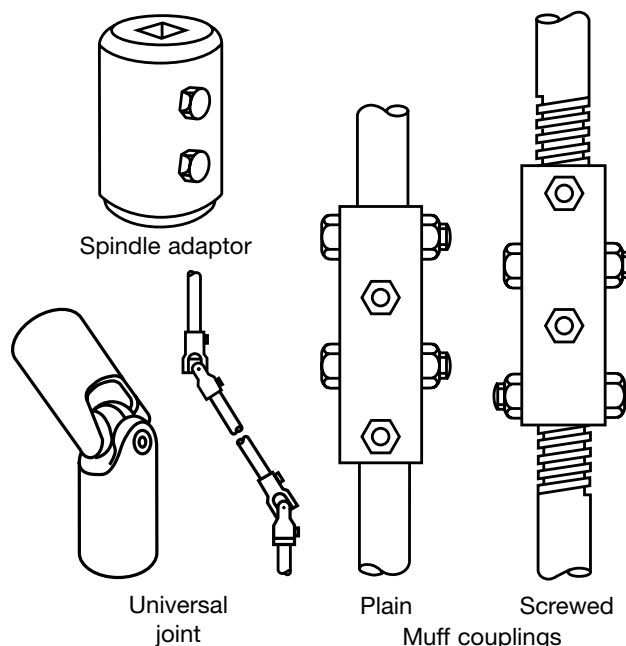
ACCESSORIES

Spindle Guides

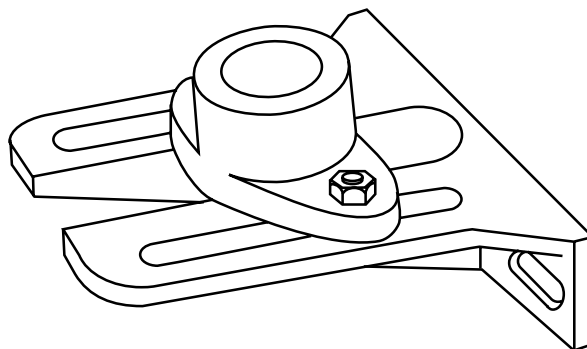
In some cases unsupported lengths of spindle are subjected to buckling under compression or from lateral thrust by debris or solids. Spindle guides are, therefore, necessary as a means of providing intermediate support. Bolt-on type adjustable guides are manufactured in cast iron, normally plain un-machined, but if required they can be bronze lined.

When considering the centres or vertical spacing of the guide, the l/r (length/radius of gyration of the spindle) should not normally exceed 200.

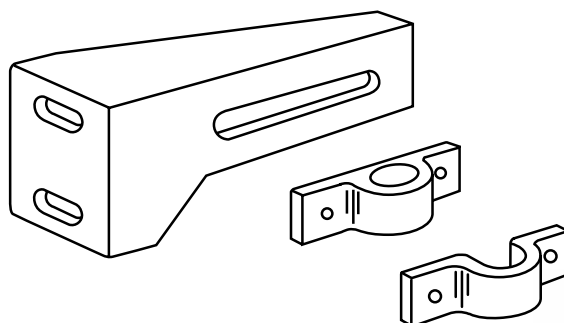
TYPICAL COUPLINGS



TYPICAL SPINDLE GUIDES



Used on larger sizes of penstocks for rising and non-rising spindle applications.



Used on smaller sizes of penstocks for rising and non-rising spindle applications.

Cast Iron Series 60

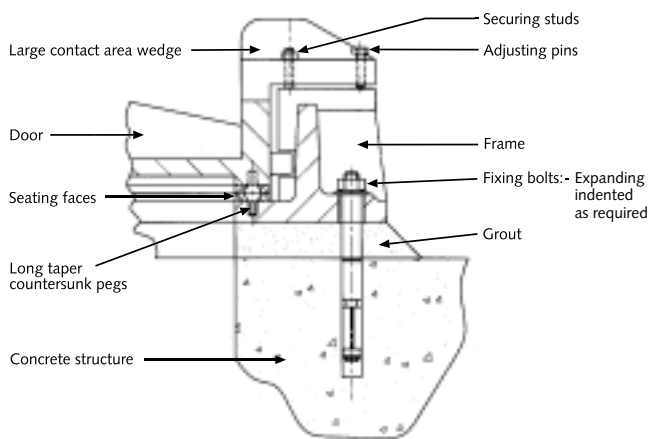
DESCRIPTION

The Series 60 is a circular metal faced penstock suitable for wall and flange mounting application, suitable for on-seating pressure as standard but, dependent on size, will take a degree of off-seating pressure.

Conventional adjustable wedges are positioned around the door as required to suit the duty and provide a practical degree of watertightness.

FEATURES / BENEFITS

- An extensive range of operating equipment can be utilised
- Faced wedges available in the same material as the sealing faces
- Fixing bolts supplied on request
- Flange/pipe mounting (BS EN 1092-2 : PN 16)



TYPICAL SECTION THROUGH SIDE MEMBER

MATERIAL SPECIFICATION

Frame

Constructed in BS EN 1561 min. 250 cast iron designed for wall or flange mounting applications.

Door

Constructed in BS EN 1561 min. 250 cast iron to withstand seating heads up to 6m on and off seating as specified in table below.

Sealing Faces

Sealing faces are bedded to 0.1mm feeler gauge non-acceptance to provide an effective seal. The sealing face material for penstocks up to and including 600mm diameter sizes is to BS EN 1982:1999, sizes above 600mm diameter BS EN 12167:1998.

For sizes up to and including 600mm diameter the sealing faces are force fit, for sizes above 600mm the sealing face is secured to the frame using long countersunk taper screws in the same material as the sealing face.

Side Wedges

Constructed in BS EN 1561 min. 250 cast iron to provide a large contact area with the door. The side wedges are adjustable to accommodate wear during the life of the penstock.

Aperture Size (mm)	Maximum Head (Metres)	
	On-Seat	Off-Seat
100	6	6
150	6	5
200	6	4
250	6	4
300	6	3.5
350	6	3
400	6	3
450	6	2.5
500	6	2.5
600	6	2.5
700	6	1.5
800	6	1.5
900	6	1
1000	6	1

NOTE: Heads taken from invert

Thrust Housing (direct operation)

Manufactured in cast iron to BS EN 1561 min. 250 with low friction thrust washer and lubricator.

Door Nut

Manufactured from phosphor bronze to BS EN 12167:1998 for non-rising stem applications or cast iron to BS EN 1561 min. 250 for rising stem types.

Fasteners

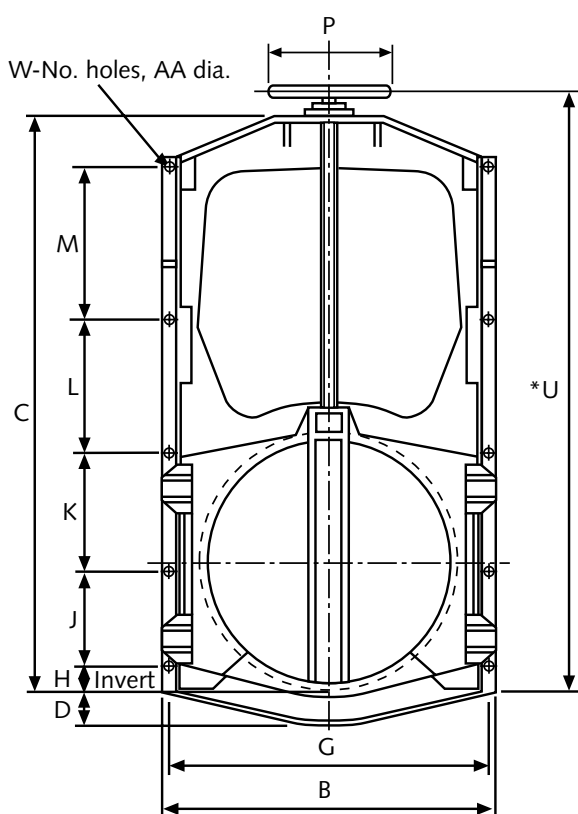
Standard fasteners are supplied in stainless steel to BS EN 10088:1995 grade 1.4401 (316; A4).

Operating Spindles

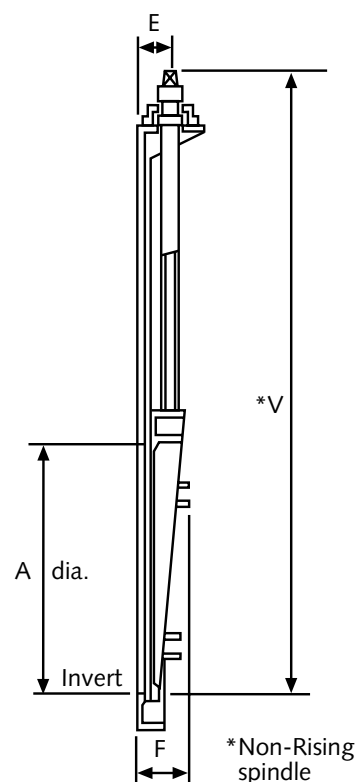
Alternative materials can be supplied for operating spindles and extension.

Methods of Operation

The method of operation will depend upon several factors which are outside the control of the penstock manufacturer, but the range of operating gear available is extensive which can be provided to meet customer requirements. (See page 30)



Thrust Direct



A	B	C	D	E	F	G	H	J	K	L	M	P	U	V	W	AA
DIMENSIONS IN MILLIMETRES																
100	254	285	57	48	78	216	3	197	-	-	-	250	382	445	4	13
150	295	385	65	64	84	251	6	295	-	-	-	250	484	550	4	13
200	390	565	70	55	98	345	25	415	-	-	-	250	675	750	4	13
225	415	615	73	55	98	370	25	450	-	-	-	250	725	800	4	13
250	440	665	78	55	98	395	25	500	-	-	-	250	775	850	4	13
300	495	765	80	55	98	450	25	575	-	-	-	250	875	950	4	13
350	575	885	85	65	118	525	25	650	-	-	-	250	995	1070	4	16
400	625	985	90	65	118	575	25	725	-	-	-	250	1095	1170	4	16
450	675	1085	95	65	118	625	25	400	400	-	-	250	1195	1270	6	16
500	725	1185	108	65	118	675	25	425	450	-	-	250	1290	1395	6	16
600	825	1375	120	65	118	775	25	525	550	-	-	250	1490	1595	6	16
700	915	1610	90	75	146	865	25	450	560	350	-	250	1715	1820	8	16
750	965	1710	90	75	147	915	25	665	420	365	-	250	1815	1920	8	16
800	1015	1810	90	75	148	965	25	525	635	380	-	250	1915	2020	8	16
900	1115	2010	90	75	151	1065	25	440	440	430	410	250	2115	2220	10	16
1000	1215	2210	100	105	168	1165	25	490	490	480	445	400	2325	2425	10	16

Cast Iron Series 60 - 30

DESCRIPTION

The Series 60-30 is a rectangular metal faced penstock suitable for wall and thimble mounting, with on-seating heads up to 6 metres and off-seating heads up to 3 metres. Conventional wedges are positioned each side of the frame to apply a face to the door in the closed position.

OPTIONS

- An extensive range of operating gear can be utilised
- Faced wedges available in the same material as the sealing faces
- Fixing bolts supplied on request
- Sealing faces can be secured to satisfy the requirements of the American Water Works Association specification - AWWA C501-92
- Circular apertures (sealing faces remain rectangular)
- Thimble mounting (See page 6)
- Full and half frames available

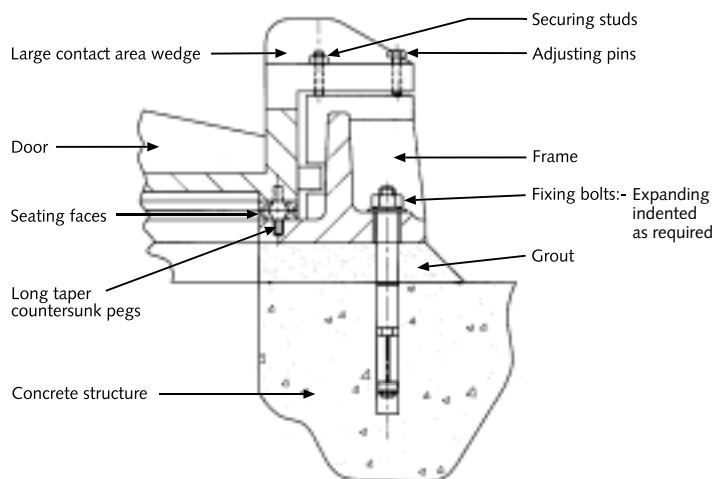
MATERIAL SPECIFICATION

Frame

Constructed in BS EN 1561 min. 250 cast iron for wall or thimble mounting applications.

Door

Constructed in BS EN 1561 min. 250 cast iron designed to withstand seating heads up to 6 metres, and 3 metres off-seating.



TYPICAL SECTION THROUGH SIDE MEMBER

Sealing Faces

Phosphor bronze sealing faces to BS EN 12167:1998 are supplied as the standard material bedded to 0.1mm feeler gauge non-acceptance to provide an effective seal.

Door and Frame

The sealing faces are fixed securely using long taper countersunk pegs in the same material as the sealing face.

Wedges

Constructed in BS EN 1561 min. 250 cast iron to provide a large contact area with the door. The wedges are adjustable to accommodate wear during the life of the penstock.

Flush Invert

The resilient flush invert seal is bolted onto the frame invert member.

Thrust Housing

Manufactured in cast iron to BS EN 1561 min. 250 with low friction washer and lubricator.

Invert Seal

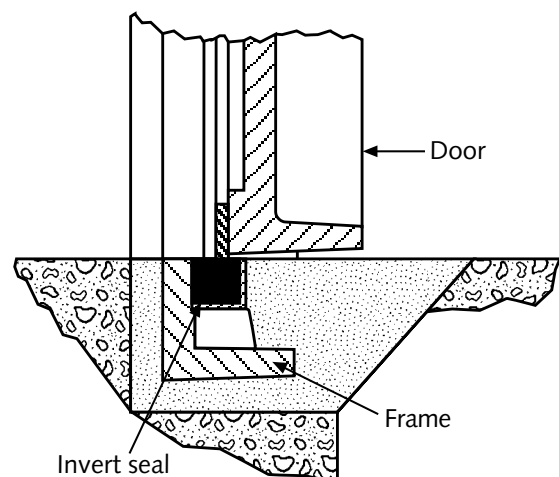
A flush invert is supplied as a standard feature, the seal is manufactured from Ethylene Propylene Di-Methyl (EPDM) to ASTM D2000.

Door Nut

Manufactured from phosphor bronze to BS EN 12167:1998 for non-rising stem applications, or cast iron to BS EN 1561 min. 250 for rising stem types.

Fasteners

Standard fasteners are supplied in stainless steel to BS EN 10088:1995 grade 1.4401 (316; A4).



FLUSH INVERT SECTION & REBATE

Operating Spindles

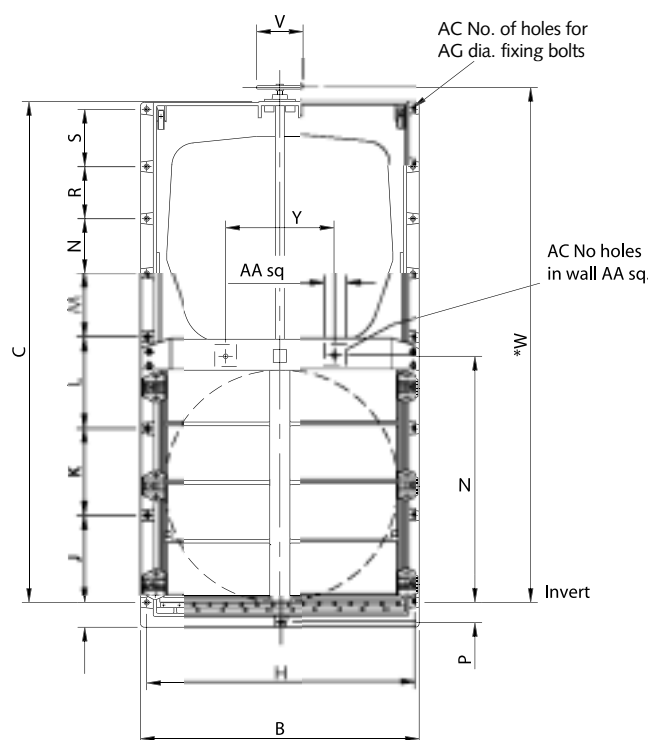
Alternative materials can be supplied for operating spindles and extensions.

Alternative Frame

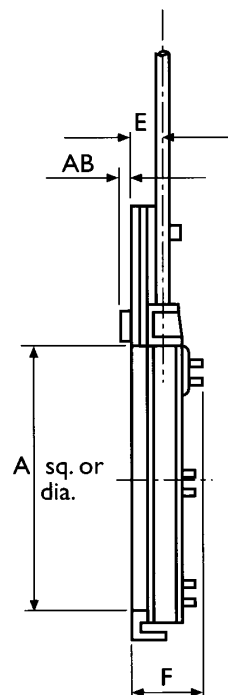
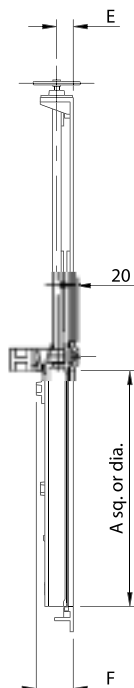
Alternative half frame penstocks are also available.

Methods of Operation

The method of operation will depend on several factors which are outside the control of the penstock manufacturer, but the range of operating gear available is extensive. (See page 30)



FULL FRAME - Thrust Direct



**HALF FRAME
Thrust Remote Rising Spindle**

A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	V	W	Y	Z	AA	AB	AC	AG
DIMENSIONS IN MILLIMETRES																							
150	345	465	55	65	113	-	300	430	-	-	-	-	-	-	-	250	575	-	-	-	-	4	12
200	395	565	55	65	113	-	350	290	240	-	-	-	-	-	-	250	675	-	-	-	-	6	12
225	420	615	55	65	113	-	375	330	250	-	-	-	-	-	-	250	725	-	-	-	-	6	12
250	445	665	55	65	113	-	400	365	265	-	-	-	-	-	-	250	775	-		-	-	6	12
300	495	765	55	65	113	-	450	440	290	-	-	-	-	-	-	250	875	-	-	-	-	6	12
350	565	885	75	70	127	-	515	510	330	-	-	-	-	-	-	250	995	-	-	-	-	6	16
400	615	985	75	70	129	-	565	585	355	-	-	-	-	-	-	250	1095	-	-	-	-	6	16
450	665	1085	75	70	131	-	615	660	380	-	-	-	-	-	-	250	1195	-	-	-	-	6	16
500	715	1185	75	70	138	-	665	375	360	405	-	-	-	-	-	250	1290	-	-	-	-	8	16
600	815	1385	75	70	142	-	765	435	450	455	-	-	-	-	-	250	1490	-	-	-	-	8	16
700	915	1610	75	75	156	-	865	510	525	530	-	-	-	-	-	250	1715	-	-	-	-	8	16
750	965	1710	75	75	158	-	915	560	550	555	-	-	-	-	-	250	1815	-	-	-	-	8	16
800	1015	1810	75	75	160	-	965	585	600	580	-	-	-	-	-	250	1915	-	-	-	-	8	16
900	1115	2010	75	75	164	-	1065	360	360	615	630	-	-	-	-	250	2115	-	-	-	-	10	16
1000	1215	2210	100	105	188	-	1165	400	420	665	680	-	-	-	-	400	2325	-	-	-	-	10	16
1100	1315	2410	130	105	195	-	1265	450	450	735	730	-	105	-	-	400	2525	500	1175	120	15	13	16
1200	1415	2610	130	105	205	-	1365	500	500	785	780	-	105	-	-	400	2725	550	1275	120	15	13	16
1300	1515	2810	130	105	233	-	1465	380	380	340	835	840	105	-	-	-	-	600	1375	120	15	13	16
1400	1700	3035	160	105	240	-	1620	525	525	560	650	725	130	-	-	-	-	650	1490	140	20	15	20
1500	1800	3235	160	105	245	-	1720	560	560	590	700	775	130	-	-	-	-	700	1590	140	20	15	20
1600	1900	3440	160	113	234	-	1820	450	450	450	565	645	130	815	-	-	-	750	1690	140	20	17	20
1700	2000	4075	190	217	370	-	1920	600	500	600	800	400	160	600	-	-	-	1000	1880	140	20	18	20
1800	2100	3860	160	222	380	-	2020	375	375	650	650	650	130	260	840	-	-	1000	1980	140	-	20	20
2000	2380	4715	210	247	420	-	2280	305	460	505	735	945	160	420	800	-	-	500	2210	140	-	22	20

Cast Iron Series 90 - 60

DESCRIPTION

The Series 90-60 is a rectangular metal faced penstock suitable for wall and thimble mounting, with on-seating heads up to 9 metres and off-seating heads up to 6 metres.

Penstocks for seating duties are supplied with side wedges only. Off-seating applications may require bottom and/or top wedges in addition to side wedges, depending on the operating conditions.

Chased invert penstocks are supplied as standard. Flush invert can be supplied when requested.

OPTIONS

- Flush invert eliminating grit traps
- An extensive range of operating gear can be utilised
- Faced wedges available in the same material as the sealing faces
- Fixing bolts supplied on request
- Sealing faces can be sealed to satisfy the requirements of both BS7775 and AWWA C501-92
- Circular apertures (sealing faces remain rectangular) for penstocks 700mm - 2000mm
- Thimble mounting (See page 6)
- Full and half frames available

MATERIAL SPECIFICATION

Frame

Constructed in BS EN 1561 min. 250 iron for wall or thimble mounting applications.

Door

Constructed in BS EN 1561 min. 250 iron designed to withstand seating heads up to 9 metres, and 6 metres off-seating.

Sealing Faces

Phosphor bronze sealing faces to BS EN 12167:1998 are supplied as the standard material bedded to 0.1mm feeler gauge non-acceptance. The sealing face is fixed securely to the frame using long taper countersunk pegs in the same material as the sealing face.

Wedges

Constructed in BS EN 1561 min. 250 iron to provide a large contact area with the door. The wedges are adjustable to accommodate wear during the life of the penstock.

Thrust Housing (direct operation)

Manufactured in cast iron to BS EN 1561 min. 250 with low friction thrust washer and lubricator.

Door Nut

Manufactured from phosphor bronze to BS EN 12167:1998 for non-rising stem applications, or cast iron to BS EN 1561 min. 250 for rising stem types.

Fasteners

Standard fasteners are supplied in stainless steel to BS EN 10088:1995 grade 1.4401 (316; A4).

Alternative Materials

Alternative materials can be supplied for operating spindles, sealing faces, fasteners etc.

Methods of Operation

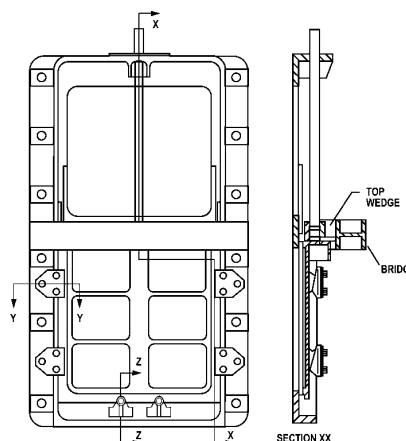
The method of operation will depend on several factors which are outside the control of the penstock manufacturer, but the range of operating gear available is extensive, and can be provided to meet clients requirements. (See page 30)

For square penstocks with apertures up to 350mm respectively, the wedge bars/blocks are cast integrally with the frame into which stainless steel jacking screws are fitted to provide the wedging effect onto the door when it is in the closed position.

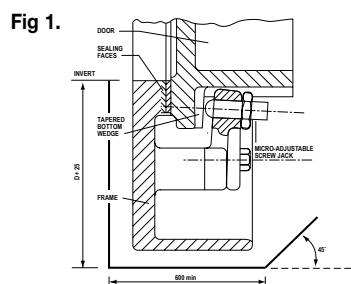
Bottom wedge blocks are provided across the invert member of the frame to give additional sealing force when required. (Fig. 1.)

Sluice gates with a flush invert resilient seal do not require bottom wedges. (Fig. 3.)

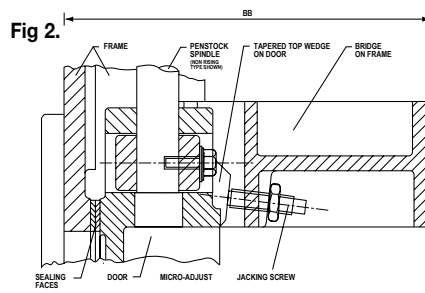
For OFF seating pressures a bridge mounted across the soffit of the frame embodies jacking screws to mate with top wedges on the door when required. (Fig. 2.)



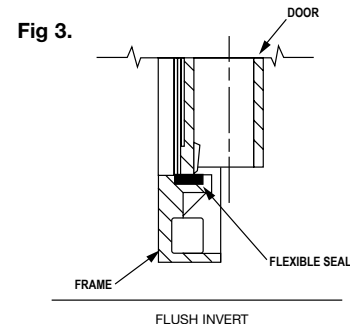
TYPICAL ARRANGEMENT OF A RECTANGULAR PENSTOCK WITH MICRO-ADJUSTABLE TOP, SIDE AND BOTTOM WEDGES



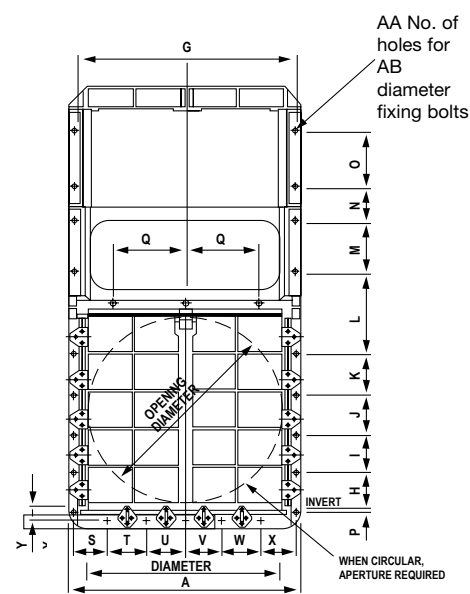
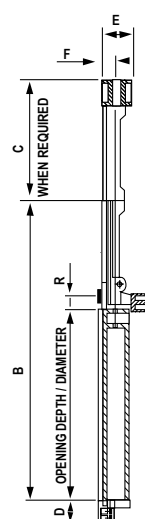
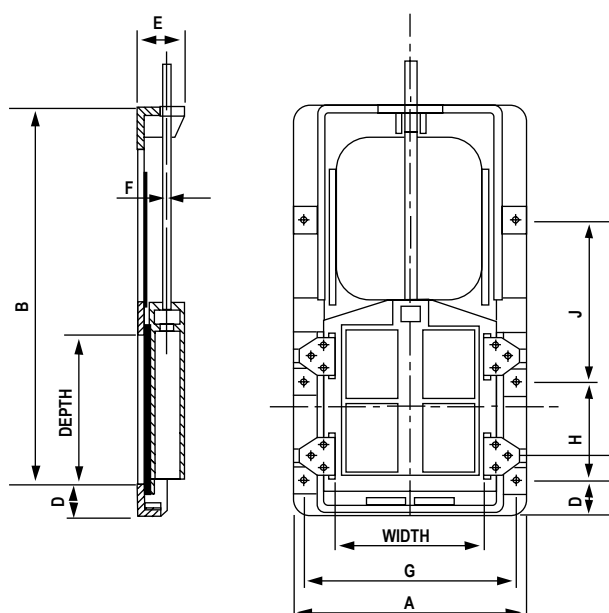
BOTTOM-WEDGE ARRANGEMENT - SECTION ZZ AND CHASE DETAILS



TOP-WEDGE & BRIDGE ARRANGEMENT - PART SECTION XX



FLUSH INVERT



PENSTOCK SIZES 150 x 150 to 450 x 450mm

**PENSTOCK SIZES 500 x 500 to 2000 x 2000mm
OPEN OR CLOSED TOP**

Effective Gate Opening	A B C D E F G H I J K L M N O P Q R S T U V W X Y																								AA	AB	dia.		
	Half Frame																								Full Frame				
DIMENSIONS IN MILLIMETRES																													
150x150	370	460	-	55	105	55	300	355	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	18	
200x200	400	570	-	65	120	60	350	450	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	18	
250x250	470	687	-	75	125	72	410	280	280	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	18	
300x300	520	790	-	75	125	64	460	280	280	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	22	
350x350	590	890	-	90	125	63	530	350	300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	22	
400x400	670	1007	-	110	125	67	610	390	400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	22	
450x450	710	1135	-	100	150	90	650	300	480	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	22	
500x500	800	995	270	120	210	110	740	500	400	-	-	-	-	200	-	-	-	-	-	-	-	-	-	-	-	-	4	6	22
600x600	900	985	560	150	220	120	830	245	300	335	-	-	-	500	-	55	-	-	-	-	-	-	-	-	-	-	8	12	22
700x700	1000	1135	570	150	220	120	930	295	350	385	-	-	-	500	-	55	-	-	-	-	-	-	-	-	-	-	8	12	22
800x800	1100	1285	580	150	220	120	1030	345	400	435	-	-	-	500	-	55	-	-	-	-	-	-	-	-	-	-	8	12	22
900x900	1200	1485	590	150	220	120	1130	245	300	300	535	-	-	500	-	55	-	125	375	380	375	-	-	-	100	10	14	22	
1000x1000	1300	1685	600	150	220	120	1230	285	330	330	635	-	-	500	-	45	340	125	410	410	410	-	-	-	100	13	17	22	
1100x1100	1440	1785	725	190	235	135	1350	345	415	415	500	-	-	255	250	70	340	125	335	340	340	335	-	-	125	15	19	28	
1200x1200	1540	1885	895	190	235	135	1450	375	450	450	500	-	-	255	400	75	365	125	360	365	365	360	-	-	125	15	19	28	
1300x1300	1640	2035	915	190	235	135	1550	295	360	360	360	550	-	255	400	65	390	125	385	390	390	385	-	-	125	18	22	28	
1400x1400	1740	2235	895	190	235	135	1650	320	385	385	385	650	-	255	400	65	495	125	330	330	330	330	330	-	125	20	24	28	
1500x1500	1840	2335	1060	190	235	135	1750	345	410	410	410	650	-	255	500	65	525	125	350	350	350	350	350	-	125	20	24	28	
1600x1600	2000	2485	1080	240	240	140	1880	370	435	435	435	700	-	255	550	65	570	140	370	380	380	380	370	-	140	20	24	28	
1700x1700	2100	2685	1086	240	240	140	1980	295	360	360	360	400	800	255	550	65	595	140	395	395	400	395	395	-	140	22	26	28	
1800x1800	2200	2785	1246	240	240	140	2080	310	385	385	385	410	750	355	600	75	690	140	350	345	345	345	345	350	140	24	28	28	
1900x1900	2300	2935	1250	240	240	140	2180	325	400	400	400	450	800	355	600	75	720	140	370	360	360	360	360	370	140	24	28	28	
2000x2000	2400	3135	1260	240	240	140	2280	345	420	420	420	470	900	355	600	75	760	140	380	380	380	380	380	380	140	24	28	28	

Cast Iron Series 160 - 80

DESCRIPTION

The Series 160-80 is a rectangular metal faced penstock suitable for wall and thimble mounting, seating heads up to 16 metres and off-seat heads up to 8 metres.

Penstocks for seating duties are supplied with side wedges only; off-seating applications may require bottom and/or top wedges in addition to side wedges depending on the operating conditions.

Chased invert penstocks are supplied as a standard. Flush invert can be supplied when specified.

Conventional wedges are positioned around the frame as required to suit the duty. The wedges apply a force to the door in the closed position. During the opening and closing travel the door is retained by integral guides in the frame.

OPTIONS

- Flush invert
- An extensive range of operating gear can be utilised
- Faced wedges available in the same material as the sealing faces
- Fixing bolts supplied on request
- Sealing faces can be secured to satisfy the requirements of BS 7775 and AWWA C501-92
- Circular apertures (sealing faces remain rectangular)
- Thimble mounting (See page 6)
- Full and half frames available
- Available up to 5000mm square

MATERIAL SPECIFICATION

Frame

Constructed in BS EN 1561 min. 250 iron for wall or thimble mounting applications.

Door

Constructed in BS EN 1561 min. 250 iron designed to withstand seating heads up to 16 metres, and 8 metres off-seating.

Sealing Faces

Phosphor bronze sealing faces to BS EN 12167:1998 are supplied as the standard material bedded to 0.1mm feeler gauge non-acceptance. The sealing face is fixed securely to the frame using long taper countersunk pegs in the same material as the sealing face.

Wedges

Constructed in BS EN 1561 min. 250 iron to provide a large

contact area with the door. The wedges are adjustable to accommodate wear during the life of the penstock.

Flush Invert

The resilient flush invert seal is bolted onto the frame invert member. The seal is manufactured from Ethylene Propylene Di-Methyl (EPDM).

Thrust Housing (direct operation)

Manufactured in cast iron to BS 1561 min. 250 with low friction thrust washer and lubricator.

Door Nut

Manufactured from phosphor bronze to BS EN 12167:1998 for non-rising stem applications, or cast iron to BS EN 1561 min. 250 for rising stems.

Fasteners

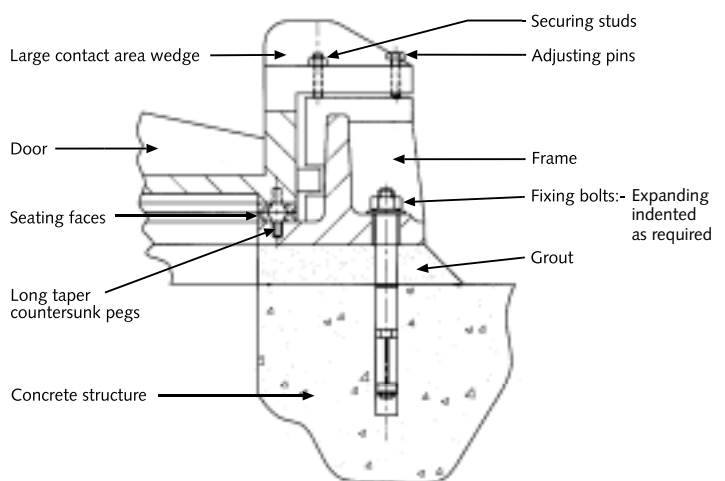
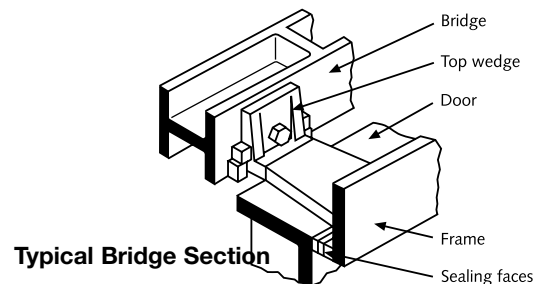
Standard fasteners are supplied in stainless steel to BS EN 10088:1995 grade 1.4401 (316; A4)..

Alternative Materials

Alternative materials can be supplied for operating spindles, sealing faces, fasteners etc.

Methods of Operation

The method of operation will depend on several factors which are outside the control of the penstock manufacturer, but the range of operating gear available is extensive, which can be provided to meet customer requirements. (See page 30)



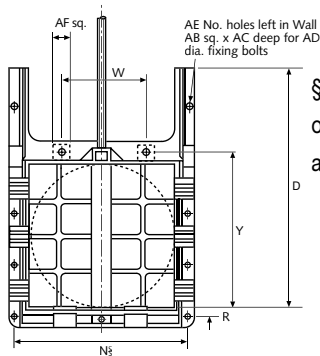
TYPICAL SECTION THROUGH SIDE MEMBER

SIZE RANGE 150 TO 1500mm Sq. or Dia. (Refer to both tables)

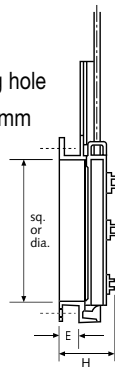
A N R S T U V W Y AA AB AC AD AE AF AG

DIMENSIONS IN MILLIMETRES

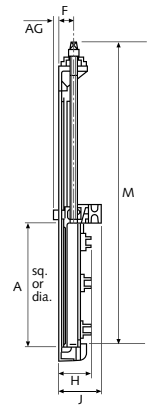
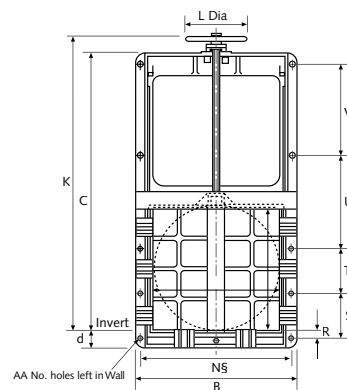
150	280	45	275	160	-	-	-	-	6	45	100	12	4	65	
200	330	45	300	235	-	-	-	-	6	45	100	12	4	65	
250	380	45	375	260	-	-	-	-	6	60	125	16	4	65	
300	430	45	425	310	-	-	-	-	6	60	125	16	4	65	
350	510	65	240	320	280	-	-	-	8	60	125	16	6	65	
400	560	65	265	345	330	-	-	-	8	60	125	16	6	65	
450	610	65	290	365	385	-	-	-	8	60	125	16	6	65	
500	660	65	315	400	425	-	-	-	8	60	125	16	6	65	
600	760	65	365	450	525	-	-	-	8	60	125	16	6	65	
700	940	80	425	625	625	-	-	-	8	75	200	24	6	65	
750	990	80	450	650	650	-	-	-	8	75	200	24	6	65	
800	1040	80	480	700	700	-	-	-	8	75	200	24	6	65	
900	1140	80	700	600	600	-	-	-	8	75	200	24	6	65	
1000	1240\$	80	750	750	750	-	-	-	8	75	200	24	6	65	
1100	1340\$	100	830	810	810	-	600	1225	11	75	200	24	9	190	65
1200	1440\$	100	900	900	900	-	600	1325	11	75	200	24	9	190	65
1300	1540\$	100	400	650	900	900	650	1450	13	75	200	24	11	190	65
1400	1640\$	100	700	500	900	900	650	1550	13	75	200	24	11	190	65
1500	1740\$	100	700	600	900	900	750	1650	15	75	200	24	11	190	65



§ Central fixing hole
on sizes 1100 mm
and above.



Flanged back type illustrated
for thimble mounting.
Thimble fixing hole details
available on request.



HALF FRAME
Thrust Remote - Rising Spindle

FULL FRAME
Thrust Direct

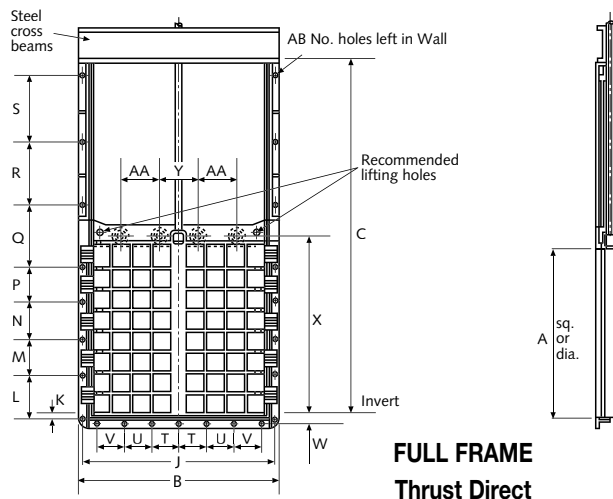
A B C D d E F H J K L M

DIMENSIONS IN MILLIMETRES

150	320	425	225	90	75	70	120	-	510	250	635
200	370	525	300	90	75	70	135	-	595	250	735
250	420	625	375	90	75	70	120	-	710	250	835
300	470	725	450	90	75	70	125	210	810	250	935
350	580	835	525	115	100	70	170	235	920	300	1045
400	630	935	600	115	100	70	175	235	1020	300	1145
450	680	1035	675	115	100	70	175	235	1120	300	1245
500	730	1155	750	115	100	90	185	290	1240	400	1365
600	830	1350	900	115	125	90	190	290	1440	400	1565
700	1020	1710	1050	160	125	135	250	395	1830	400	1935
750	1070	1810	1125	160	125	135	255	395	1930	400	2035
800	1120	1910	1200	160	125	135	265	395	2030	400	2135
900	1220	2110	1350	160	125	135	275	395	2230	500	2335
1000	1320	2310	1500	160	125	135	280	400	2430	500	2535
1100	1420	2510	1650	160	125	135	280	510	2630	500	2735
1200	1520	2710	1800	160	125	135	290	490	2830	500	2935
1300	1620	2910	1950	160	125	135	295	480	±	500	±
1400	1720	3110	2100	160	125	135	300	550	±	500	±
1500	1820	3310	2250	160	125	135	310	600	±	500	±

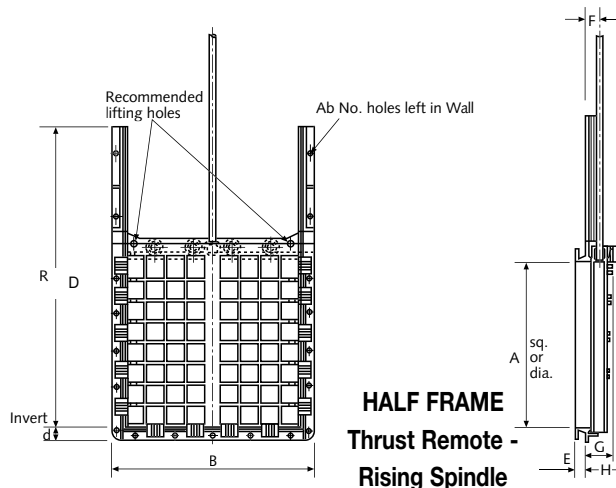
± ON SIZES 1300 MM AND ABOVE, MANUAL GEARBOXES OR POWER OPERATED ACTUATORS ARE NORMALLY SUPPLIED. DIMENSIONS COVER SERIES 160-80 ONLY. DETAILS FOR SERIES 260-130 AND 300-150 ARE ON REQUEST.

SIZE RANGE 1600 TO 3000mm Sq. or Dia.
(Refer to both tables)



FULL FRAME
Thrust Direct

A	B	C	D	d	E	F	G	H	J	K	L	M	N
DIMENSIONS IN MILLIMETRES													
1600	2000	3550	2430	230	120	180	350	550	1900	100	465	860	775
1700	2100	3750	2580	230	120	180	355	560	2000	100	760	720	720
1800	2200	3950	2730	230	120	180	360	570	2100	100	860	720	700
2000	2400	4350	3030	230	120	180	370	580	2300	100	900	800	750
2100	2500	4550	3180	230	120	180	375	590	2400	100	950	850	800
2200	2600	4750	3330	230	120	180	380	600	2500	100	950	950	800
2300	2700	4950	3480	230	120	200	385	625	2600	100	950	950	900
2400	2800	5150	3630	230	120	200	390	625	2700	100	1000	1000	850
2500	2900	5350	3780	230	120	200	395	650	2800	100	1000	1000	950
3000	3400	6350	4530	230	120	200	420	700	3300	130	930	880	880



HALF FRAME
Thrust Remote -
Rising Spindle

A	P	Q	R	S	T	U	V	W	X	Y	AA	AB	Ab	AC
DIMENSIONS IN MILLIMETRES														
1600	650	800	-	-	500	-	-	150	1750	650	-	17	13	90
1700	350	600	600	-	525	-	-	150	1850	675	-	19	15	90
1800	420	625	625	-	550	-	-	150	1950	700	-	19	15	90
2000	550	675	675	-	600	-	-	150	2150	800	-	19	15	90
2100	550	700	700	-	625	-	-	150	2250	850	-	19	15	90
2200	600	725	725	-	650	-	-	150	2350	900	-	19	15	90
2300	650	750	750	-	675	-	-	150	2450	500	500	21	17	90
2400	700	800	800	-	700	-	-	150	2550	550	550	21	17	90
2500	800	800	800	-	700	-	-	150	2650	600	600	21	17	90
3000	840	950	950	950	*300	600	500	150	3150	750	700	26	22	900

1. No hole on centre line (marked *).

Sizes up to 5000mm square. Details upon request.



Cast Iron Weir Penstocks

DESCRIPTION

Weir Penstocks are utilised in water and sewage plants for accurate regulation or measurement of flow.

Operation of the Weir Penstock is opposite to that of a conventional penstock, with the door opening downwards.

OPTIONS

- Alternative trim materials
- Face plate on door
- Fixing bolts supplied if requested
- Clear opening type penstock (no flow restriction by stem)

MATERIAL SPECIFICATION

Size Range

The Weir Penstock series is available in both square and rectangular apertures; the size range available is extensive and details are available on request.

Frame

Constructed in BS EN 1561 min. 250 iron for wall or thimble mounting applications. The sealing face is fixed securely to the frame using long taper countersunk pegs in the same material as the sealing face.

Door

Constructed in BS EN 1561 min. 250 cast iron designed to withstand seating and off seating pressure as required. Door sealing face as standard is machined cast iron. When required door can be fully faced with copper alloy. Option for perimeter sealing (fully closed position) only.

Sealing Faces

Phosphor bronze sealing faces to BS EN 12167:1998 are supplied as the standard material bedded to 0.1mm feeler gauge non-acceptance. The sealing face is fixed securely to the frame using long taper countersunk pegs in the same material as the sealing face.

Pressure Adjusters

Manufactured from BS EN 1561 min. 250 cast iron.

Side Bars

During operation a force is applied to the sealing faces by springs positioned along the side of the frame.

Pressure Plates

Adjustable cast iron pressure plates are used as an alternative to side bars on certain sizes of penstock.

Alternative Materials

A wide range of alternative materials can be supplied for pressure adjusters, operating spindle, fasteners etc.

Fasteners

Standard fasteners are supplied in stainless steel to BS EN 10088:1995 grade 1.4401 (316; A4).

Door Nut

Manufactured from phosphor bronze to BS EN 12167:1998 for non-rising stem applications; or cast iron to BS EN 1561 min. 250 for non rising stems.

Methods of Operation

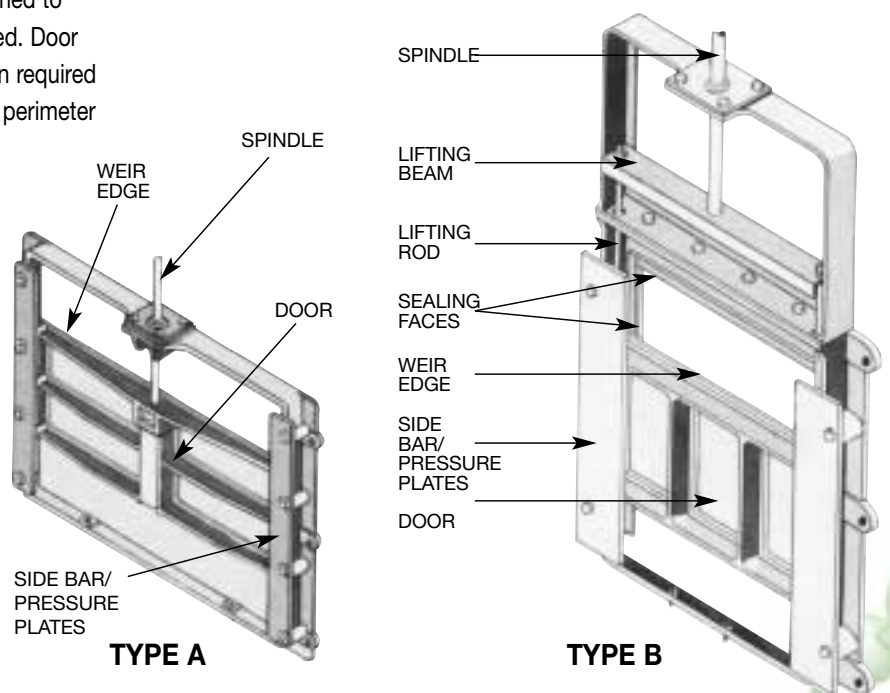
The method of operation will depend on several factors which are outside the control of the penstock manufacturer, but the range of operating gear available is extensive and can be provided to meet customer requirements. (See page 30)

The following types of Weir Penstocks are manufactured:

Type A Weir Penstocks of the screw-down variety with rising or non-rising spindles, the spindle operates through a nut which is either housed in the door for the non-rising types or housed in handwheel, gearbox or actuator for the rising types.

Type B Screw-down weir penstocks with unobstructed openings, the rising spindle is attached to a horizontal lifting beam above the opening and operates the door by lifting rods fitted to each side of the door.

For accurate measurement of flow, Type B Weir Penstocks are recommended because the spindle does not obstruct the flow over the weir. Indicators with metric or imperial graduations can be fitted for the application.



Plastigate Series 20 - 20

DESCRIPTION

The Plastigate Series 20-20 is a standardised range of penstocks with sizes up to 1000mm square which have been specifically designed to meet lower pressure heads up to 2m on-seating and 2m off-seating pressures.

Suitable for wall and channel applications.

The design embodies the latest use of synthetic materials combined with stainless steel and plastic.

Provides a range of penstocks suitable for use in most water, sewage and industrial effluent treatment plants.

OPTIONS

- Wall mounted
- Channel mounted
- Rebate or sidewall fixed
- Material choice (frame and door)

MATERIAL SPECIFICATION

Seals

The frame seals are of resilient, low friction materials selected for its resistance to ultra violet degradation.

Frames

Frames are manufactured from stainless steel to BS EN 10088:1995 grades 1.4301 (304) or 1.4401 (316).

Doors

Doors are manufactured from stainless steel to BS EN 10088:1995 grades 1.4301 (304) or 1.4401 (316).

Flush Invert

The Plastigate Series 20-20 penstocks are supplied as standard with a flush invert seal arrangement to allow for a smooth transmission of flow through the penstock.

Spindle

The spindle is manufactured in stainless steel.

Frame Yoke

For wall mounted penstocks the frame yokes are fitted when the thrust needs to be taken by the frame. The yoke is gusseted and bolted to the frame to allow for removal. The yoke material is the same as for the frame. For channel mounted penstocks the yoke forms an integral part of the frame.



Pressure Pads

Pressure pads are only fitted to penstocks which are wall mounted type only and subjected both on/off seating pressures.

Fixing Bolts

Bolts can be provided for wall mounted units if required.

Door Nut

Manufactured from phosphor bronze to BS EN 12167:1998 for non-rising stem applications, or cast iron to BS EN 1561 min. 250 for rising stem types.

Operating Gear

A dedicated range of standardised operating equipment is available for use with the Series 20-20 penstocks.

- Type 1. Square Cap & Adaptor
- Type 2. Handwheel
- Type 3. Actuator

The following door and frame combinations are available.

1. Wall Mounting Options

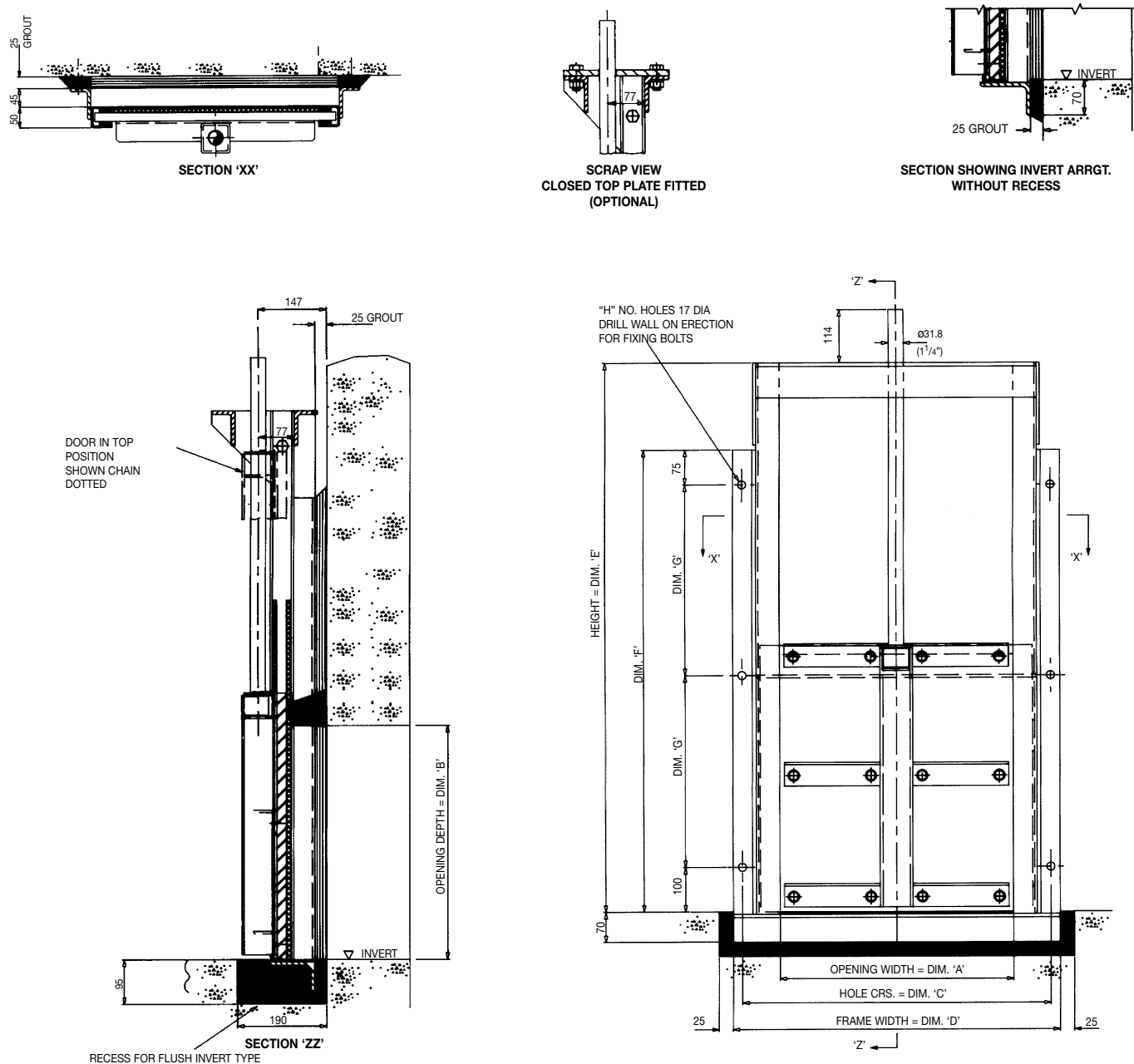
- a. On seat, stainless steel frame, rigid pvc door. (Fig. 1.)
- b. On seat, stainless steel frame and door. (Fig. 1.)
- c. On/off seat, stainless steel frame, rigid pvc door. (Fig. 1.)
- d. On/off seat, stainless steel frame and door. (Fig. 1.)

2. Channel Mounting Options (door depth pressure only)

- a. On/off seat seat, stainless steel frame, rigid pvc door. (Fig. 2.)
- b. On/of seat, stainless steel frame and door. (Fig. 2.)

WALL MOUNTING "ON/OFF" SEATING; RIGID PVC DOOR

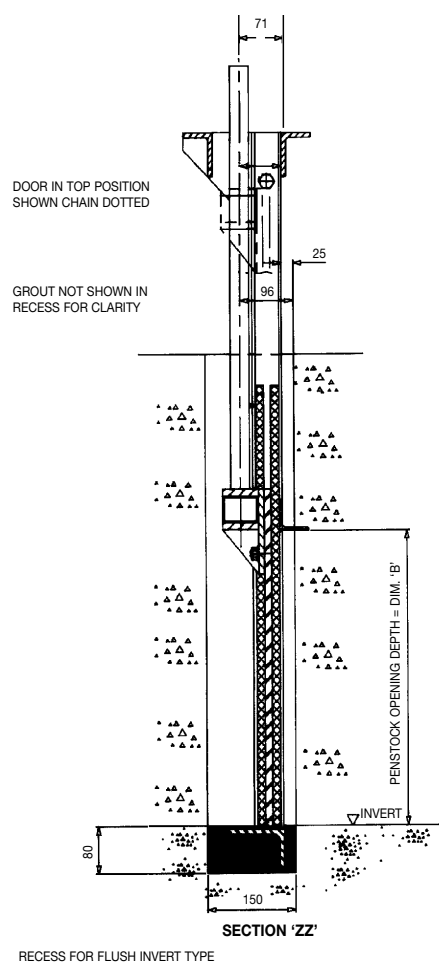
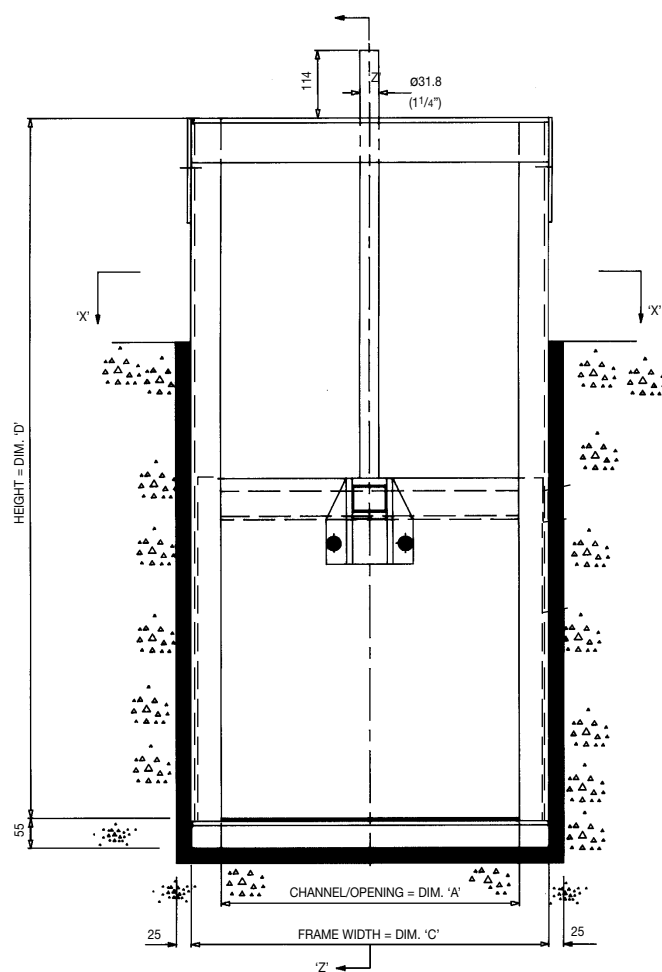
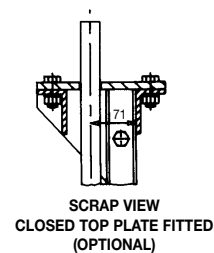
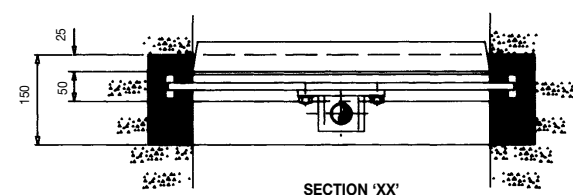
Fig 1.



Width A	Depth B	Dim. C	Dim. D	Dim. E	Dim. F	Dim. G	Dim. H
DIMENSIONS IN MILLIMETRES							
200	200	360	400	577	390	215	4
250	250	410	450	677	490	315	4
300	300	460	500	777	590	415	4
350	350	510	550	877	690	515	4
400	400	560	600	977	790	608	6
450	450	610	650	1077	890	708	6
500	500	660	700	1177	990	808	6
600	600	760	800	1377	1190	1008	6
700	700	860	900	1577	1390	1208	6
800	800	960	1000	1777	1590	1408	6
900	900	1060	1100	1977	1790	1608	6
1000	1000	1160	1200	2177	1990	1808	6

CHANNEL MOUNTING; STAINLESS STEEL CONSTRUCTION

Fig 2.



Width A	Depth B	Dim. C	Dim. D
DIMENSIONS IN MILLIMETRES			
200	200	300	577
250	250	350	677
300	300	400	777
350	350	450	877
400	400	500	977
450	450	550	1077
500	500	600	1177
600	600	700	1377
700	700	800	1577
800	800	900	1777
900	900	1000	1977
1000	1000	1100	2177

Stainless Steel Fabricated Penstock

DESCRIPTION

The Fabricated Stainless Steel Penstock is a rectangular faced penstock designed to meet the ever changing fluid handling demands of customers, combining the latest in penstock design and parametrics software.

The generic penstock design, which is tailored using parametrics software, develops and individualises the penstock to suit specific duty and aperture requirements.

The Fabricated Stainless Steel Series also offers greatly enhanced levels of customer service, reduced design drawing turnaround, improved reply to enquires and an enhanced delivery performance.

OPTIONS

- Size Range 400mm² upto 3000mm²

MOUNTING

- Wall
- Channel
- Side Wall

MATERIAL SPECIFICATION

FRAME

Open top and full frame versions are available. The frames are manufactured from stainless steel to BS EN 10088 : 1955 grades 1.4301 (304) or 1.4401 (316)

DOOR

Design for high impact whilst incorporating a lightweight single skin design with rib reinforcing manufactured in stainless steel to BS EN 10088:1955 grades 1.4301(304) or 1.4401 (316). The number of reinforcing ribs will vary according to the specific duty and size requirements.

SEALING FACES

The sealing arrangements combine the use of resilient and or synthetic materials.

INVERT

A flush invert is utilised as standard on the Fabricated Stainless Steel Series (to ensure a smooth flow with a positive seal and allowing complete drainage at the invert of the penstock).

WEDGING / PRESSURE PAD ASSEMBLY

An adjustable wedging or pressure pad assembly is included within the design to accommodate specified duties, wear in service and ensure a positive seal.

SPINDLE

Rising or non-rising type in stainless steel to BS EN 10088 : 1955 grade 1.4401 (316). Extension spindles are in the same material.

FRAME YOKE

Frame yokes are fitted when thrust is required to be taken by the frame and positioned to allow removal of the door. The yoke material is the same material as for the frame.

FIXING BOLTS

Can be supplied when requested.



Coplastix® Series 50 - 40

DESCRIPTION

The Coplastix® Series 50-40 is a rectangular faced penstock designed and manufactured to suit modern industrial and domestic effluent environments. Utilisation of the latest synthetic materials for both sealing mechanisms and door construction combined with the use of steel or stainless steel in the construction of the penstock frames ranges.

A range of penstocks suitable for use in most water, sewage and effluent treatment plants. The penstocks are available for wall mounting and can be provided with either manual or power operators, manufactured in sizes ranging from 400mm square to 2000mm square as standard.

MATERIAL SPECIFICATION

Frames

Frames are manufactured from mild steel to BS EN 10025:1993 grade S275 or stainless steel to BS EN 10088:1995 grades 1.4301 (304) or 1.4401 (316). Mild steel frames can be protected to suit sea water, potable or sewage application, stainless steel - natural finish. The penstock frames for both wall and channel mounting (downward closing) have a resilient flush invert seal to allow smooth transmission of the flow through the penstock.

Frame Seals

The sealing arrangements for the Coplastix® Penstocks combine the use of resilient and low friction synthetic materials, which ensures a high degree of sealing with easy movement.

Doors

Doors are manufactured as a composite sandwich construction comprising a lightweight rigid, cellular core with a fully welded steel box section matrix between two other skins of rigid, compressed composite plastic which is asbestos free, ultra violet stabilised, rigid and non toxic. All materials are chemically bonded and sealed. Doors for non-rising spindle penstocks have a stainless steel lining tube inside the central vertical box section of the inner matrix.

Spindles

Rising or non-rising type in stainless steel BS EN 10088:1995 grades 1.4301 (304) or 1.4401 (316) with extension spindles in the same material as standard.

Frame Yokes

Frame yokes form an integral part of the frame and are positioned to allow removal of the door should this be necessary. The yoke material is the same as for the frame.

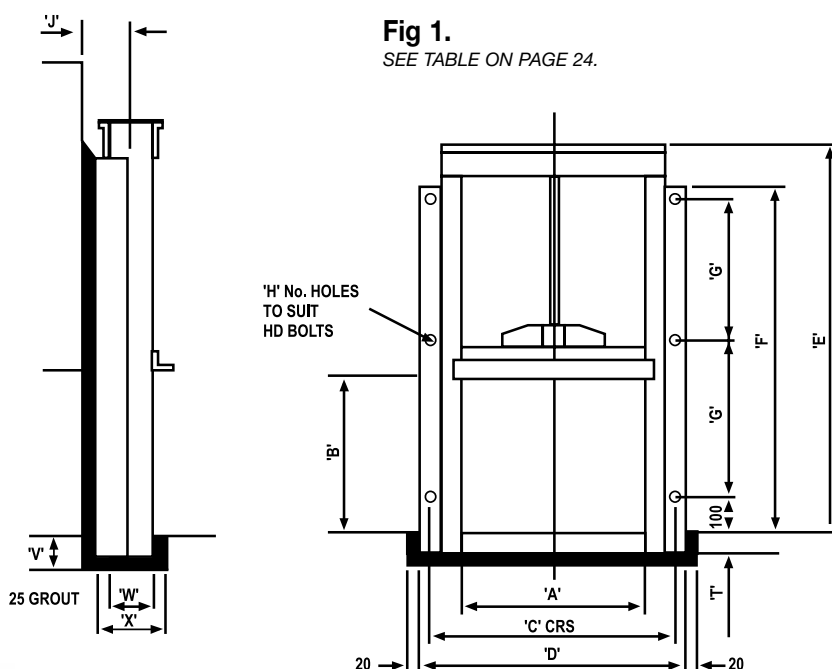
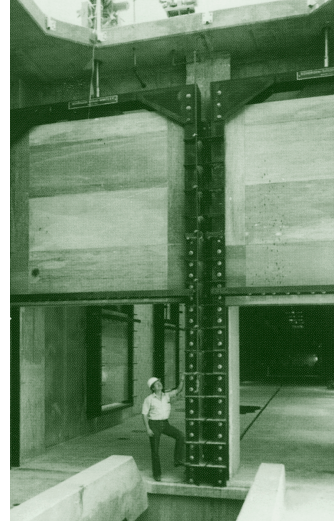
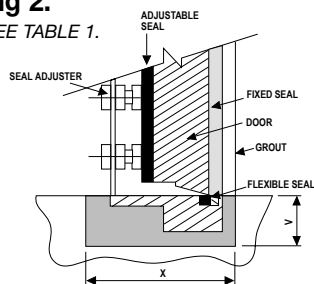


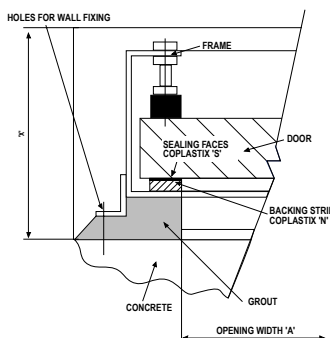
Fig 1.
SEE TABLE ON PAGE 24.

TABLE 1					
RANGE	J	T	V	W	X
DIMENSIONS IN MILLIMETRES					
SMALL	104	50	80	165	215
MEDIUM	122	60	80	195	235
LARGE	146	80	100	245	295

Fig 2.
SEE TABLE 1.

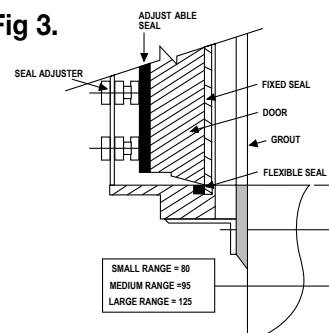


SECTION SHOWING INVERT SEAL
ARRANGEMENT FOR WALL PENSTOCK
WITH RECESS



SECTION SHOWING SIDE SEAL
ARRANGEMENT FOR WALL PENSTOCKS

Fig 3.



SECTION SHOWING INVERT SEAL ARRANGEMENT FOR
WALL PENSTOCK
WITHOUT RECESS

Stem Nuts

The stem nuts are phosphor bronze to BS 12167:1998. For non-rising stems, the nut is housed in a cast-iron bracket secured to top of the penstock door. For rising stems, the nut is housed in the handwheel.

Fixing Bolts

Can be supplied when requested.

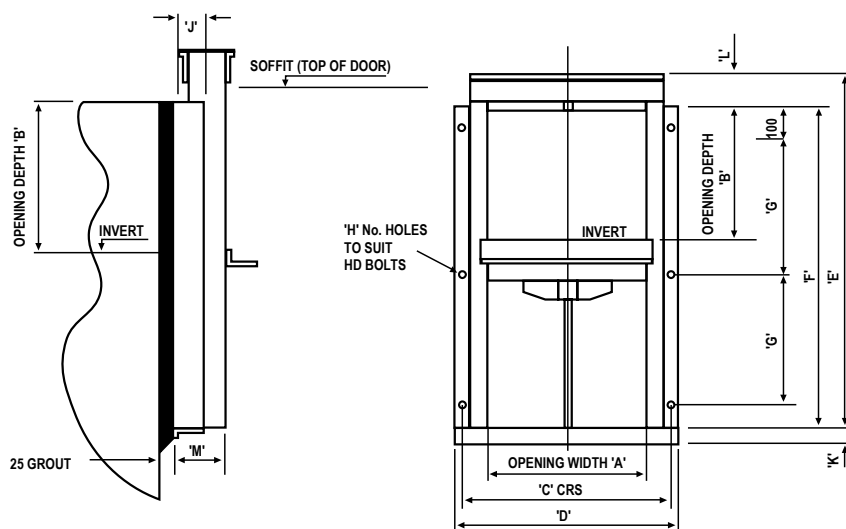
Pressure Pads

Adjustable pressure pads are fitted as standard and pre-set at the works to provide maximum degree of water tightness.

WEIR (Downward Opening)

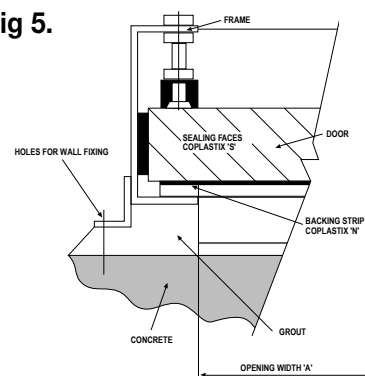
Coplaxix® Weir Penstocks are constructed as described for the wall mounted type other than the stem is secured to the lower edge of the penstock door via a cast iron bracket, thus permitting maximum unhibited flow over the upper weir edge of the door. Flush invert does not apply for Weir Penstocks. The sealing arrangements for the Coplastix® Penstocks combine the use of resilient and low friction synthetic materials which ensures a high degree of sealing with easy movement.

Fig 4.
SEE TABLE ON PAGE 25.



OVERALL DIMENSIONS DIAGRAM OF WEIR PENSTOCKS

Fig 5.



SECTION SHOWING SIDE SEALS
arrangement for weir products

RANGE	J	K	L	M
DIMENSIONS IN MILLIMETRES				
SMALL	104	50	85	165
MEDIUM	122	68	110	185
LARGE	146	80	160	245

Small Range Fig.1 Wall Mounted Version

WIDTH A	DEPTH B	C	D	E	F	G	H	J	K	L	M
DIMENSIONS IN MILLIMETRES											
400	400	560	600	977	880	370	6	104	-	-	-
450	450	610	650	1077	980	420	6	104	-	-	-
500	500	660	700	1177	1080	470	6	104	-	-	-
600	600	760	800	1377	1280	570	6	104	300	-	-
600	800	760	800	1777	1680	770	6	104	300	-	-
700	700	860	900	1577	1480	670	6	104	350	-	-
800	600	960	1000	1377	1280	570	6	104	400	-	-
800	800	960	1000	1777	1680	385	10	104	400	-	-
800	1000	960	1000	2177	2080	485	10	104	400	-	-
900	900	1060	1000	1977	1880	435	10	104	450	-	-

Medium Range Fig.1 Wall Mounted Version

WIDTH A	DEPTH B	C	D	E	F	G	H	J	K	L	M
DIMENSIONS IN MILLIMETRES											
800	1200	990	1050	2597	2480	585	10	122	400	-	-
1000	600	1190	1250	1397	1280	570	6	122	500	-	-
1000	800	1190	1250	1797	1680	770	6	122	500	-	-
1000	1000	1190	1250	2197	2080	485	10	122	500	-	-
1000	1200	1190	1250	2597	2480	585	10	122	500	-	-
1000	1400	1190	1250	2997	2880	685	10	122	500	-	-
1200	600	1390	1450	1397	1280	570	6	122	300	300	300
1200	800	1390	1450	1797	1680	385	10	122	300	300	300
1200	1000	1390	1450	2197	2080	485	10	122	300	300	300
1200	1200	1390	1450	2597	2480	468	12	122	300	300	300
1200	1400	1390	1450	2997	2880	548	12	122	300	300	300
1200	1600	1390	1450	3397	3280	628	12	122	300	300	300
1200	1800	1390	1450	3797	3680	590	14	122	300	300	300
1400	800	1590	1650	1797	1680	385	10	122	300	400	400
1400	1000	1590	1650	2197	2080	388	12	122	300	400	400
1400	1200	1590	1650	2597	2480	468	12	122	300	400	400
1400	1400	1590	1650	2997	2880	457	14	122	300	400	400

Large Range Fig.1 Wall Mounted Version

WIDTH A	DEPTH B	C	D	E	F	G	H	J	K	L	M
DIMENSIONS IN MILLIMETRES											
1400	1600	1650	1710	3420	3270	780	10	146	300	400	400
1400	1800	1650	1710	3820	3670	587	14	146	300	400	400
1400	2000	1650	1710	4220	4070	653	14	146	300	400	400
1500	1500	1750	1810	3220	3070	487	14	146	450	400	400
1600	800	1850	1910	1820	1670	760	6	146	500	400	400
1600	1000	1850	1910	2220	2070	480	10	146	500	400	400
1600	1200	1850	1910	2620	2470	580	10	146	500	400	400
1600	1400	1850	1910	3020	2870	453	14	146	500	400	400
1600	1600	1850	1910	3420	3270	520	14	146	500	400	400
1600	1800	1850	1910	3820	3670	587	14	146	500	400	400
1600	2000	1850	1910	4220	4070	653	14	146	500	400	400
1800	1000	2050	2110	2220	2070	480	10	146	600	400	400
1800	1200	2050	2110	2620	2470	387	14	146	600	400	400
1800	1400	2050	2110	3020	2870	453	14	146	600	400	400
1800	1600	2050	2110	3420	3270	520	14	146	600	400	400
1800	1800	2050	2110	3820	3670	440	18	146	600	400	400
1800	2000	2050	2110	4220	4070	490	18	146	600	400	400
2000	1000	2250	2310	2220	2070	480	10	146	700	400	400
2000	1200	2250	2310	2620	2470	387	14	146	700	400	400
2000	1400	2250	2310	3020	2870	453	14	146	700	400	400
2000	1600	2250	2310	3420	3270	390	18	146	700	400	400
2000	1800	2250	2310	3820	3670	440	18	146	700	400	400
2000	2000	2250	2310	4220	4070	490	18	146	700	400	400

Small Range Fig.4 Weir Penstock (Downward Opening)

WIDTH A	DEPTH B	C	D	E	F	G	H
DIMENSIONS IN MILLIMETRES							
400	400	560	600	1062	977	370	6
450	450	610	650	1162	1077	420	6
500	500	660	700	1262	1177	470	6
600	600	760	800	1462	1377	570	6
600	800	760	800	1862	1777	770	6
700	700	860	900	1662	1577	670	6
800	600	960	1000	1462	1377	570	6
800	800	960	1000	1862	1777	385	10
800	1000	960	1000	2262	2177	485	10
900	900	1060	1100	2062	1977	435	10

Medium Range Fig.4 Weir Penstock (Downward Opening)

WIDTH A	DEPTH B	C	D	E	F	G	H
DIMENSIONS IN MILLIMETRES							
800	1200	990	1050	2707	2597	585	10
1000	600	1190	1250	1507	1397	570	6
1000	800	1190	1250	1907	1797	770	6
1000	1000	1190	1250	2307	2197	485	10
1000	1200	1190	1250	2707	2597	585	10
1000	1400	1190	1250	3107	2997	685	10
1200	600	1390	1450	1507	1397	570	6
1200	800	1390	1450	1907	1797	385	10
1200	1000	1390	1450	2307	2197	485	10
1200	1200	1390	1450	2707	2597	468	12
1200	1400	1390	1450	3107	2997	548	12
1200	1600	1390	1450	3507	3397	628	12
1200	1800	1390	1450	3907	3797	590	14
1400	800	1590	1650	1907	1797	385	10
1400	1000	1590	1650	2307	2197	388	12
1400	1200	1590	1650	2707	2597	468	12
1400	1400	1590	1650	3107	2997	457	14

Large Range Fig.4 Weir Penstock (Downward Opening)

WIDTH A	DEPTH B	C	D	E	F	G	H
DIMENSIONS IN MILLIMETRES							
1400	1600	1650	1710	3580	3430	780	10
1400	1800	1650	1710	3980	3830	587	14
1400	2000	1650	1710	4380	4230	653	14
1500	1500	1750	1810	3380	3230	487	14
1600	800	1850	1910	1980	1830	760	6
1600	1000	1850	1910	2380	2230	480	10
1600	1200	1850	1910	2780	2630	580	10
1600	1400	1850	1910	3180	3030	453	14
1600	1600	1850	1910	3580	3430	520	14
1600	1800	1850	1910	3980	3830	587	14
1600	2000	1850	1910	4380	4230	653	14
1800	1000	2050	2110	2380	2230	480	10
1800	1200	2050	2110	2780	2630	387	14
1800	1400	2050	2110	3180	3030	453	14
1800	1600	2050	2110	3580	3430	520	14
1800	1800	2050	2110	3980	3830	440	18
1800	2000	2050	2110	4380	4230	490	18
2000	1000	2250	2310	2380	2230	480	10
2000	1200	2250	2310	2780	2630	387	14
2000	1400	2250	2310	3180	3030	453	14
2000	1600	2250	2310	3580	3430	390	18
2000	1800	2250	2310	3980	3830	440	18
2000	2000	2250	2310	4380	4230	490	18

Technical Details

PREPARATION AND PROTECTIVE COATING

The following coating systems are offered by Ham Baker as standard.

PS42 - POTABLE WATER APPLICATIONS

1) Grit Blast to ISO8501:1988 Sa2.5.

2) 3 coats 2 pack Black High Build Epoxy (COPON KSIR88 OR EQUAL), each coat to be 100 microns average dry film thickness.

Giving a final coating thickness of 300 microns.

This is a 2pack Epoxy high performance coating system with WRAS approval for use in Potable water.

PS46 - ALL OTHER APPLICATIONS

1) Grit Blast to ISO8501:1988 Sa2.5.

2) 1 coat 2 pack Black High Build Epoxy (COPON KSIR88 OR EQUAL), the coat to be 150 microns average dry film thickness.

Giving a final coating thickness of 150 microns.

This is a 2pack Epoxy high performance coating system developed in conjunction with the paint manufacturer to give optimum performance in all none potable applications.

Standard Paint Specification	Application	Surface Treatment
PS42 - High Build 2 Pack Epoxy Coating System with WRAS approval for all materials.	Seawater/Potable/Seawater: Cast Iron and Mild Steel below Floor/Operating level.	1. Grit blast to ISO8501:1988 Sa2.5 2. 3 Coat of 2 pack black High Build Epoxy Final coating thickness: 300 microns average dry film thickness. This coating has been tested to BS 6920 and has been approved by WRAS for use in water intended for human consumption.
PS46 - High Build 2 Pack Epoxy Coating System.	Seawater/Potable/Seawater: Cast Iron and Mild Steel below Floor/Operating level.	1. Grit blast to ISO8501:1988 Sa2.5 2. 1 Coat of 2 pack black High Build Epoxy Final coating thickness: 150 microns average dry film thickness. This coating has good resistance to abrasion and mechanical damage. Is unaffected by fuel oil, chemical products, aviation fuel and sour gas mixtures. It is also suitable for use up to a 120°C dry heat.

Note on paint specifications: Average of paint thickness readings taken over a square metre should equal or exceed the defined thickness stipulated. In no case should any reading be less than 75% of the stipulated thickness.

SIZES

BS7775 'Specification for Penstocks' provides useful information regarding sizes for penstocks.

Penstocks are suitable for three shapes of aperture

- Square
- Rectangular
- Circular

Standard Rectangular Penstocks have an aspect ratio (width divided by depth) between 0.5 and 2. Penstocks outside this range can be considered but will be special designs.

Cast Iron Circular penstocks below 600mm to 1000mm in diameter, depending on type, have a circular sealing face. For all other circular penstocks the sealing face is as a square penstock.

FLOW CHARACTERISTICS

1. General

Penstocks are installed in civil engineering structures. When a penstock is fully open, the head loss attributable to the penstock alone is generally quite small compared to the losses due to the civil engineering structure. An exception to this is a channel mounted penstock where the top water level is above the top of the door opening.

2. Discharge through an orifice

This type of flow occurs where a penstock controls flow into or out of a tank or other large container. If the gate is fully submerged, the flow through an open or partially open penstock and its associated civil engineering structure opening will be given by

$$q = CA \sqrt{2gH}$$

Where

q is the discharge rate - cubic metres per second

C is a discharge coefficient generally taken to be 0.7

A is the aperture area - square metres

The aperture area is the penstock opening if the penstock is fully open. If the penstock is not fully open, the aperture area will be reduced.

H is the differential head at the centre of the opening - metres

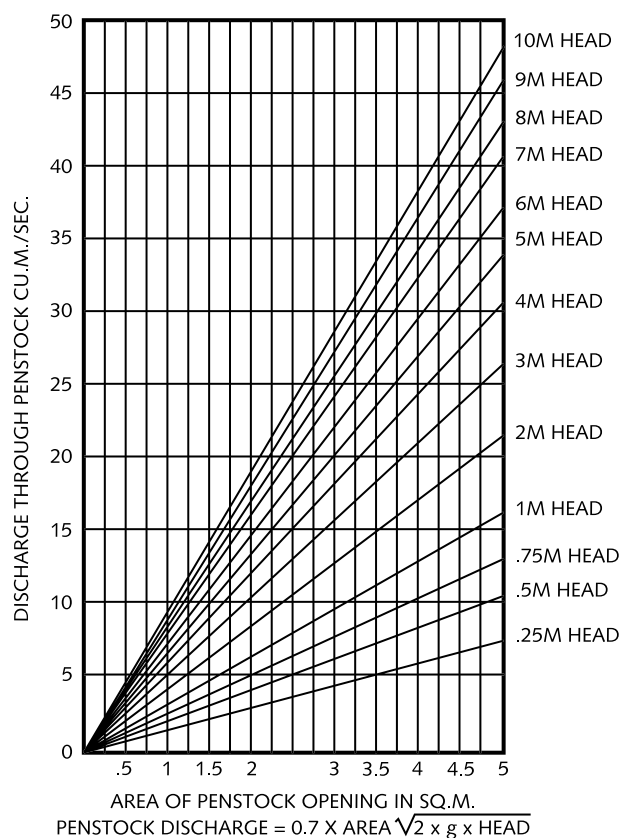
The differential head is the difference between the upstream and down stream water levels.

g is the acceleration due to gravity - 9.81 m/s²

For example a penstock 1.5 metres wide by 2 metres deep with a 6 metre differential head at the centre of the door will discharge 22.8 cubic metres per second.

A graph of a range of discharges for different penstock apertures and differential heads is shown below.

Fig. 1 - Graph of Discharge against Head



3. Channel mounted penstocks

If a channel mounted penstock is fully open and the top of the penstock opening is above the water level in the channel, then the head loss results from disturbed flow in the rebates in the channel walls in which the penstock frame is mounted. These losses can generally be disregarded provided that the channel is not obstructed. Channel mounted penstocks usually have flush invert.

When a penstock is in a channel and is partially closed, or the water level is above the top of the door opening, the calculations are complex. Reference should be made to a suitable publication on civil engineering hydraulics.

References

Open Channel Hydraulics

By V T Chow

McGraw-Hill Education

Open Channel Flow

By F M Henderson

Macmillan USA

Hydraulic Gates and Valves in Free Surface Flow and Submerged Outlets

By J Lewin

British Nuclear Energy Society

4. Weir Penstocks

Weir Penstocks behave in their discharge capability as a rectangular weir with partial end contractions, the extent of the end contraction being influenced by the civil engineering design in the locality of the weir.

An approximation to the discharge is given by

$$Q = 1.73 WH^{1.5}$$

Where

Q is the discharge rate - cubic metres per second

W is the width of the weir opening - metres

H is the head at the weir crest - metres

For example a weir 2 metres wide having a water depth of 200mm (0.2m) at the crest will discharge 0.31 cubic metres per second.

If the weir is used as a flow measuring or control device reference should be made to BS 3680-4A:1981 'Methods of measurement of liquid flow in open channels. Weirs and flumes. Methods using thin plate weirs' for channel design and relative water levels.

LEAKAGE

Ham Baker penstocks will be virtually drop-tight at their working pressure if installation has been carried out correctly.

Leakage rates are influenced by

- The head
- The seating direction, on or off
- The correct installation of the penstock
- Time

An on-seating penstock will leak less with increasing head.

An off-seating penstock will leak more with an increasing head.

Penstocks subject to an on-seating head seal more tightly than those subject to an off-seating head.

If the penstock is installed so that the frame is twisted, then the leakage rate will increase. Penstocks should be installed by experienced contractors and mounted on grout.

Over the course of time after closure of the penstock, the leakage rate will decrease as leakage paths are blocked by small pieces of debris in the water.

From the above it is clear that if leakage is required to be minimised, then the penstock should be configured so that it is on-seating.

Allowable Leakage Rates

Leakage rates are defined by the amount of water which leaks through a 1 metre length of seal in 1 minute.

BS 7775:1995 leakage rates apply to penstocks subject to a head of 6 metres or less and widths of 2 metres or less.

Penstocks with metal seals (Cast Iron Penstocks)

The allowable leakage rates listed are derived from BS 7775 'Specification for Penstocks' and AWWA C501-92 'AWWA Standard for Cast Iron Sluice Gates' as appropriate.

On-seating head	Allowable leakage rate
Any head	1.25 litres/min/m
Off-seating head	Allowable leakage rate
Up to 6 metres	2.5 litres/min/m
Up to 9 metres	3.0 litres/min/m
Up to 12 metres	3.75 litres/min/m
Up to 15 metres	4.5 litres/min/m

Leakage rates for off-seating heads greater than 15 metres will be advised on request.

Penstocks with resilient rubber or plastic seals (Plastigate, Coplastix and Series 2000 Penstocks).

There is currently no standard which applies to leakage rates for this type of penstock. The figures given below are Ham Baker's estimates.

On-seating head	Allowable leakage rate
Up to 5 metres	0.4 litres/min/m
Off-seating head	Allowable leakage rate
Up to 4 metres	0.4 litres/min/m

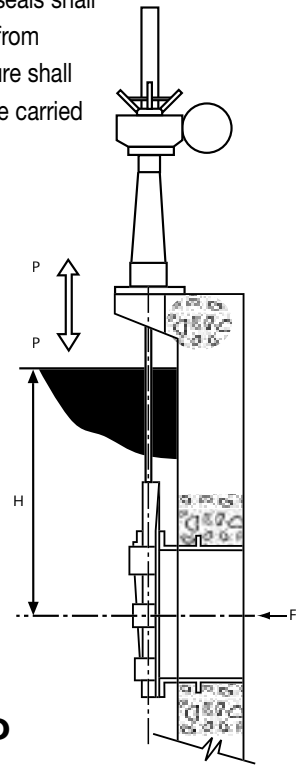
For example, a 1500mm wide by 2000mm deep cast iron penstock subject to an off-seating head of 9 metres would have a seal periphery of $2(1.5+2) = 7\text{m}$ and an allowable leakage rate of 3.0 litres/min/m.

Therefore maximum allowable leakage rate = $7 \times 3 = 21$ litres/min

On-site Leakage Test According to BS 7775

Before a site leakage test is undertaken the installer shall ensure that the penstock and its associated operating equipment have been correctly installed and fixed in position. Penstocks and associated operating equipment shall be installed strictly in accordance with the manufacturer's recommendations. Final adjustments to the penstock shall be made and all moving parts shall be operated through one complete open and shut cycle to confirm proper operation before the leakage test commences.

Measurement of the liquid loss through the seals shall be carried out in such a way that any leaks from between the penstock frame and the structure shall not affect the result of the test. Tests shall be carried out over a period of 30 minutes.



FOUNDATION LOADS AND OPERATING FORCES

Precise foundation loads can be given by Ham Baker once a penstock has been specified. As a guide to the foundation loads to be expected, the following formulae can be used.

A penstock exerts two types of load on the civil engineering structure.

- Hydrostatic
- Operating

Note on heads.

Heads for penstocks are specified to the invert in BS 7775. These heads can be used conservatively for these calculations. More accurately, the head at the centre of the door should be used, this is the head at the invert less half the door depth.

1. Hydrostatic Force.

The hydrostatic load F is the force of the water against the penstock door, which will be transferred to the civil engineering structure by the penstock frame. This force acts horizontally.

The force F is given by (approximately)

$$F = 10HA \quad \text{where } F \text{ is in units of kN}$$

H is the maximum differential head at the centre of the door - metres. This should be the worst case which could occur.

A is the door area in square metres

For example a 1.5 metre square door with a head at the centre of the door of 6 metres will experience a hydrostatic force of

$$F = 10 \times 6 \times 1.52 \quad \text{that is } F = 135 \text{ kN}$$

2. Operating Force

This is the force required to open and close the penstock door.

The civil engineering structure will experience this load where the penstock operating device is connected to the civil engineering structure and the penstock frame is connected to the civil engineering structure.

However the civil engineering structure will not experience this force if the penstock operating device is connected directly to the penstock or the thrust reaction is taken at the top of the penstock frame.

The normal operating force of the penstock P can be taken as first approximation as

$$P = 0.5F \quad \text{kN} \quad \text{where } F \text{ is defined above}$$

This force acts vertically and can be up or down. For example the 1.5 metre square door with a head at the centre of the door of 6 metres considered above will have an operating force

$$P = 0.5 \times 135 = 67.5 \text{ kN}$$

In addition to the normal operating condition, a fault condition Pf

(e.g. actuator limit switch failure, or excessive force applied to the operating hand wheel) should be considered.

$$P_f = 2F \text{ kN} \quad \text{where } F \text{ is defined above}$$

The operator generates a torque, but the forces associated with this can be neglected for a first approximation.

The weight of the penstock is usually secondary to the operating force, except for low head applications.

SPINDLE DIAMETER

This is determined by many factors, included in these are

- The spindle should not fail due to yield or buckling during normal operation.
- The spindle should not fail due to yielding under the worst fault condition.
- The slenderness ratio of the spindle should be less than 250 or 200 if specified. The slenderness ratio is the length of a spindle section between guides divided by a quarter of the spindle diameter.
- The spindle should be self-sustaining (that is the weight of the penstock door should not back-drive the spindle through its power screw).

HANDWHEEL AND TEE KEY EFFORT

The efforts considered below are for normal operation of the penstock against the specified heads. For a manually operated penstock the handwheel effort is limited to 250 N (55 lbf) as a single pull on the rim unless otherwise specified.

A Tee Key is usually 500mm across the handle and has a push/pull effort limited to 125N thus generating a torque of 62.5 Nm.

MANUAL OPERATION OF ELECTRIC ACTUATORS

Where a handwheel is fitted to an electric actuator as an auxiliary method of operation, the handwheel effort is limited to 250N if this is reasonable. Although the handwheel effort can be limited to 250N in most cases, this increases the complexity of the penstock drive.

For larger penstocks (above about 2000mm square) manual operation of the actuator for a full stroke of the door is not practicable due to the excessive number of turns required. If the penstock must be operable in the case of electrical failure, provision can be made for an auxiliary power device such as a mobile internal combustion engine power pack.

INTERNATIONAL STANDARDS

BS EN ISO 9001 : 2000	Quality Management System : Requirements
BS EN 1092-2 : 1997	Flanges and their joints; Circular flanges for pipes, valves, fittings and accessories; PN designated; Cast Iron Flanges
BS EN 1561 : 1997	Founding - Grey Cast Irons
BS EN 1982 : 1999	Copper and Copper Alloys : Ingots and Castings
BS 7775 : 1995	Specification for penstocks
BS EN 10025 : 1993	Hot rolled products of non-alloy structured steels. Technical delivery conditions.
BS EN 12167 : 1998	Copper and Copper Alloys : Profiles and rectangular bar for general purposes.
AWWA C501-92	Standard for Cast Iron sluice gates

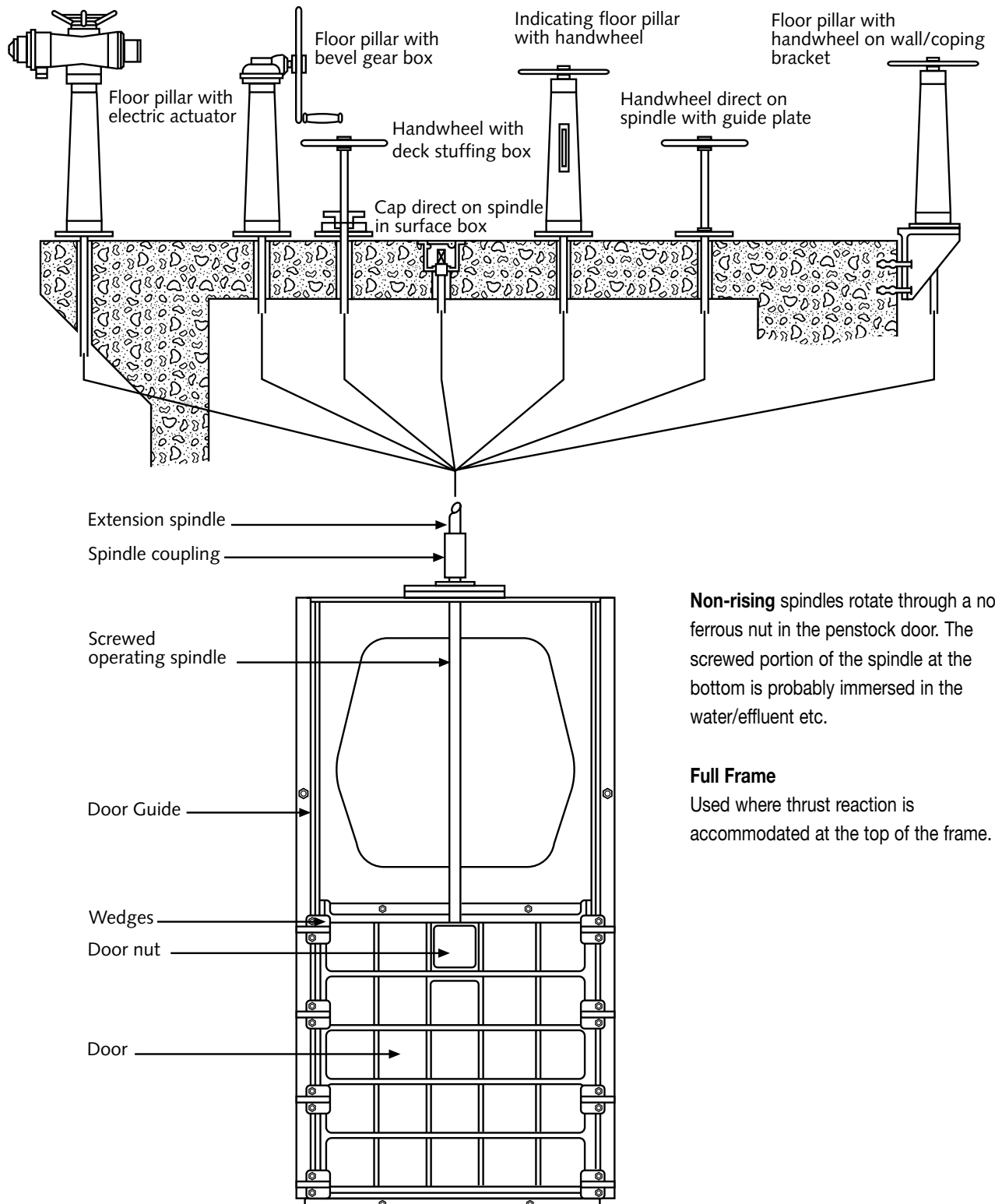
Special designs for non-standard sizes and high heads are available in

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Operating Gear

SELECTION

- Remote operation
- Thrust direct on frame
- Non-rising extension systems.



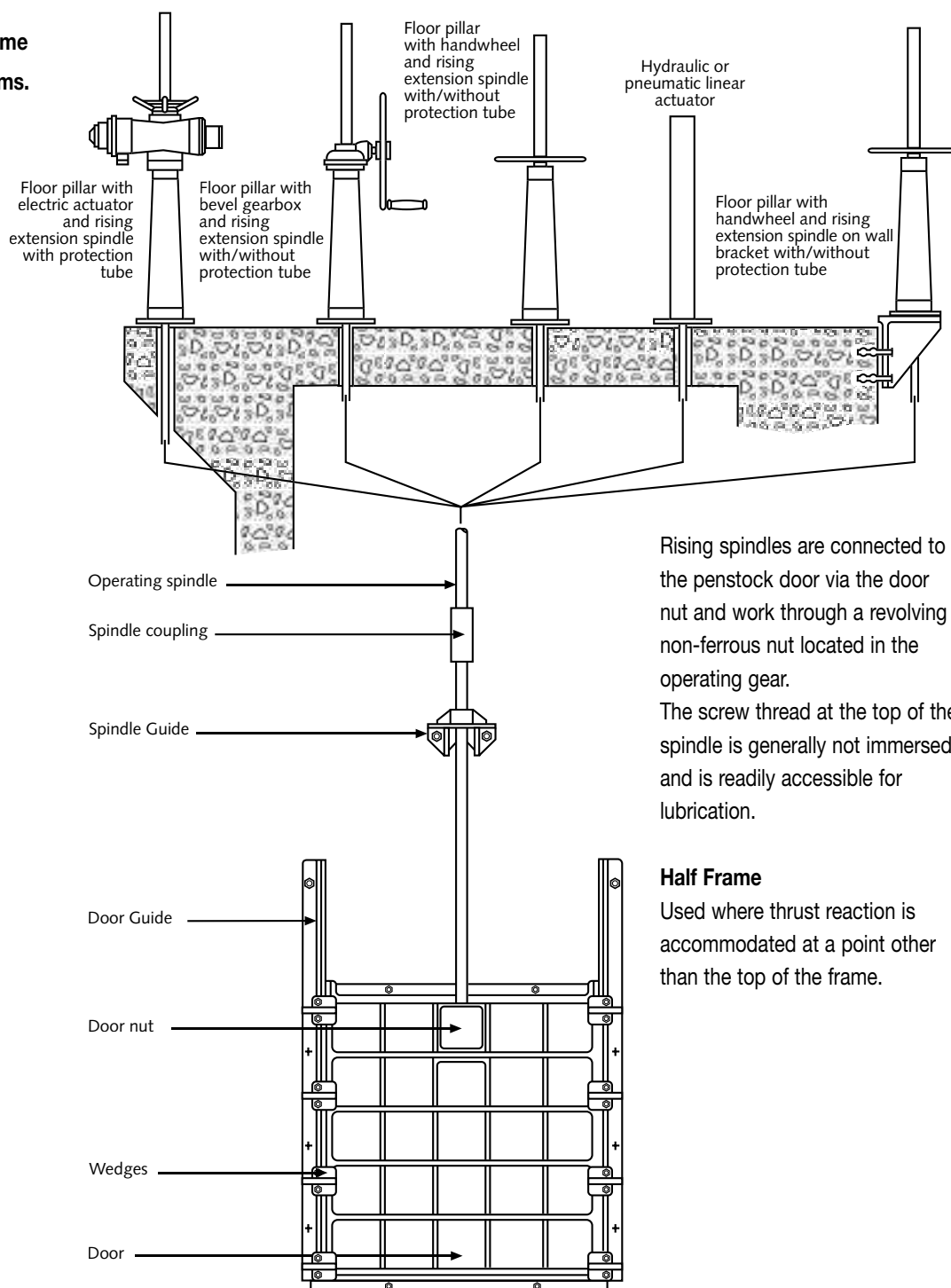
Non-rising spindles rotate through a non-ferrous nut in the penstock door. The screwed portion of the spindle at the bottom is probably immersed in the water/effluent etc.

Full Frame

Used where thrust reaction is accommodated at the top of the frame.

SELECTION

- Remote operation
- Thrust remote from frame
- Rising extension systems.



Rising spindles are connected to the penstock door via the door nut and work through a revolving non-ferrous nut located in the operating gear.

The screw thread at the top of the spindle is generally not immersed and is readily accessible for lubrication.

Half Frame

Used where thrust reaction is accommodated at a point other than the top of the frame.

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