



PENBERTHY AUTOMATIC INJECTORS

Hot water injectors used primarily as boiler feed pumps but also in numerous other applications for pumping liquids and discharging at high pressure and temperature



FEATURES

- Durable construction.
- Compact design that is free of mechanical parts.
- No foundation or floor space required.
- No external power source needed.
- Low initial cost, easy to operate and virtually maintenance-free.
- Eliminates the need for water pre-heating.
- Operating steam is condensed and returned to the boiler resulting in a thermal efficiency of nearly 100%.

GENERAL APPLICATION

Primary boiler feed service, stand-by boiler feed service, preheating make-up water, injection of feedwater treatment compounds and high-pressure, high-temperature water supply.

TECHNICAL DATA

Materials:	Bronze
Sizes:	3/8" to 2 1/2" (9.5 to 63.5 mm)
Connections:	Threaded with union tailpipes
Pressures:	to 250 psig (17.2 barg)
Temperatures:	to 212°F (100°C)

PENBERTHY AUTOMATIC INJECTORS

PRODUCT OVERVIEW

The injector may be defined as a boiler feeding pump, utilizing the velocity and condensation of a jet of steam from the boiler to lift and force into the same boiler a jet of water many times the weight of the original jet of steam.

The injector offers definite advantages over mechanically operated pumps when cold water make-up is used to feed boilers.

Automatic restarting

All Penberthy injectors are of the automatic restarting type. If the established flow of water from an injector to the boiler is interrupted temporarily by the admission of air into the suction line or by a jolt causing the overflow valve to open, the injector will re-establish flow automatically without the necessity of regulating any valves.

Feeds warm water to boiler

Penberthy injectors feed water into the boiler at a temperature of from 130°F to 212°F (55°C to 100°C) depending on the steam pressure and temperature of the supply water. By throttling the water supply line, feed water temperatures up to 212°F can be obtained under most operating conditions.

DESIGN

Injectors are designed to give well-balanced operation against the greatest possible range of steam pressure, water temperature and suction lift and to maintain satisfactory performance for a long period of service. Designs are the result of years of experience with injector applications. Injector connections have union tailpipes permitting quick removal from the line.

The standard connection configuration, known as 'stock', features the suction connection to the left and the delivery connection to the back. The optional 'F-B' configuration features suction to the front and delivery to the back. All parts are removed easily for cleaning or replacement and are precision made to assure interchangeability in the field.

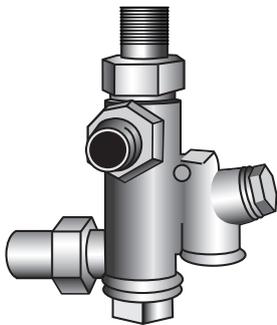
Material

Injectors are of all bronze construction with special bronze alloys being used for suction and delivery jets to resist wear.

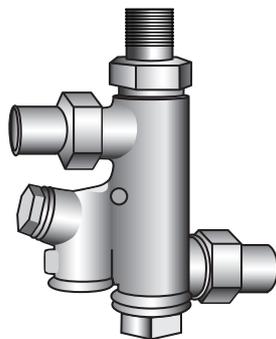
Inspection and testing

All injectors are tested at the factory on actual boiler installations, assuring that injectors will meet all performance claims as specified for the various models.

STANDARD AND HIGH PRESSURE INJECTORS

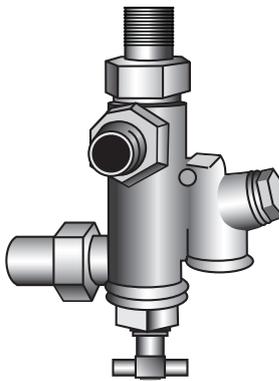


Stock model
Suction left - delivery back

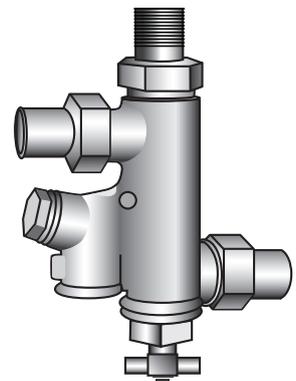


Suction front - delivery back

LOW PRESSURE INJECTORS



Stock model
Suction left - delivery back



Suction front - delivery back

PENBERTHY AUTOMATIC INJECTORS

APPLICATIONS

Injectors are installed as auxiliary equipment on power boilers, package steam generators, locomotive boilers and heating boilers that are required by many industries such as:

Manufacturing industries: Food processing, chemical, oil production and refining, agriculture, mining, lumber etc.

Service industries: Pressing and dry cleaning, vulcanizing, dairies, laundries, public utilities, transportation.

USES

Uses for injectors can be classified generally as follows:

Stand-by boiler feed pump service

Injectors provide boilers, which are already equipped with mechanically operated boiler feed pumps, with a reliable low cost secondary means of feed water supply.

Primary boiler feed pump service

Boilers not provided with mechanical feed water pumps can depend on injectors to function satisfactorily as the sole source of feed water supply.

Preheating make-up water

On applications where the water supply pressure exceeds the boiler steam pressure, injectors may be used to heat the water before injection into the boiler, avoiding the disadvantage of cold water striking hot boiler surfaces.

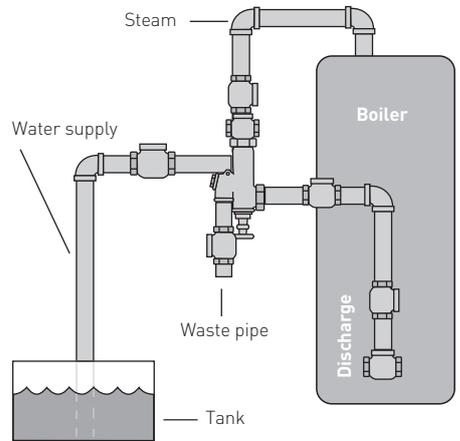
Injecting feed water treatment compounds

Suitably diluted mixtures of boiler feed water treatment compounds are picked up and injected into the boiler without difficulty.

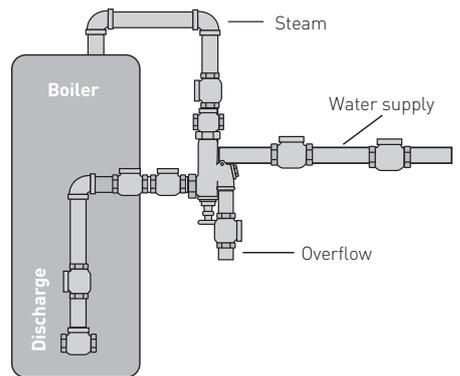
High pressure and temperature water supply

Injectors may be used as a source for obtaining a supply of hot water under high pressure for washing floors, containers, machine parts, etc. When used for this purpose the discharge nozzle must be sized to suit the injector capacity.

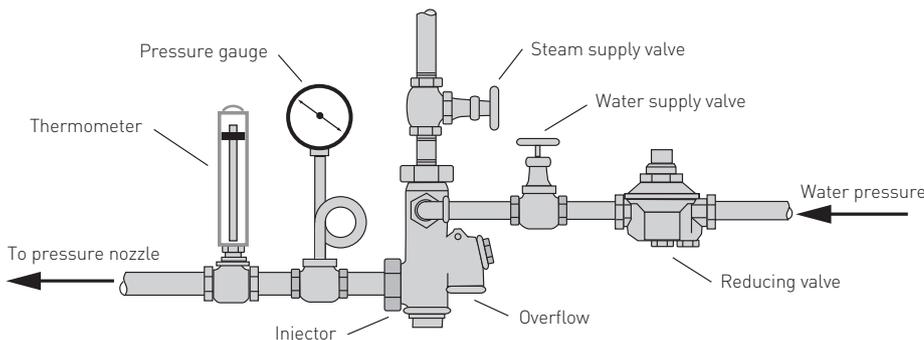
INSTALLATION FOR SUCTION LIFT



INSTALLATION FOR WATER PRESSURE SUPPLY



INSTALLATION FOR PRESSURE WASHING



PENBERTHY AUTOMATIC INJECTORS

OPERATING PRINCIPLE

Stage 1

When the steam supply valve is opened, steam passes through the steam jet into a suction chamber, proceeds through a suction jet and out of the overflow. Steam, which attains a velocity of approximately 2500 ft per second as it leaves the steam jet, entrains the air in the suction chamber and creates a vacuum.

Stage 2

The vacuum created in the suction chamber begins to draw in water from the supply line. The water is now entrained by the steam and a high velocity mixture of water and steam passes through the suction jet and out of the overflow.

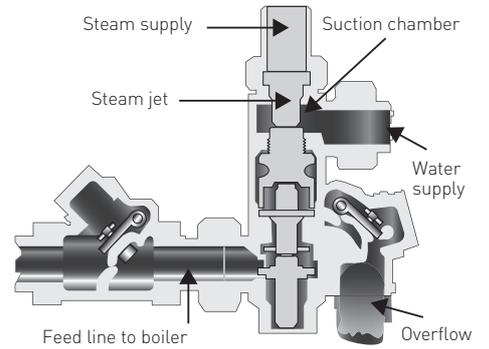
Stage 3

When the amount of steam and water reach the proper proportion, the steam condenses gradually as the mixture advances through the injector. The mixture is condensed fully on reaching the delivery jet parallel.

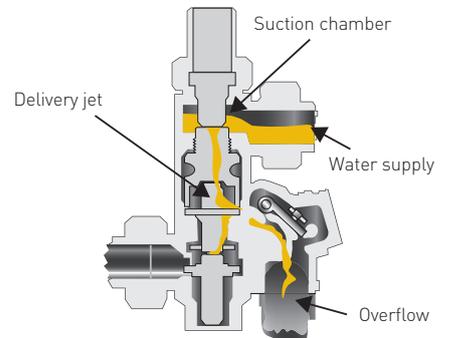
Stage 4

The energy contained in the water passing through the delivery jet is sufficient to build up a pressure, greater than the boiler pressure, causing water to flow through the discharge check valve into the boiler. When flow into the boiler is established, the overflow valve closes automatically and prevents the entrance of air which would disrupt operation of the injector. The total operating cycle requires only a few seconds.

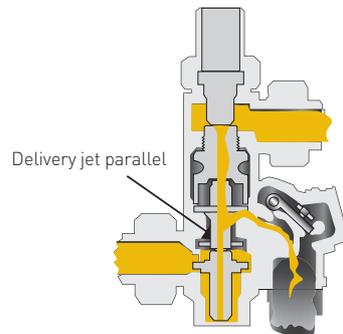
STAGE 1



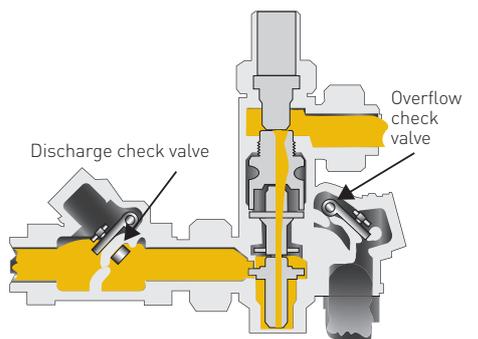
STAGE 2



STAGE 3



STAGE 4



PENBERTHY AUTOMATIC INJECTORS

STANDARD INJECTORS

Standard injectors are for suction lift applications with steam pressure from 25 to 140 psi (1.72 to 9.7 bar); suitable for steam pressures up to 250 psi (17.2 bar) in water pressure supply applications.

Standard injectors are available in two body styles and 8 sizes with screwed connections from 3/8" to 2 1/2" pipe size, with capacities as given in the performance tables on page 6. They are designed to meet the requirements of most applications and will operate satisfactorily within the following range of operating conditions:

TABLE 1 - STANDARD INJECTORS: OPERATING SPECIFICATIONS

Suction lift applications	
Minimum operating pressure	25 psi (172.5 kPa) steam pressure with 3ft. (0.9 m) lift and 74°F (23°C) water
Maximum operating pressure	up to 140 psi (965 kPa) steam pressure with 3ft. (0.9 m) lift and 74°F (23°C) water
Lift water	20 ft. (6.1 m) at 60-80 psi (414-552 kPa) steam pressure with 74°F (23°C) water
Maximum temperature of suction water	3ft. (0.9 m) lift and steam pressure as follows: 120°F (49°C) at 60-80 psi (414-552 kPa) 115°F (46°C) at 100 psi (689 kPa) 105°F (40.5°C) at 120 psi (830 kPa) 90°F (29°C) at 140 psi (1380 kPa)

WATER PRESSURE SUPPLY APPLICATIONS

When water under pressure is connected directly to the injector suction, standard injectors can be operated at steam pressures up to 250 psi (17.2 bar). At steam pressures of 100 psi or more, capacities are increased substantially and water supply must be regulated with extra care. On applications where steam pressures are below 100 psi (6.9 bar), Penberthy 'low pressure' injectors are recommended.

TABLE 2 - STANDARD MODELS AVAILABLE

Size no.	Boiler horsepower rating*	Pipe size conn. (in.)	Shipping weight (boxed) lb
OO-21	12	3/8	2 1/2
AA-21	25	1/2	3 1/2
BB-21	50	3/4	5 1/2
CC-21	85	1	8
DD-21	150	1 1/4	12
EE-23	250	1 1/2	25
FF-23	425	2	39
GG-21	600	2 1/2	75

NOTES

- *Boiler horsepower ratings based on supplying approximately 7 gallons of water per horsepower per hour with 3 ft suction lift and 80 psi steam pressure.
- Each injector is supplied with an all bronze pipe strainer one size larger than injector connection for installation at the end of the suction pipe.
- Size OO-21 injector is provided with a relief valve to facilitate starting at lower steam pressures.
- Size OO-21 injector is supplied with two small strainers for insertion in the steam and water supply union connections.

IMPORTANT

Injectors deliver their maximum capacity and operate most satisfactorily in the intermediate zone of their pressure operating range.
To be assured of best possible performance when selecting an injector, refer to also to pages 6, 7, 8 and 9 covering operating characteristics of the standard, high pressure and low pressure injectors.

PENBERTHY AUTOMATIC INJECTORS

STANDARD INJECTORS

Performance

TABLE 3 – SUCTION LIFT OPERATION

Capacities in gallons per hour at various suction lifts - 74°F water temperature							
Size no.	Lift in feet	Steam pressures - psig					
		40	60	80	100	120	140
OO-21	3	60	70	80	75	65	55
	8	50	65	75	70	61	-
	12	45	55	70	65	55	-
	16	36	50	65	60	45	-
	20	-	45	60	53	-	-
AA-21	3	150	175	180	165	155	150
	8	142	165	157	145	135	-
	12	135	155	135	133	120	-
	16	120	140	125	110	-	-
	20	-	110	110	-	-	-
BB-21	3	300	350	350	310	295	280
	8	290	300	300	270	250	230
	12	260	270	265	240	220	-
	16	-	240	235	215	-	-
	20	-	220	210	-	-	-
CC-21	3	540	585	585	550	520	480
	8	520	550	540	490	470	460
	12	420	425	420	400	390	-
	16	-	405	390	380	-	-
	20	-	360	300	-	-	-
DD-21	3	780	940	950	915	840	800
	8	760	900	870	780	720	705
	12	730	750	750	630	570	-
	16	-	580	555	525	-	-
	20	-	440	440	-	-	-
EE-23	3	1440	1800	1800	1740	1620	1500
	8	1300	1710	1710	1600	1460	1320
	12	1200	1500	1500	1450	1400	-
	16	-	1220	1200	1150	-	-
	20	-	1020	1000	-	-	-
FF-23	3	2200	2520	2940	2880	2640	2500
	8	2200	2520	2400	2160	1920	-
	12	2040	2280	2160	1920	-	-
	16	-	1920	1800	1560	-	-
	20	-	1560	1400	-	-	-
GG-21	3	3140	3600	4200	4100	3750	3550
	8	3100	3600	3430	3100	2700	-
	12	2900	3250	3000	2700	-	-
	16	-	2740	2550	2200	-	-
	20	-	2200	2000	-	-	-

Capacities shown are the maximum amount an injector can pump at the steam pressures indicated. If flow exceeds the amounts shown, due to excessive water supply pressure, the valve in the water supply line can be regulated to provide the correct flow.

Capacities are reduced if injectors are required to handle water at higher than normal temperature. When operating with a 3 ft lift at the limiting temperature, for a given steam pressure, capacities are reduced approximately as follows:

TABLE 4 – PRESSURE SUPPLY OPERATION

Capacities in gallons per hour with 12 psig water pressure supply at 74°F temperature							
Size no.	Steam pressure - psig						
	80	100	120	140	160	200	250
OO-21	80	95	100	115	115	110	105
AA-21	180	210	225	255	255	245	230
BB-21	350	405	440	490	490	475	445
CC-21	585	675	730	820	820	790	745
DD-21	950	1095	1190	1330	1330	1285	1205
EE-23	1800	2070	2250	2520	2520	2430	2285
FF-23	2940	3385	3675	4120	4120	3970	3735
GG-21	4200	4830	5250	5880	5880	5670	5335

TABLE 5

Water temperature (°F)	Reduction in capacity (%)
90	10
100	12
110	15
120	20

PENBERTHY AUTOMATIC INJECTORS

HIGH PRESSURE INJECTORS

High pressure injectors are for suction lift applications with steam pressures from 50 to 200 psi (3.4 to 13.8 bar).

They are available in two body styles and 8 sizes with screwed connections from 3/8" to 2 1/2" pipe size with capacities as given in Table 8. At the same operating pressure, they use less steam than 'standard' injectors, permitting the handling of warmer supply water and higher suction lift as indicated by their design range given below.

TABLE 6 - HIGH-PRESSURE MODELS AVAILABLE

Size no.	Boiler horsepower rating*	Pipe size conn. (in.)	Shipping weight (boxed) lb
OO-326	12	3/8	2 1/2
AA-328	27	1/2	3 1/2
BB-330	50	3/4	5 1/2
CC-332	90	1	8
DD-334	140	1 1/4	12
EE-336	275	1 1/2	25
FF-338	450	2	39
GG-340	650	2 1/2	75

TABLE 7 - HIGH-PRESSURE INJECTORS: OPERATING SPECIFICATIONS

Suction lift applications	
Minimum operating pressure	50 psi (345 kPa) steam pressure with 3ft. (0.9 m) lift and 74°F (23°C) water
Maximum operating pressure	up to 200 psi (1380 kPa) steam pressure with 3ft. (0.9 m) lift and 74°F (23°C) water
Lift water	20 ft. (6.1 m) at 80-120 psi (552-830 kPa) steam pressure with 74°F (23°C) water
Maximum temperature of suction water	3ft. (0.9 m) lift and steam pressure as follows: 120°F (49°C) at 120 psi (830 kPa) 115°F (46°C) at 140 psi (689 kPa) 105°F (40.5°C) at 170 psi (830 kPa) 85°F (29°C) at 200 psi (1380 kPa)

NOTES

*Boiler horsepower ratings based on supplying approximately 7 gallons of water per horsepower per hour with 3 ft suction lift and 140 psi steam pressure.

Each injector is supplied with an all bronze pipe strainer one size larger than injector connection for installation at the end of the suction pipe.

Sizes OO-326 through DD-334 are provided with a relief valve to facilitate starting at the lower steam pressures.

Size OO-326 injector is supplied with two small strainers for insertion in the steam and water supply union connections.

PENBERTHY AUTOMATIC INJECTORS

TABLE 8 – SUCTION LIFT OPERATION

Capacities in gallons per hour at various suction lifts - 74°F water temperature									
Size no.	Vertical lift in feet	Steam pressures - psig							
		60	80	100	120	140	160	180	200
OO-326	3	54	68	84	89	91	85	81	76
	8	50	61	74	77	78	72	68	-
	12	43	52	63	66	66	61	-	-
	16	39	44	54	56	56	-	-	-
AA-328	20	-	36	44	45	-	-	-	-
	3	130	150	180	200	210	200	190	180
	8	120	135	158	174	181	170	161	-
	12	104	115	135	148	153	144	-	-
BB-330	16	94	97	115	126	130	-	-	-
	20	-	79	94	102	-	-	-	-
	3	238	300	367	390	400	375	357	332
	8	220	270	323	339	344	318	303	-
CC-332	12	190	231	275	288	292	270	-	-
	16	171	195	234	246	248	-	-	-
	20	-	159	191	199	-	-	-	-
	3	450	510	640	680	670	640	600	540
DD-334	8	416	459	563	592	576	544	510	-
	12	360	393	480	503	489	391	-	-
	16	324	331	409	428	415	-	-	-
	20	-	270	333	347	-	-	-	-
EE-336	3	600	820	930	1020	1080	1000	960	900
	8	555	738	818	887	929	850	816	-
	12	480	631	697	755	788	720	-	-
	16	432	533	595	643	670	-	-	-
FF-338	20	-	434	483	520	-	-	-	-
	3	1220	1550	1890	2010	2050	1920	1830	1710
	8	1128	1395	1663	1748	1763	1632	1555	-
	12	976	1193	1417	1487	1497	1382	-	-
GG-340	16	878	1007	1209	1266	1271	-	-	-
	20	-	821	983	1025	-	-	-	-
	3	2000	2530	3080	3290	3350	3140	3000	2790
	8	1850	2277	2710	2862	2881	2669	2550	-
GG-340	12	1600	1948	2310	2435	2446	2261	-	-
	16	1440	1644	1971	2073	2077	-	-	-
	20	-	1341	1601	1678	-	-	-	-
	3	2750	3470	4225	4500	4600	4300	4100	3800
GG-340	8	2540	3100	3700	3900	3950	3660	3500	-
	12	2200	2670	2170	3330	3350	3100	-	-
	16	1950	2250	2700	2840	2800	-	-	-
	20	-	1840	2200	2300	-	-	-	-

PENBERTHY AUTOMATIC INJECTORS

LOW PRESSURE INJECTORS

Low pressure injectors are for steam pressures from 15 to 100 psi (1 to 6.9 bar) with 3 ft suction lift or water pressure supply.

Designed to operate under conditions of relatively low boiler pressure using cold water with a 3 ft maximum suction lift or water pressure supply connected directly to the suction connection, the injector is ideal as a feed water pump for process steam boilers used in vulcanizing shops, dairies, laundries or for clothes pressing machines.

Available in 2 body styles and 7 sizes with screwed connections from 3/8" to 2" pipe size and with capacities as indicated in Table 11. The injector uses the same body as the 'standard' and 'high pressure' models.

TABLE 9 - LOW-PRESSURE MODELS AVAILABLE

Size no.	Boiler horsepower rating*	Pipe size conn. (in.)	Shipping weight (boxed) lb
OO-526	12	3/8	2 1/2
AA-528	25	1/2	3 1/2
BB-530	50	3/4	5 1/2
CC-532	85	1	8
DD-534	125	1 1/4	12
EE-536	240	1 1/2	25
FF-538	400	2	39

NOTES

*Boiler horsepower ratings based on supplying approximately 7 gallons of water per horsepower, per hour with 3 ft suction lift and 40 lbs steam pressure.

Each injector is supplied with an all bronze pipe strainer one size larger than injector connection for installation at the end of the suction pipe.

Sizes OO-526 through DD-534 are provided with a relief valve to facilitate starting at the lower steam pressures.

Size OO-526 injector is supplied with two small strainers for insertion in the steam and water supply union connections.

TABLE 10 - LOW-PRESSURE INJECTORS: OPERATING SPECIFICATIONS

Suction lift or water supply applications	
Minimum operating pressure	15 psi (100 kPa) steam pressure with 3ft. (0.9 m) lift and cold water
Maximum operating pressure	up to 100 psi (689 kPa) steam pressure with 3ft. (0.9 m) lift and cold water
Lift water	3 ft. (0.9 m) lift max at 20-100 psig steam (138-689 kPag) pressure

TABLE 11 - LOW PRESSURE CAPACITIES

Capacities in gallons per hour 3 ft lift - 74°F water temperature					
Size no.	Steam pressures - psig				
	20	40	60	80	100
OO-526	55	80	75	65	55
AA-528	125	180	170	160	150
BB-530	270	350	330	305	280
CC-532	490	585	565	520	480
DD-534	720	900	880	800	720
EE-536	1350	1700	1650	1500	1350
FF-538	2300	2900	2800	2350	2300

NOTE

When operated with water pressure supply, capacities shown in the table will be increased by approximately 20%.

PENBERTHY AUTOMATIC INJECTORS

DIMENSIONS

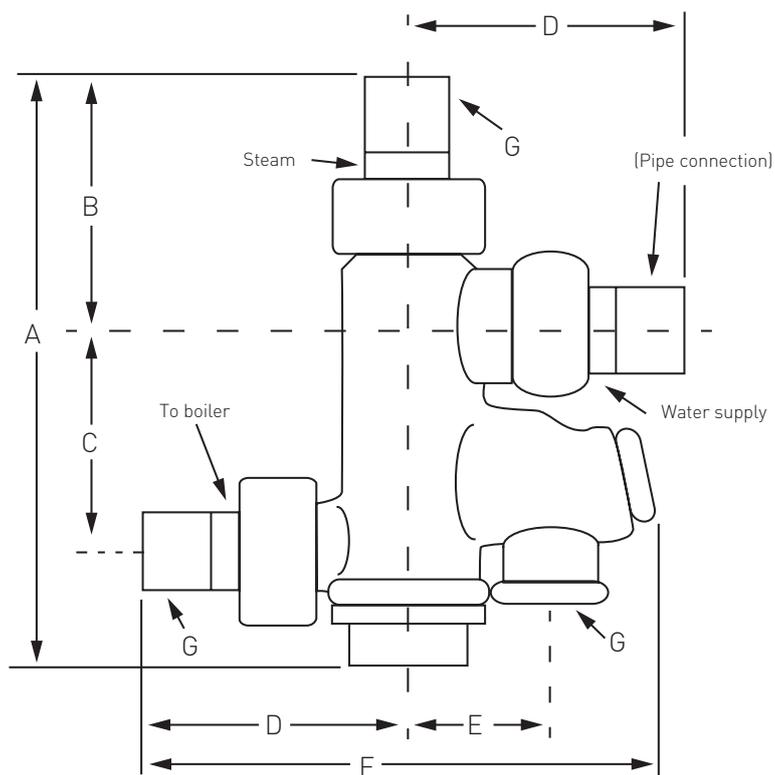


TABLE 12 - STANDARD, HIGH AND LOW PRESSURE INJECTORS DIMENSIONS

Size no.	Dimensions in inches						
	A	B	C	D	E	F	G
OO	4 ³ / ₄	2	1 ³ / ₄	2 ³ / ₈	1 ¹ / ₄	4 ¹ / ₂	³ / ₈
AA	5 ⁷ / ₈	2 ³ / ₈	2 ³ / ₈	2 ⁵ / ₈	1 ¹ / ₄	5 ¹ / ₈	¹ / ₂
BB	7 ¹ / ₈	2 ³ / ₄	2 ⁷ / ₈	3 ¹ / ₈	1 ⁵ / ₈	5 ³ / ₄	³ / ₄
CC	8 ¹ / ₈	3	3 ³ / ₈	3 ³ / ₈	1 ⁷ / ₈	6 ⁵ / ₈	1
DD	9 ³ / ₄	3 ⁵ / ₈	4 ¹ / ₄	4 ¹ / ₄	2 ¹ / ₄	7 ⁷ / ₈	1 ¹ / ₄
EE	13 ¹ / ₄	4 ³ / ₄	5 ³ / ₈	4 ³ / ₄	3	9 ⁵ / ₈	1 ¹ / ₂
FF	15 ¹ / ₈	5 ¹ / ₄	6 ⁷ / ₈	5 ¹ / ₄	3 ⁵ / ₈	11 ¹ / ₄	2
GG*	17 ⁵ / ₈	5 ⁷ / ₈	8 ¹ / ₂	6 ⁵ / ₈	4 ¹ / ₂	14 ¹ / ₂	2 ¹ / ₂

* Standard and high pressure injectors only.

PENBERTHY AUTOMATIC INJECTORS

BRASS STRAINERS

These large-capacity strainers are furnished with every injector to prevent passageways in the jets from becoming stopped up by foreign matter. Sizes 2" and larger are the flat type shown at the right.

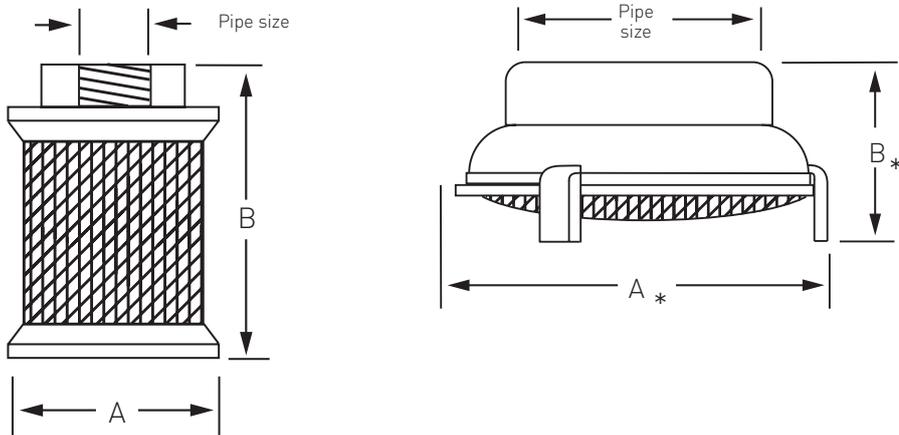


TABLE 13 - BRASS STRAINERS DIMENSIONS IN INCHES

Pipe size	A (dia)	B	Wire mesh
3/8	1 11/16	2 1/4	30
1/2	1 11/16	2 1/4	30
3/4	1 11/16	2 5/16	30
1	1 7/8	2 7/16	16
1 1/4	2 3/16	2 7/16	16
1 1/2	2 1/2	2 11/16	16
2*	3 3/8 *	1 3/4 *	1/8 **
2 1/2*	4 3/5 *	1 13/16 *	1/8 **
3*	4 1/4 *❖	1 13/16 *	1/8 **

❖ square

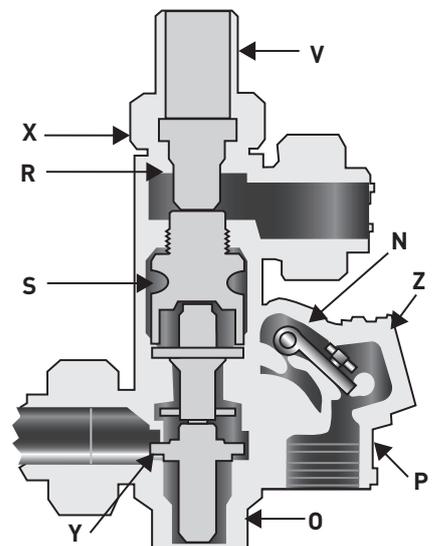
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TABLE 14 - SPARE PARTS

Code	Item
N	Hinge
O	Solid plug or plug with relief valve (3/8" to 1 1/4" high and low pressure injectors)
P	Valve
R	Steam jet
S	Suction jet
V	Tail pipe
X	Coupling nut
Y	Delivery jet
Z	Cap
-	Strainer steam and water supply union connection (00-21, 00-326, 00-526)

NOTE

The steam jet, suction jet and delivery jet are not interchangeable on various models; therefore you must supply us with the injector's serial number, which is stamped on the nameplate above the overflow connection.



PENBERTHY AUTOMATIC INJECTORS

SELECTION GUIDE

To determine the correct automatic injectors for a specific application, focus on information relating to the operating conditions of the application, make note of the required specification data listed below. Consult the sizing guides on the preceding pages or contact your sales representative who can help select the proper automatic injector for the conditions.

Information required

Injectors can be selected properly by considering the following facts relating to the operating conditions under which the injectors will be required to work:

1. Lowest and highest operating steam pressure carried by the boiler.
2. Vertical distance that the supply water must be lifted, if the water supply is below the injector, and the horizontal distance from the water intake to the injector.
3. The supply water pressure if the water is taken from the city mains or from elevated tanks.
4. The temperature of the supply water.
5. The maximum rate of evaporation of water from the boiler.

CAPACITY

The size of the injector to be selected depends principally on the rate at which the boiler is called upon to evaporate water. It should be chosen so that it will deliver at least 30% (preferably 50 to 100%) more water than the expected maximum evaporation rate of the boiler.

The horsepower ratings given are based on supplying approximately 75% more than the rate of evaporation of a boiler operating at full rating, or between 7 and 8 gallons per boiler horsepower. Reference to injector performance tables will indicate that the capacity of an injector will vary, depending upon the operating steam pressure, suction lift, suction water temperature or a combination of these conditions. Unless an injector is already operating at limiting conditions, its capacity can be reduced by regulating the water supply line valve.

SELECTION GUIDE

Example:	00	- 2	S	NT	- 01
Injector size					
00 3/8"					
AA 1/2"					
BB 3/4"					
CC 1"					
DD 1 1/4"					
EE 1 1/2"					
FF 2"					
GG 2 1/2"					
Pressure rating					
2 Standard 25 - 140 psi					
3 High pressure 50 - 200 psi					
5 Low pressure 15- 100 psi					
Body style					
S Stock (suction left - delivery back)					
F F - B (suction front - delivery back)					
Connection style					
NT NPT					
Variation					
01 Catalog standard					

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