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HIGH SHOCK SERIES TURBINE FLOWMETERS

Installation, Operation and Maintenance Manual

SERIAL NUMBER________________________________

The specifications contained in this manual are subject to change without notice and any user of these specifications should verify from the manufacturer that the specifications are currently in effect. Otherwise, the manufacturer assumes no responsibility for the use of specifications that have been changed and are no longer in effect.

HS SERIES

TURBINE FLOWMETERS
Installation, Operation
and
Maintenance Manual

TM-65397 REV. G

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Virtually every major commercial, government, and scientific organization is making use of our products, expertise and extensive technical support. This is a culmination of years of refinement in our flowmeter and calibrator designs that has resulted in the technological leadership in the flow measurements field that we enjoy.

We are proud of our quality products, our courteous service and welcome you, as a valued customer, to our growing family.

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TM-65397 REVISIONS

DATE	REVISION	ECO NUMBER	APPROVAL
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1 INTRODUCTION

This manual provides information and guidance for the installation, operation, and maintenance of the High Shock Turbine Flowmeters, manufactured by FTI Flow Technology, Inc., Phoenix, Arizona.

2 HIGH SHOCK FLOWMETER

The Flow Technology, Inc. High Shock Turbine Flowmeter is a volumetric flow measuring instrument. The flow sensing element is a freely suspended, bladed rotor positioned axially in the flow stream with the flowing fluid pushing against the blades. The rotational speed of the rotor is proportional to the velocity of the fluid. Since the flow passage is fixed, the turbine rotors rotational speed is also a true representation of the volume of fluid flowing through the flowmeter. The rotation of the turbine rotor generates electrical pulses in the pickoff that is attached to the flowmeter housing in close proximity to the turning rotor. Each one of these pulses represents a discrete volume of fluid. The frequency, or pulse repetition rate represents, the volumetric flow rate and the accumulated pulse total represents the total volume measured. All requests for information concerning a specific meter should contain the flowmeter model number and the flowmeter serial number.

The High Shock Flowmeter consists of 3 basic assemblies (see Figure 1).

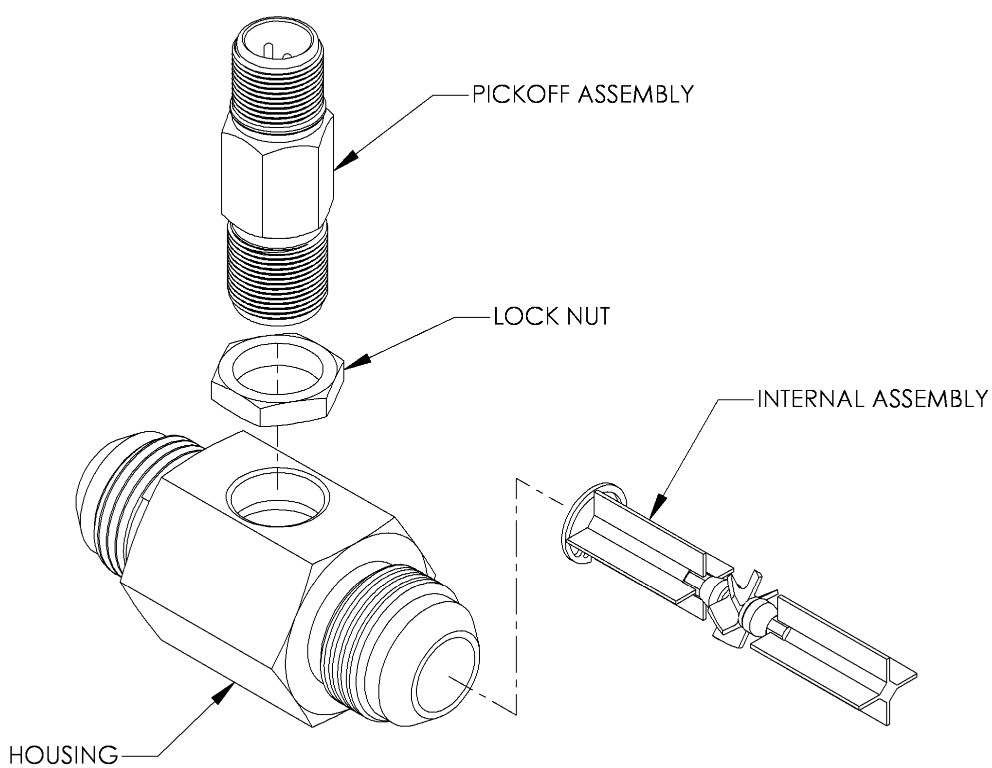


Figure 1 – Flowmeter Basic Parts

3 INSPECTION UPON RECEIPT

The flowmeter should be unpacked carefully and inspected to verify that no damage occurred during shipment. Make certain that the internal parts are clean and free from packing materials or debris.

C A U T I O N
The flowmeter is a precision instrument and may be damaged if pressurized air is used for cleaning the flowmeter or for checking the rotation of the rotor.

4 MECHANICAL CONNECTIONS

4.1 Flow Conditioning

The turbine flowmeter is sensitive to velocity profile disturbances in the flow stream. For optimizing the velocity profile it is recommended that a straight run of constant diameter piping with length of at least 10 diameters upstream of the meter and at least 5 diameters downstream be provided (see Figure 2). The upstream section should have straightening vanes or other flow conditioners. The presence of major flow disturbance generators such as pumps, valves, or elbows may require longer straight sections. If swirl is present in the line ahead of the flowmeter installation, a longer straight section or additional flow conditioning may be required. Flow Technology, Inc. provides an array of innovative state of the art flow conditioners.

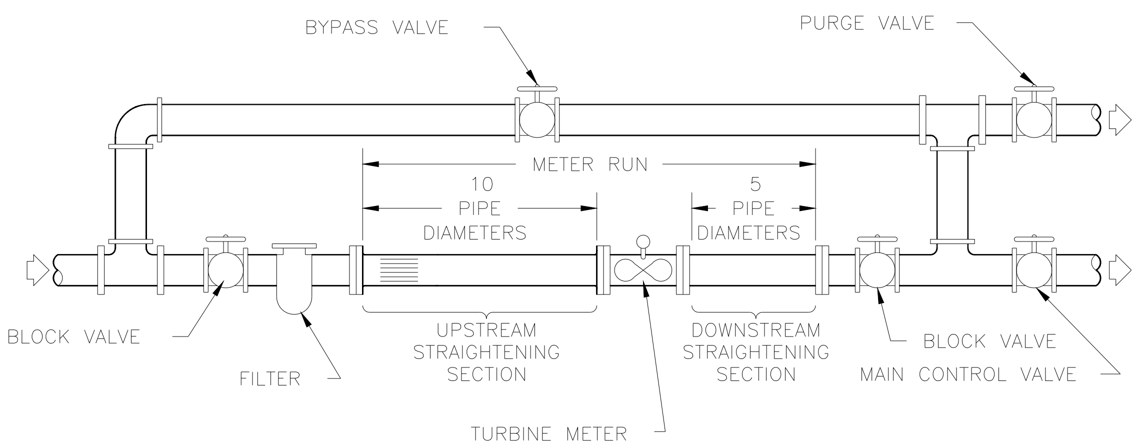


Figure 2 - 3-Valve Bypass Manifold Pipe Schematic

4.2 Purging

All flow lines in the meter system should be purged prior to installation of the meter. This will remove pipe dope, metal shavings, slag and debris that may damage the turbine meter. Control valves should be located downstream from the turbine meter (see Figure 2). System start-ups with upstream control valves in an unfilled system can result in a hydraulic shock on the meter. While the High Shock Flowmeter is designed to withstand hydraulic shock, the lines should still be purged to avoid unnecessary stresses on the flowmeter. A large amount of shock can cause damage and a change in calibration of the flowmeter.

4.3 Installation Recommendation

For liquid flowmeters, it is recommended that the flowmeter is installed so that it remains full of fluid when the flow ceases. When the flowmeter is left installed in a line that is temporarily out of service and has been partially or fully drained, severe bearing corrosion may occur. The type and corrosiveness of the fluid being metered, the type of bearing used in the flowmeter, and the length of time the line will be out of service are factors which may affect the life and operation of the flowmeters. If it is economically feasible and conditions permit, the flowmeter should be removed, cleaned, and stored when there is any doubt about the fluid level in the line during these out-of-service periods. See Section 9.1, Inspection, Cleaning, and Storage.

4.4 Orientation and Calibration

The orientation of the turbine flowmeter will influence the nature of the load on the rotor bearings, and thus, the performance of the meter at low flow rates. For optimum accuracy a turbine meter should be installed in the same orientation in which it was calibrated. Standard calibration orientation is with the meter axis horizontal.

4.5 Filtration

A filter should be installed upstream of the flowmeter (see Figure 2). Table 1 shows the recommended filtration levels.

Table 1 – Recommended Filter Size in microns

Flow Meter Size	Ball Bearing	Journal Bearing
1/2” and smaller	10 micron	75-100
3/4”	20	75-100
1”	20	75-100
1-1/2”	50	75-100

4.6 Torque Requirements

Table 2 provides the recommended torque in ft-lbs. for tightening MS-33656 flared-tube end fittings

Table 2 – Torque Requirements (ft-lbs.)

Fitting Size	Aluminum Tubing		Steel Tubing	
	MIN	MAX	MIN	MAX
1/2”	19	21	37	40
5/8”	27	30	54	58
3/4”	35	40	75	85
1”	41	58	100	116
1-1/4”	66	75	126	140
1-1/2”	66	75	158	175
2”	150	166	221	245

5 PICKOFFS

5.1 Installation

Pickoffs should bottom in the well of the flowmeter housing but should only be finger tightened to approximately 4 in-lbs. (4500 gm-cm max) to prevent distortion of the coil housing. The pickoff is secured in position by tightening the lock nut to approximately 25 in-lbs. (30000 gm-cm). The pickoff is removed by loosening the hex lock nut and unscrewing the pickoff from the housing.

C A U T I O N
Meter pressure ratings are established with a pickoff installed. Do not operate a flowmeter under pressure without a pickoff installed.

5.2 Magnetic Pickoff

The magnetic pickoff output is a low level signal that ranges from 10 mV to several volts peak-to-peak. A pulse amplifier may be needed to convert the pickoff low level signal to a 10 V peak-to-peak pulse signal suitable for process instrumentation. Typical resistance of magnetic pickoffs is 2275 Ω ± 20%.

5.3 RF Pickoff

The modulated carrier (RF) pickoff must be installed with an appropriate amplifier (consult factory). The amplifier is needed to convert the modulated carrier signal to a 10 V peak-to-peak pulse signal suitable for process instrumentation. Typical resistance of modulated carrier pickoffs is 10 Ω ± 10%.

6 ELECTRICAL CONNECTIONS

6.1 Connections

Standard pickoffs are available with a two or three-contact connector or with a threaded body and pigtail connectors.

6.2 Connection Cable

The connecting cable between the flowmeter and the electronic instrumentation should be a two conductor, 22 AWG, shielded and twisted cable with a vinyl jacket (Belden 8761 or equivalent). The cable should not be installed in a conduit or tray containing power lines, or close to strong electromagnetic sources such as electric lines, electric motors, transformers, welding machines, or high voltage lines. These sources may induce transient electrical noise in the coil and cause false pulse signals. Connections from standard pickoffs are not polarized and may be connected in either position. For non-standard pickoffs please refer to manufacturer's specifications.

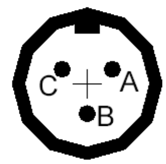
6.3 Grounding Considerations

The shield of the cable is to be grounded at only one point in accordance with the instructions of the display instrument. Flow Technology, Inc. display instruments specify where the shield is to be grounded.

6.4 Signal Processing

An electronic signal conditioning circuit is required to either convert the frequency output of the flowmeter into a visual presentation on a display or to provide process control signals. Flow Technology, Inc. manufactures a complete line of electronic packages, which include rate and total displays, rate converters, and microprocessor based units for linearization and temperature / pressure compensation.

Table 3 – Signal Processing Specifications

Pickoff	Connector	Specifications
Standard	2 Pin MS	Non-polarized Pins Mating Connector FTI P/N:15-89515-101
Amplified Pickoffs 27-94057	3 Pin MS Wire Leads	A = Power B = Ground C = Pulse  Mating Connector FTI P/N: 15-89515-102 Red = Power Black = Ground White = Pulse Input Power = 8 to 30 VDC @ 10 mA Output = 0 to 5 VDC Pulse Output Impedance = 2.2 kΩ Mag Amp: Frequency Range = 10 Hz to 10 kHz Input Sensitivity = 20 mV p-p RF Amp: Frequency Range = 10 to 3200 Hz Oscillator Carrier Frequency = 45 kHz Junction Box with Terminal Strip FTI P/N 73-31836-105

7 OPERATION

7.1 Over Range

In general, turbine flowmeters remain quite linear when they are over ranged, and may not provide any indication that the instrument is being misused. However, the pressure drop will become excessive and over speeding of the bearings could cause permanent damage. Bearings may also be damaged by excessive downstream thrust load. The probability of an over speed condition for a liquid meter usually occurs during system start up when there is still air in the lines. Air should be bled carefully from the lines before high flow range is established. The flow rate or output frequency should be monitored to insure maximum capability is not exceeded. Flow Technology's specifications should be consulted for specific maximum operating flow rates (see Table 5 and Table 6). Under extreme conditions, the maximum operating flow rates can be exceeded for brief periods of time without meter damage. Table 4 shows the maximum allowable over range capabilities.

Table 4 – Maximum Overspeed Allowances

Bearing Type	Overspeed Allowance (%)
Ball	50%
Journal	50%

7.2 Under Range

When used below the minimum specified range, turbine meters may become very non-linear. The repeatability of the meter may also be reduced due to bearing and magnetic pickoff drag.

Table 5 – Ball Bearing Operating Conditions

Meter Size	Standard Range 10:1 RF& MAG Pickoff (GPM)	Extended Range		Nominal K Factor (PULSE/ GALLON)	Maximum Frequency (Hz)
		RF Pickoff (GPM)	MAG Pickoff (GPM)		
HS4-6	.25-2.5	.03-3	.1-3	48000	2000
HS4-8	.25-2.5	.03-3	.1-3	48000	2000
HS6-8	.5-5	.05-5	.12-5	25000	2100
HS8-8	.75-7.5	.08-8	.16-8	16000	2000
HS-08	1-10	.1-10	.2-10	12000	2000
HS-10	1.25-12.5	.15-15	.3-15	9600	2000
HS-12	2-20	.25-25	.5-25	6000	2000
HS-16	5-50	.6-60	1-60	2400	2000
HS-20	9-90	1-100	1-100	1300	1950
HS-24	15-150	1.6-160	2.5-160	600	1500
HS-32	22-225	2.5-250	3.5-250	310	1100
HS-40	40-400	4.5-450	5.0-450	180	1200

Notes:

1. Repeatability = ± .05%, over 10:1 range
   ±0.1% typical, over extended range
2. Linearity = ± 1% of reading for HS4-6 thru HS-08 over 10:1 range, water or solvent
   ± 0.5% of reading, HS-10 and larger over 10:1 range, water or solvent

Table 6 –Journal Bearing Operating Conditions

Meter Size	Standard Range 10:1 RF& MAG Pickoff (GPM)	Extended Range		Nominal K Factor (PULSE/ GALLON)	Maximum Frequency (Hz)
		RF Pickoff (GPM)	MAG Pickoff (GPM)		
HS4-6	.25-2.5	.1-3	.12-3	48000	2000
HS4-8	.25-2.5	.1-3	.12-3	48000	2000
HS6-8	.5-5	.15-5	.2-5	25000	2000
HS8-8	.75-7.5	.2-8	.25-8	16000	2000
HS-08	1-10	.25-10	.3-10	12000	2000
HS-10	1.25-12.5	.3-15	.4-15	9600	2000
HS-12	2-20	.5-25	.5-25	6000	2000
HS-16	5-50	1-60	1-60	2400	2000
HS-20	9-90	1-100	1.5-100	1300	1950
HS-24	15-150	1.6-160	2.5-160	600	1500
HS-32	22-220	2.5-250	3.5-250	310	1100
HS-40	40-400	4.5-450	5-450	180	1200

Notes:

1. Repeatability = ± .1% HS4-6 thru HS-12 over 10:1 range
   ± .05%, HS-16 and larger over 10:1 range
   ± .25% typical over extended range
2. Linearity = ± 2% of reading HS4-6 and HS4-8 over 10:1 range, water or solvent
   ± 1% of reading, HS6-8 thru HS-08 over 10:1 range, water or solvent
   ± .5% of reading, HS-10 and larger over 10:1 range, ≤ 3 cst

7.3 Liquid Turbine Flowmeter Characteristics

7.3.1 Introduction

Optimum performance of a turbine meter system depends upon a valid calibration as well as the correct selection of supporting equipment. The rotational speed of a turbine rotor depends upon fluid properties as well as the fluid velocity. The most significant fluid property for a liquid meter is the kinematic viscosity. As liquid viscosity increases, the slip of the turbine rotor due to viscous drag is increased, and the rotational speed and hence pickoff frequency is decreased. Due to these effects, the kinematic viscosity of the calibration fluid should approximate the service conditions as closely as possible.

7.3.2 Standard Calibration

Standard liquid calibrations at FTI are done with MIL-C-7024 Type II solvent or water at room temperature. The viscosity of these fluids is approximately 1.25 and 1 centistokes respectively. The standard calibration consists of 10 data points distributed over the normal 10:1 range of the flowmeter. If viscosities or flow ranges other than these are required, they must be specified.

7.3.3 Single Viscosity Calibration

If the flowmeter is to be used at a viscosity other than the standard calibration viscosities, an oil blend calibration should be done on the meter to simulate the operating conditions. The calibration curve produced will represent the flowmeter's output characteristics for that specific viscosity. If the flowmeter is used with liquids having viscosities greater than 3 centistokes, the linearity of the K-factor will be reduced.

7.3.4 Multiple Viscosity Calibrations

If the viscosity is changing due to varying temperature in the system, the performance characteristics over a range of viscosities can be established. This is done by performing multiple calibrations at different viscosities to cover the range of interest. The K-factor of the meter is then plotted as a function of frequency (f) divided by viscosity (ν). The K-factor is the number of pulses generated by a flowmeter for every unit volume of fluid passing through it. The output frequency of the meter is f in Hz and v is the kinematic viscosity of the fluid in centistokes. The plot of K vs. f/v is commonly referred to as a universal viscosity curve. The data is plotted in this manner because all points fall on a single smooth curve. To obtain a useful curve, calibration points for calibrations at several viscosities are required. By observing the output frequency of the flowmeter and obtaining the viscosity or temperature of the fluid, the value of f/v can be calculated. Using the universal viscosity curve, the value of K corresponding to the known value of f/v can be determined. With the K Factor known, the flow through the meter can be determined from the expression:

$$GPM = \frac{f\,(60)}{K\ Factor}$$

Optimum performance requires the following factors:

1) HS Series flow meters
2) Ball Bearings
3) RF pick-off
4) Viscosity range from 0.8 to 100 centistokes
5) For every factor of ten the viscosity changes, a calibration is required

8 SPECIFICATIONS AND OPTIONS

Table 7 shows the complete model numbering system for the HS series flowmeters. The sections that follow describe its contents.

Table 7 – HS Model Numbering System

HS❑❑❑ ❑❑ ❑❑ ❑ LE❑ ❑❑ ❑❑❑

BASE MODEL
4–6 through –40
(3/8" through 2-1/2")

END FITTINGS
Refer to Section 8.1

CALIBRATION
Refer to Section 8.2

NON STANDARD UNITS
– = Standard units of measure
S = Special units of measure

SERVICE
L = Liquid

CONSTRUCTION MATERIALS
E = 316 Housing, 430F Rotor

BEARINGS
A = Ball Bearing
D = Carbide Journal

PICKOFFS
Refer to Section 8.3

SPECIAL CODE
Special meter configurations will not be addressed in this manual.
Please contact the factory for a description of the special code.

8.1 End Fittings

AE = AN (or MS) external straight, per MS 33656
NE = NPT external threads, 3/8" to 2-1/2"
62 = SAE Code 62, 4 bolt split flange up to –32 per SAE J518
DB = Dynamic Beam Seal, per MIL-F-85720/1 (Up to size –20 only)

Table 8 – End Fitting Configuration and Meter Bore Diameter

Meter Size	Fitting Size				Meter Bore Diameter
	AE	NE	62	DB	
HS4-6	-6 (3/8”)	3/8”	N/A	-06 (3/8”)	.30
HS4-8	-8 (1/2”)	1/2”	-8 (1/2”)	-07 (7/16”)	.30
HS6-8	-8 (1/2”)	1/2”	-8 (1/2”)	-07 (7/16”)	.37
HS8-8	-8 (1/2”)	1/2”	-8 (1/2”)	-08 (1/2”)	.40
HS-08	-8 (1/2”)	1/2”	-8 (1/2”)	-08 (1/2”)	.44
HS-10	-10 (5/8”)	3/4”	-12 (3/4”)	-10 (5/8”)	.50
HS-12	-12 (3/4”)	3/4”	-12 (3/4"”)	-12 (3/4”)	.56
HS-16	-16 (1”)	1”	-16 (1”)	-16 (1”)	.86
HS-20	-20 (1-1/4”)	1-1/4”	-20 (1-1/4”)	-20 (1-1/4”)	1.00
HS-24	-24 (1-1/2”)	1-1/2”	-24 (1-1/2”)	-20 (1-1/4”)	1.32
HS-32	-32 (2”)	2”	-32 (2”)	N/A	1.75
HS-40	-40 (2-1/2”)	2-1/2”	N/A	N/A	2.22

8.2 Calibration

NW = 10 Point, normal 10:1 range, in Water
NS = 10 Point, normal 10:1 range, in Solvent
NB = 10 Point, normal 10:1 range, in Oil blend
XW = 10 Point, extended range, in Water
XS = 10 Point, extended range, in Solvent
XB = 10 Point, extended range, in Oil blend
TW = 20 Point, normal 10:1 range, in Water
TS = 20 Point, normal 10:1 range, in Solvent
TB = 20 Point, normal 10:1 range, in Oil blend
YW = 20 Point, extended range, in Water
YS = 20 Point, extended range, in Solvent
YB = 20 Point, extended range, in Oil blend
U2 = Universal Viscosity Curve, 2 viscosities
U3 = Universal Viscosity Curve, 3 viscosities

Table 9 – Bearing Application Guide

Code	Bearing Type	Bearing Temperature Rating	Material
A	Ball	-450°F to +300°F	440C SST
D	Journal	Up to 1200°F	C-2 Carbide

Meter temperature rating may be limited by the pickoff temperature rating.

8.3 Pickoffs

Code	Type	Connection	Approval	Max Temp (°F)	Part Number
–1	RF	MS Connector		350	27-31199-101
–2	MAG	MS Connector		350	27-30880-101
–3	MAG	Leads EP		350	27-30880-102 27-30931-102
–5	RF	Leads EP		350	27-31199-102 27-31949-101
–6	MAG	MS Connector		750	27-80666-104
–7	MAG	MS Connector EP		750	27-80666-104 27-82333-102
–L	RF	MS Connector		750	27-88628-102
–M	RF			750	27-88826-103
–Y	RF		X-Proof (CSA)	350	27-13869-101
–U	MAG	MS Connector	#	350	27-32400-101
–X	RF	MS Connector	#	350	27-32404-101
PP	MAG	Leads	#	350	27-32400-103
SS	RF	Leads	#	350	27-32404-103
TT	MAG	Leads/Threaded Connection	#	350	27-32400-102
XX	RF	Leads/Threaded Connection	#	350	27-32404-102
T1	RF w/ RTD	MS Connector		350	27-62730-101
T2	MAG w/ RTD	MS Connector		350	27-61731-101
T3	MAG w/ RTD	Leads/Threaded Connection		350	27-62731-103
T5	RF w/ RTD	Leads/Threaded Connection		350	27-62730-103

= FM/CSA/Cenelec/IS Approved

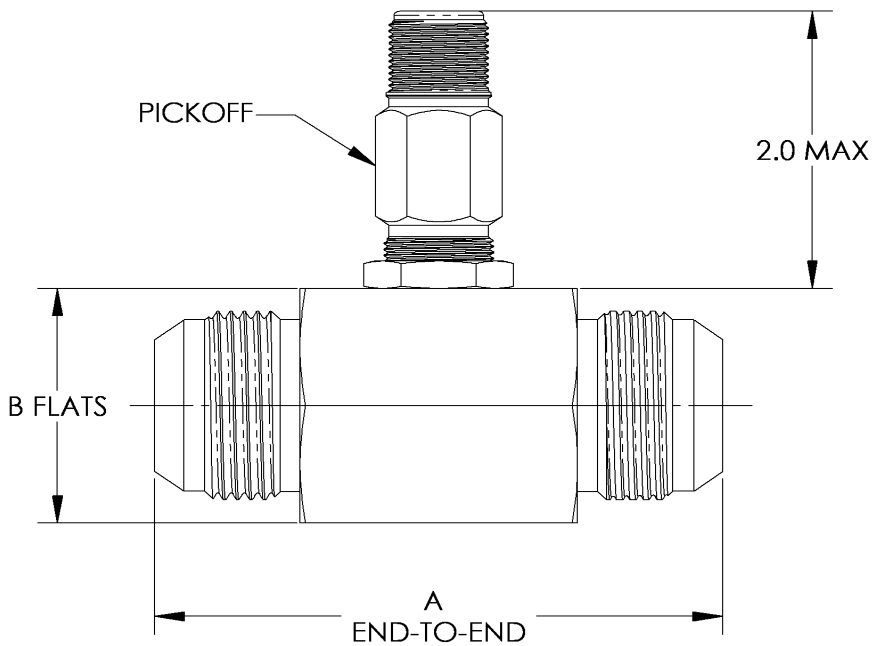


Figure 3 – Overall Dimensions, AE, NE, and DB End Fittings

(AE shown)

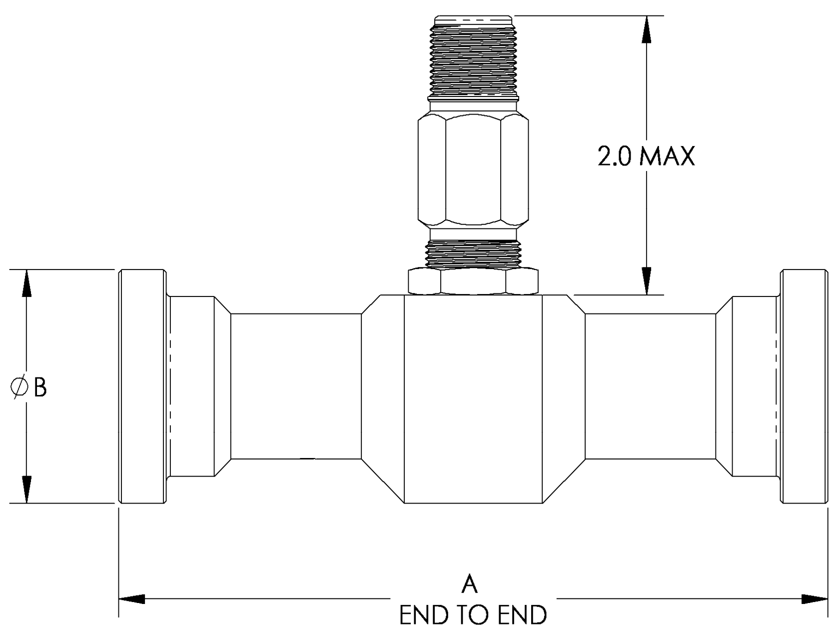


Figure 4 – Overall Dimensions, SAE Code 62 End Fitting

Table 10 – Overall Dimensions

Meter Size	AE, NE, and DB Fittings				SAE Code 62 Fitting			
	A		B		A		B	
	in.	Mm	in.	mm	in.	mm	in.	mm
HS4-6	2.45	62	1.00	25	N/A	N/A	N/A	N/A
HS4-8	2.45	62	1.00	25	4.64	118	1.25	32
HS6-8	2.45	62	1.00	25	4.64	118	1.25	32
HS8-8	2.45	62	1.00	25	4.64	118	1.25	32
HS-08	2.45	62	1.00	25	4.64	118	1.25	32
HS-10	2.72	69	1.38	35	5.13	130	1.63	41
HS-12	3.25	83	1.38	35	5.13	130	1.63	41
HS-16	3.56	90	1.63	41	5.63	143	1.88	48
HS-20	4.06	103	1.88	48	5.63	143	2.13	54
HS-24	4.59	117	2.25	57	6.63	168	2.50	64
HS-32	6.06	154	2.75	70	7.63	194	3.13	80
HS-40	8.9	226	3.5	89	N/A	N/A	N/A	N/A

9 PERIODIC MAINTENANCE

Maintenance of the High Shock Flowmeter consists of periodic inspections to insure that the internal parts have not suffered any corrosion or incrustation by measuring fluid. Should the assembly be damaged, it should be returned to the factory for exchange or repair.

9.1 Inspection, Cleaning, and Storage

For inspection and cleaning of internal parts, the rotor and support assembly may be withdrawn from the housing. The rotor support assembly and the housing may be cleaned with appropriate solvent or alcohol. If flowmeters are to be stored or out of service for an extended period, it should be dipped in light rust proofing preservative or machine oil and capped.

C A U T I O N

Service for some fluids may require special cleaning procedures before installation. Please consult fluid manufacturer and/or use industry accepted procedures.

One of the largest single sources of poor turbine meter performance is foreign material buildup on bearings whether they are journal type or ball type. It is recommended that whenever possible, the turbine meter be thoroughly flushed with an appropriate solvent immediately after use. The solvent should be chemically neutral and highly volatile so that complete drying can take place soon after the flushing operation. Some appropriate solvents would be ethyl alcohol or stoddard solvent.

All turbine flowmeters include some type of bearing for supporting its rotor. The High Shock flowmeter is normally equipped with ball bearings, but journal bearings fabricated of tungsten carbide are also available. If the bearings in the flowmeter become damaged or worn, the meter should be sent to the factory for bearing replacement. If this is not possible, a bearing replacement kit is available for most models. All bearings are not field replaceable. Consult the factory and describe the particular flowmeter before ordering a bearing replacement kit.

9.2 Disassembly and Reassembly

There are several variations of the basic turbine flowmeter design. This section will explain the general procedure for disassembling Flow Technology, Inc. High Shock turbine flowmeters. Refer to the following sections for detailed instructions on disassembly of specific flowmeters.

> **C A U T I O N**
> **Observe flow direction markings carefully. Some of the internal parts are symmetrical and may fit and function forward and reverse. The calibration will shift due to variations in the rotor blade edges and the degree of bend in the support trim tabs if installed incorrectly.**

1. Familiarize yourself with the figure applicable to your model before proceeding. The figures are located in Appendix A

2. Remove the upstream retaining ring.

> **N O T E**
> **The SAE Code 62 meter assemblies have an internal spacer between the internal assembly and the retaining ring. Be sure to keep this spacer with the meter at all times and reinstall it during reassembly.**

3. Insert a plastic rod into the downstream end of the meter and gently press against the downstream support. Select a large enough rod so that it cannot accidentally slip past the support vanes and impact the rotor. Gently slide the internal assembly out of the housing being careful not to drop any of the internal parts as they clear the housing. There are two slotted pins in the bore of the housing that keep the supports from spinning. Be sure the rotor is not damaged when sliding it past the pins. Maintain compression between the supports to insure that the internals remain assembled until you have noted the flow direction markings on the supports and the rotor.

4. Locate the flow direction of the supports and the rotor. (The upstream side of the rotor will have two small marks that are typically hand scribed on the hub. If the marks are not clear, remark the rotor to assure correct re-assembly. If you use a marking pen or pencil, be aware that your markings may be removed during cleaning.) Ball bearing style meters may have a step in the bore of the rotor. This step is on the upstream side of the rotor.

5. Spin the rotor slowly, and note any signs of scoring, wobble, damaged or bent blades. Replace the rotor if it shows any signs of damage.

I M P O R T A N T

Do not straighten the tabs on the support adjacent to the rotor. These are trim tabs used to improve meter performance. Altering the tab angle will cause a shift in the K-factor.

3. Clean or replace parts as necessary.

4. Reverse procedure to reinstall. Insure that the flow direction arrow on the internals match the flow direction arrow on the housing when the internals are reinstalled.

5. Both supports must slide in the slots of the pins within the bore. Be sure the rotor is not damaged when sliding it past the pins.

9.3 General Handling Guidelines

1. All work with bearings should be done in a clean, dry, dust and static free area.

2. Consider all foreign materials to be abrasive, corrosive or otherwise destructive.

3. Verify that the shaft and rotor have been cleaned and are free of oil, contamination and burrs.

4. Keep all replacement bearings in their original unopened packages until ready for installation. Remove the bearings from their protective packages one at a time, as required.

5. The bearings should be handled with tweezers or other special non-magnetic tools.

6. Never touch high precision bearings with fingers unprotected by finger cots or lint free gloves.

7. Seat the bearing squarely and apply even pressure to the race making contact (see Figure 5).

8. When installing a bearing in the rotor apply pressure to the outer race.

9. When installing a bearing onto a shaft, apply pressure to the inner race.

10. Never transfer force between the outer and inner races; damage could result and cause increased friction, increased torque, and shortened bearing life.

11. Shock or impact techniques should never be used to seat the bearing.

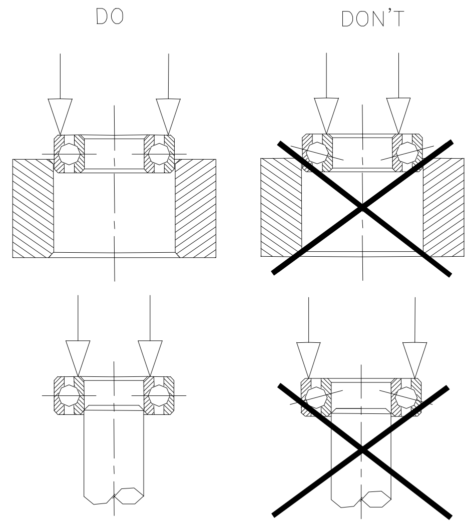


Figure 5 – Bearing Installation

12. Installing the small retaining rings requires a quality pair of sharp tweezers and good dexterity. The bearing retaining rings are under spring tension and can easily shoot out while removing or installing. Wear eye protection.

9.4 Ball Bearing Replacement

Ball bearings may be replaced in the field by the customer without significantly changing the flowmeter performance, provided the downstream orientation of the rotor is maintained. Complete replacement sets of calibrated internals are also available.

Note when replacing the bearings that an internal spacer is used on the SAE Code 62 meters. Be sure to reinstall this spacer when reassembling the meter.

9.4.1 HS4-6 & 4-8 Bearing Code A

Refer to Figure 7

1. Remove the retaining ring (11) from the upstream end of the flowmeter housing.
2. Gently slide the flowmeter rotor support assembly out of the housing, being careful not to drop any of the internal parts as they clear the housing.
3. Remove the downstream support (10) and the cone (9) from the shaft (8).
4. Note that the rotor (7) is marked on the downstream side with two lines on the rotor hub.
5. Gently slide the rotor assembly (5) from the shaft (8).
6. Slide both bearings (6A) and the bearing spacer (6B) out of the rotor hub (7).

7. Verify the retaining ring (6D) is in good condition and seated in the center of the rotor.

8. Reverse steps 1 through 6 for re-assembly. Insure the flow direction arrow on the internals match the flow direction arrow on the housing when the internals are reinstalled. Insure the rotor (7) is properly oriented with markings on the downstream side.

9.4.2 HS6-8, 8-8, & -08 Bearing Code A

Refer to Figure 8

1. Remove the retaining ring (11) from the upstream end of the flowmeter housing.

2. Gently slide the flowmeter rotor support assembly out of the housing, being careful not to drop any of the internal parts as they clear the housing.

3. Remove the downstream support (10) and the cone (9) from the shaft (8).

4. Note that the rotor (7) is marked on the downstream side with two lines on the rotor hub.

5. Gently slide the rotor assembly (5) from the shaft (8).

6. Carefully remove the retaining ring (6D) from the rotor hub (7).

7. Slide both bearings (6A) out of the rotor hub (7).

8. Verify the retaining ring (6D) is in good condition.

9. Reverse steps 1 through 7 for re-assembly. Insure the flow direction arrow on the internals match the flow direction arrow on the housing when the internals are reinstalled. Insure the rotor (7) is properly oriented with markings on the downstream side.

9.4.3 HS-10, -12, -16, -20, -24 Bearing Code A

Refer to Figure 9

1. Remove the retaining ring (11) from the upstream end of the flowmeter housing.

2. Gently slide the flowmeter rotor support assembly out of the housing, being careful not to drop any of the internal parts as they clear the housing.

3. Remove the downstream support (10) and the cone (9) from the shaft (8).

4. Note that the rotor (7) is marked on the downstream side with two lines on the rotor hub.

5. Gently slide the rotor assembly (5) from the shaft (8).

6. Carefully remove the retaining ring (6D) from the rotor hub (7).

7. Slide both bearings (6A) and the bearing spacer (6B) out of the rotor hub (7).

8. Verify the retaining ring (6D) is in good condition.

9. Reverse steps 1 through 7 for re-assembly. Insure the flow direction arrow on the internals match the flow direction arrow on the housing when the internals are reinstalled. Insure the rotor (7) is properly oriented with markings on the downstream side.

9.4.4 HS-32 Bearing Code A

Refer to Figure 10

1. Remove the retaining ring (11) from the upstream end of the flowmeter housing.

2. Gently slide the flowmeter rotor support assembly out of the housing, being careful not to drop any of the internal parts as they clear the housing.

3. Remove the downstream support (10) from the shaft (8).

4. Note that the rotor (7) is marked on the downstream side with two lines on the rotor hub.

5. Gently slide the rotor assembly (5) from the shaft (8).

6. Carefully remove the retaining ring (6D) from the rotor hub (7).

7. Slide both bearings (6A) and the bearing spacer (6B) out of the rotor hub (7).

8. Verify the retaining ring (6D) is in good condition.

9. Reverse steps 1 through 7 for re-assembly. Insure the flow direction arrow on the internals match the flow direction arrow on the housing when the internals are reinstalled. Insure the rotor (7) is properly oriented with markings on the downstream side.

9.4.5 HS-40 Bearing Code A

Refer to Figure 11

1. Remove the retaining ring (11) from the upstream end of the flowmeter housing.

2. Gently slide the flowmeter rotor support assembly out of the housing, being careful not to drop any of the internal parts as they clear the housing.

3. Remove the downstream lock nut (12).

4. Remove the downstream support (10) and the cone (9) from the shaft (8).

5. Note that the rotor (7) is marked on the downstream side with two lines on the rotor hub.

6. Gently slide the rotor assembly (5) from the shaft (8).

7. Carefully remove the retaining ring (6D) from the rotor hub (7).

8. Slide both bearings (6A) and the bearing spacer (6B) out of the rotor hub (7).

9. Verify the retaining ring (6D) is in good condition.

10. Reverse steps 1 through 8 for re-assembly. Insure the flow direction arrow on the internals match the flow direction arrow on the housing when the internals are reinstalled. Insure the rotor (7) is properly oriented with markings on the downstream side.

9.5 Journal Bearing Replacement

Flow Technology, Inc. has bearing replacement kits available for turbine flowmeters equipped with journal bearings. The use of a replacement kit will allow the customer to repair the flowmeter in the field. To maintain accuracy it is necessary that the meter be recalibrated or the entire internal assembly be replaced with a compete set of calibrated internals. Journal bearings have the same basic design as their ball bearing counterparts; however, instead of removable ball bearings with spacers and retaining rings, the journal bearings are pressed into the rotor and utilize a special cone (or washer) for a thrust surface.

The procedure for removing and inserting the internal assembly from the flowmeter housing is similar for journal and ball bearing flowmeters. Flow Technology, Inc. however does NOT recommend field replacement of journal bearings. Replacing the journal bearing often requires special tools and can easily result in damage to other components. Figures are shown in APPENDIX A.

9.5.1 Replacement Kits

The part numbers for replacement parts can be obtained from the parts list in this manual. Complete sets of calibrated internals are available and strongly recommended over replacing only the rotating assembly. Complete calibrated internals can be ordered by specifying the flowmeter model and serial number.

10 TROUBLESHOOTING GUIDE

The following guide shows some of the common problems that may occur during the operation of turbine flowmeters. Various causes are given for each problem including a description of the cause and the corrective action to be taken.

Table 11 – Meter Reads High

Probable Cause	Corrective Action
Line not full of fluid Jetting through meter.	Fill and bleed system.
Cavitation, fluid vaporizes as it slips over rotor blades. Cavitation of the fluid as it passes through the meter.	Check for insufficient backpressure and insure that the flow rate is throttled down stream of the meter. Increase static pressure of system if it is safe and feasible.
Meter installed backwards.	Check to see if the flow direction arrow on the flowmeter is aligned with the direction of flow.
Internals installed backwards.	Verify internals are installed properly.
Meter installed in different orientation than when calibrated.	Insure meter is installed in horizontal position unless otherwise specified on data sheet.
Flowmeter is not mated to proper electronics.	Check data sheets and assemble system correctly.
Operating fluid has a different kinematic viscosity than the original calibration.	Recalibrate meter at correct kinematic viscosity.
Electronics picking up noise. A.C. signals override flowmeter signals and are detected as pulses.	Separate power cables from signal cables and check for noise signal of sufficient amplitude to be mistaken as a flowmeter signal. Check for improper connection of ground shield. Shield to be connected at only one end of system.
Foreign material upstream or in flowmeter creating jetting.	Remove material, install manufactures recommended filtration.
Input line to flowmeter has a much smaller opening than meter, creating jetting.	Check input line connections and size per manufacturer's recommendations.
Swirl in flow stream created by valves, line geometry, fittings and insufficient flow straightening causing rotor to have artificially high frequency.	Check the geometry of the line, install appropriate flow straighteners.
Diagnostic equipment used to check the turbine meter is incorrect.	Check calibration and accuracy of diagnostic equipment used to check turbine flowmeter.

Table 12 – Meter Reads Low

Probable Cause	Corrective Action
Corroded or worn bearings.	Replace bearings.
Bearing misapplication.	Use proper bearings.
Improper flowmeter assembly after installing bearing kit.	Check for proper internal component assembly.
Fluid contamination.	Clean internals and check location, size and condition of filter and/or replace fluid.
Meter installed backwards.	Check to see if the flow direction arrow on the flowmeter is aligned with the direction of flow.
Internals installed backwards.	Verify internals are installed properly.
Meter installed in different orientation than calibration.	Insure meter is installed in horizontal position unless otherwise specified on data sheet.
Bent rotor blades.	Visually inspect and replace rotor if necessary.
Fluid pulsations.	Provide damping in the system.
Shift in fluid viscosity.	Insure the operating condition remains equivalent with the calibration conditions. If the viscosity cannot be stabilized contact the factory for additional information.
Swirl in flow stream created by valves, line geometry, fittings and insufficient flow straightening causing rotor to have artificially low frequency.	Check the geometry of the line, install appropriate flow straighteners.
Electronics not detecting some pulses.	Adjust amplifier gain.
A.C. signals override flowmeter signals and are detected as pulses.	Check for A.C. signals that override flowmeter signals. Insure signal and power cables are not run together.
Flowmeter is not mated to proper electronics.	Check data sheets and assemble system correctly.
Loose pickoff.	Verify that the pickoff bottoms in the housing and secure locknut.
Improper hook-up of cable shield.	Check for improper connection of ground shield. Shield to be connected at only one end of system.

Table 13 – Zero Output

Probable Cause	Corrective Action
Pickoff not connected or not properly installed.	Check connection between pickoff and amplifier or readout. Verify that the pickoff bottoms in the housing and secure locknut.
Pickoff defective. Impedance mismatch.	Perform resistance test on pickoff. Insure that amplifier has been matched to flowmeter. Some amplifiers require tuning for non-standard pickoffs. Verify proper type of amplifier is used.
System temperature above meter rating.	Insure the fluid temperature is not above the operational temperature of the meter.
Amplifier overheated.	Insure that the temperature range of the amplifier is not exceeded.
Flowmeter and readout device are not connected properly.	Check wiring connections of system and verify connections are correctly installed.
Broken wire in system.	Check continuity of interconnecting wires between components.
Excessive distance from flowmeter to readout device.	Check distance between pickoff and amplifier. Distance should not exceed 300 feet for magnetic pickoffs and 30 feet for RF pickoffs.
Flowmeter rotor locked and will not turn.	Disassemble flowmeter and inspect for debris lodged in rotor. Inspect for damaged bearings or other internal components.
Flow rate below minimum required for meter operation.	Check flowmeter and electronic data sheet for low cutoff frequency.
No flow in system.	Check for closed valves in system or a by-pass valve in an open position.

Table 14 – Intermittent Operation

Probable Cause	Corrective Action
Loose electrical connections.	Check and tighten connections.
Improperly seated pickoff.	Verify that pickoff is bottomed and retighten lock nut.
Intermittent electromagnetic noise.	Separate power cables from signal cables and check for noise signal of sufficient amplitude to be mistaken as a flowmeter signal.
Electronic malfunction.	Troubleshoot electronics. Consult electronics manual.
Fluid temperature exceeds range of pickoff.	Replace with high temperature pickoff or reduce operating temperature.
Ambient temperature exceeds range of electronics.	Relocate the electronics to reduce temperature to an acceptable level.
Bearings are worn, broken or contaminated.	Replace bearings and recalibrate meter. Provide appropriate filtration.
Uneven flow, flow surging or pulsating.	Increase system back pressure or provide damping.

Table 15 – Non-repeatable Meter Output

Probable Cause	Corrective Action
Bearings have become worn, damaged or corroded.	Replace bearings as necessary and recalibrate meter. Check for appropriate filtration and material / fluid compatibility.
Internals have become contaminated with foreign material.	Clean or replace meter internals including supports, cones, rotor and/or bearings and recalibrate meter. Check for appropriate filtration as necessary.
Damaged internals.	Replace internals and recalibrate meter.
Line not full of fluid - bubbles or froth present.	Check plumbing for source of bubbles or froth and correct. Bleed line of foreign gas.
Cavitation of the fluid as it passes through the meter.	Check for insufficient backpressure and insure the flow rate is throttled down stream of the meter. Increase static pressure of the system if it is safe and feasible.
Shift in fluid viscosity.	Insure the operating condition remains equivalent to the calibration conditions. If viscosity cannot be stabilized, contact the factory for additional information.
Internals not properly secured.	Inspect retaining rings for proper seating. Inspect bore for signs of scoring. Reseat retaining ring(s) and/or replace internals if necessary.
Piping configuration changed.	Insure the operational piping configuration is the same as that with which the meter was calibrated. If not, recalibrate meter with the new piping configuration.
Intermittent operation.	Intermittent operation will cause non-repeatable meter output. Refer to the trouble shooting section on intermittent operation.

Table 16 – Constant Non-Zero Output

Probable Cause	Corrective Action
Improper oscillation of amplifier circuit.	Pickoff and amplifier mismatch, replace with compatible component.
Electronics picking up noise.	Separate power cables from signal cables and check for noise signal of sufficient amplitude to be mistaken as a flowmeter signal.
Improper wiring.	Check for appropriate wiring configuration and connections.
Electronic malfunction.	See electronic manual troubleshooting guide to correct problem.

11 PARTS LIST

The following pages contain a detailed listing of the turbine flowmeter parts referenced in this manual. For non-standard material, please consult factory for part numbers. Information from the list must be used when contacting the factory for repairs, ordering spare parts or for questions in reference to the turbine flowmeters.

Table 17 - High Shock Housings and Internals

Base Model	Housing P/N					
	(1A) AE (AN/MS)	**(1B) DB (SAE AS 85720/1)**	**(1C) NE (NPT)**	**(1D) 62 (SAE 62)**	**(4) Internals P/N (Bearing Code A)**	**(4) Internals P/N (Bearing Code D)**
HS4-6	13-64818-101	13-84815-101	13-64813-101	N/A	06-65311-102	06-65291-102
HS4-8	13-64818-102	13-84815-102	13-64813-102	13-64816-102	06-65311-102	06-65291-102
HS6-8	13-64818-103	13-84815-103	13-64813-103	13-64816-103	06-65311-103	06-65291-103
HS8-8	13-64818-104	13-84815-104	13-64813-104	13-64816-104	06-65311-104	06-65291-104
HS-08	13-64818-105	13-84815-105	13-64813-105	13-64816-105	06-65311-105	06-65291-105
HS-10	13-64818-106	13-84815-106	13-64813-106	13-64816-106	06-65311-106	06-65291-106
HS-12	13-64818-107	13-84815-107	13-64813-107	13-64816-107	06-65311-107	06-65291-107
HS-16	13-64818-108	13-84815-108	13-64813-108	13-64816-108	06-65311-108	06-65291-108
HS-20	13-64818-109	13-84815-109	13-64813-109	13-64816-109	06-65311-109	06-65291-109
HS-24	13-64818-110	N/A	13-64813-110	13-64816-110	06-65311-110	06-65291-110
HS-32	13-64818-111	N/A	13-64813-111	13-64816-111	06-65311-111	06-65291-111
HS-40	13-64818-112	N/A	13-64813-112	N/A	06-65311-112	06-65291-112

Notes:
1. Refer to Figure 6.
2. The lock nut (2) P/N is 46-10036-01 for all models.

Table 18 – HS4-6 & HS4-8 Ball Bearing Internal Assembly (Bearing Code A)

Item #	Description	Qty.	HS4-6	HS4-8
5	Rotor Assembly	1	53-65312-102	53-65312-102
6	Bearing Kit	1	51-65402-102	51-65402-102
6A	Ball Bearing	2	N/A	N/A
6B	Spacer	1	N/A	N/A
6D	Retaining Ring	1	57-84388-01	57-84388-01
7	Rotor	1	53-65290-02	53-65290-02
8	Shaft	1	N/A	N/A
9	Cone	2	N/A	N/A
10	Support	2	N/A	N/A
11	Retaining Ring	1	57-13000-31	57-13000-31

Notes:
1. Refer to Figure 7.

Table 19 – HS6-8, 8-8, & -08 Ball Bearing Internal Assembly (Bearing Code A)

Item #	Description	Qty.	HS6-8	HS8-8	HS-08
5	Rotor Assembly	1	53-65312-103	53-65312-104	53-65312-105
6	Bearing Kit	1	51-65402-103	51-65402-103	51-65402-103
6A	Ball Bearing	2	N/A	N/A	N/A
6D	Retaining Ring	1	57-10017-01	57-10017-01	57-10017-01
7	Rotor	1	53-65290-03	53-65290-04	53-65290-05
8	Shaft	1	N/A	N/A	N/A
9	Cone	2	N/A	N/A	N/A
10	Support	2	N/A	N/A	N/A
11	Retaining Ring	1	57-13000-37	57-31648-01	57-13000-43

Notes:
1. Refer to Figure 8.

Table 20 – HS-10, -12, -16-, -20, & -24 Ball Bearing Internal Assembly (Bearing Code A)

Item #	Description	Qty.	HS-10	HS-12	HS-16	HS-20	HS-24
5	Rotor Assembly	1	53-65312-106	53-65312-107	53-65312-108	53-65312-109	53-65312-110
6	Bearing Kit	1	51-65402-106	51-65402-106	51-65402-108	51-65402-108	51-65402-110
6A	Ball Bearing	2	N/A	N/A	N/A	N/A	N/A
6B	Spacer	1	N/A	N/A	N/A	N/A	N/A
6D	Retaining Ring	1	57-10058-02	57-10058-02	57-11530-01	57-11530-01	57-10317-02
7	Rotor	1	53-65290-06	53-65290-07	53-65290-08	53-65290-09	53-65290-10
8	Shaft	1	N/A	N/A	N/A	N/A	N/A
9	Cone	2	N/A	N/A	N/A	N/A	N/A
10	Support	2	N/A	N/A	N/A	N/A	N/A
11	Retaining Ring	1	57-13000-50	57-13000-56	57-13000-86	57-13000-100	57-13000-137

Notes:
1. Refer to Figure 9.

Table 21 – HS-32 Ball Bearing Internal Assembly (Bearing Code A)

Item #	Description	Qty.	HS-32
5	Rotor Assembly	1	53-65312-111
6	Bearing Kit	1	51-65402-110
6A	Ball Bearing	2	N/A
6B	Spacer	1	N/A
6D	Retaining Ring	1	57-10317-02
7	Rotor	1	53-65290-11
8	Shaft	1	N/A
10	Support	2	N/A
11	Retaining Ring	1	57-13000-175

Notes:
1. Refer to Figure 10.

Table 22 – HS-40 Ball Bearing Internal Assembly (Bearing Code A)

Item #	**Description**	**Qty.**	**HS-40**
5	Rotor Assembly	1	53-65312-112
6	Bearing Kit	1	51-65402-112
6A	Ball Bearing	2	N/A
6B	Spacer	1	N/A
6C	Shaft	1	N/A
6D	Retaining Ring	1	57-13000-62
7	Rotor	1	53-65290-12
8	Shaft	1	N/A
9	Cone	2	N/A
10	Support	2	N/A
11	Retaining Ring	1	57-13000-225
12	Lock Nut	2	46-90781-01
13	Spacer, Upstream	1	N/A
14	Spacer, Downstream	1	N/A

Notes:
Refer to Figure 11.

Table 23 – HS4-6, 4-8, 6-8, 8-8, & -08 Journal Bearing Internal Assembly (Bearing Code D)

Item #	Description	Qty.	HS4-6	HS4-8	HS6-8	HS8-8	HS-08
5	Rotor Assembly	1	53-65403-102	53-65403-102	53-65403-103	53-65403-104	53-65403-105
5A	Rotor	1	N/A	N/A	N/A	N/A	N/A
5B	Journal Bearing	1	N/A	N/A	N/A	N/A	N/A
6	Rotating Assembly	1	06-65404-102	06-65404-102	06-65404-103	06-65404-104	06-65404-105
6A	Shaft	1	N/A	N/A	N/A	N/A	N/A
6B	Cone/Washer Assembly	2	N/A	N/A	N/A	N/A	N/A
8	Support	2	N/A	N/A	N/A	N/A	N/A
9	Retaining Ring	1	57-13000-31	57-13000-31	57-13000-37	57-31648-01	57-13000-43

Notes:
1. Refer to Figure 12.

Table 24 – HS-10, -12, -16, -20, & -24 Journal Bearing Internal Assembly (Bearing Code D)

Item #	Description	Qty.	HS-10	HS-12	HS-16	HS-20	HS-24
5	Rotor Assembly	1	53-65403-106	53-65403-107	53-65403-108	53-65403-109	53-65403-110
5A	Rotor	1	N/A	N/A	N/A	N/A	N/A
5B	Journal Bearing	1	N/A	N/A	N/A	N/A	N/A
6	Rotating Assembly	1	06-65404-106	06-65404-107	06-65404-108	06-65404-109	06-65404-110
6A	Shaft	1	N/A	N/A	N/A	N/A	N/A
6B	Cone/Washer Assembly	2	N/A	N/A	N/A	N/A	N/A
8	Support	2	N/A	N/A	N/A	N/A	N/A
9	Retaining Ring	1	57-13000-50	57-13000-56	57-13000-86	57-13000-100	57-13000-137

Notes:
1. Refer to Figure 12.

Table 25 – HS-32 Journal Bearing Internal Assembly (Bearing Code D)

Item #	Description	Qty.	HS-32
5	Rotor Assembly	1	53-65403-111
5A	Rotor	1	N/A
5B	Journal Bearing	1	N/A
6	Rotating Assembly	1	06-65404-111
6A	Shaft	1	N/A
8	Support/Cone/Washer	2	N/A
9	Retaining Ring	1	57-13000-175

Notes:
1. Refer to Figure 13.

Table 26 – HS-40 Journal Bearing Internal Assembly (Bearing Code D)

Item #	Description	Qty.	HS-40
5	Rotor Assembly	1	53-65403-112
5A	Rotor	1	N/A
5B	Journal Bearing	1	N/A
6	Rotating Assembly	1	06-65404-112
6A	Shaft	1	N/A
6B	Thrust Washer	2	N/A
7	Cone	2	N/A
8	Support	2	N/A
9	Retaining Ring	1	57-13000-225
10	Shaft	1	N/A
11	Lock Nut	2	46-90781-01

Notes: Refer to Figure 14.

12 APPENDIX A

On the following pages, details of the flowmeter assemblies are given to aid in the disassembly and reassembly.

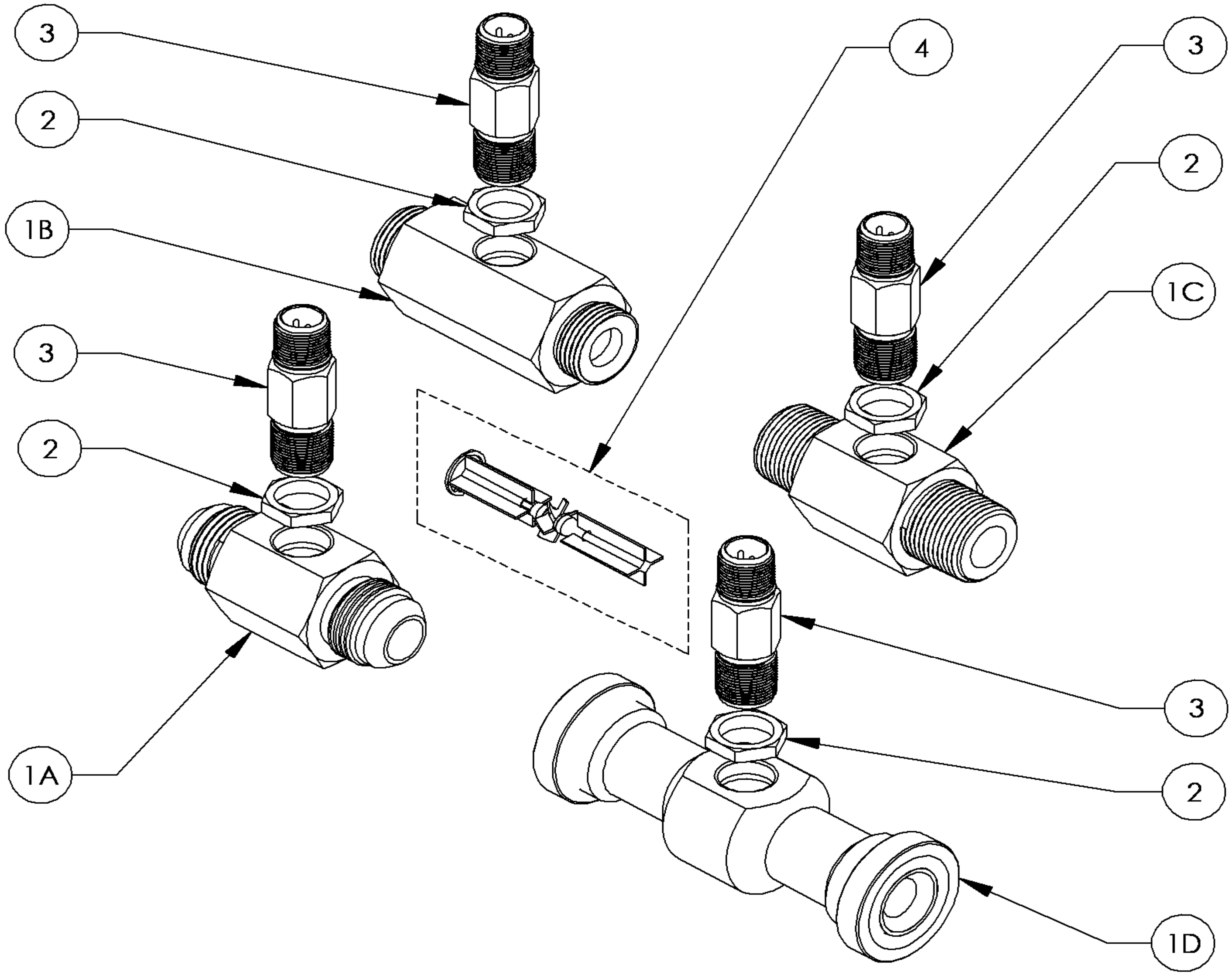


Figure 6 - High Shock Meter Assembly

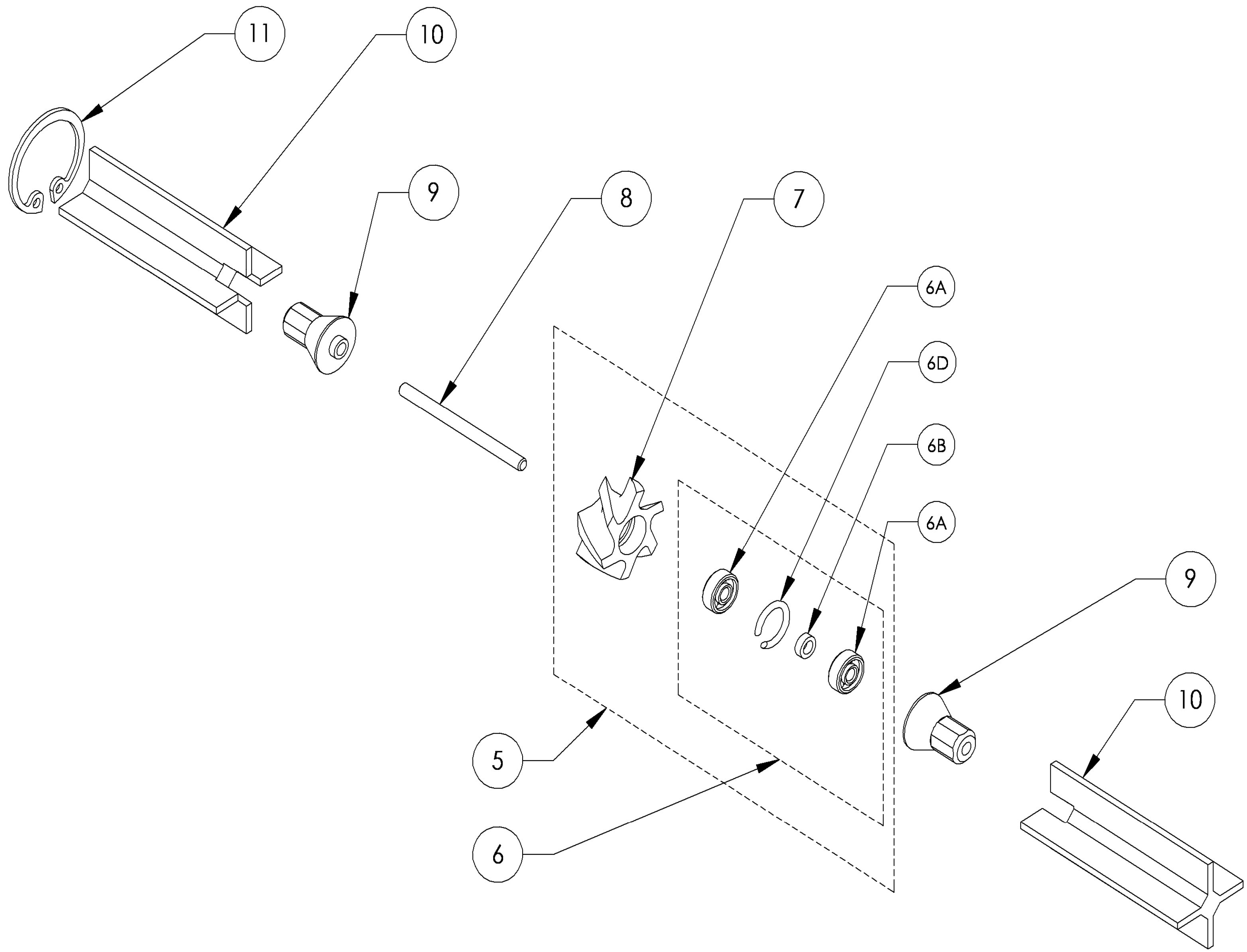


Figure 7 – HS4-6 & 4-8 Ball Bearing Internal Assembly (Bearing Code A)

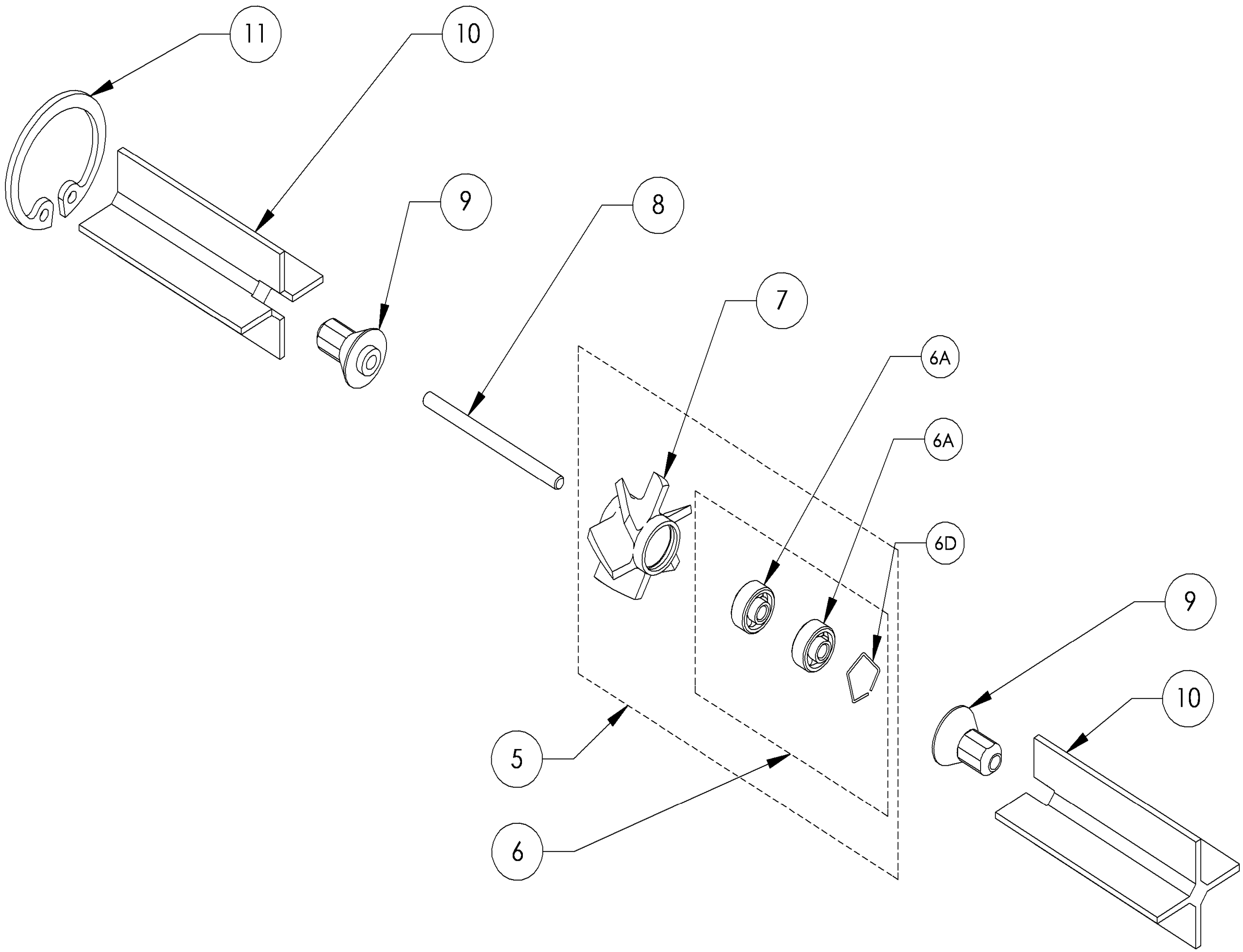


Figure 8 – HS6-8, 8-8, & -08 Ball Bearing Internal Assembly (Bearing Code A)

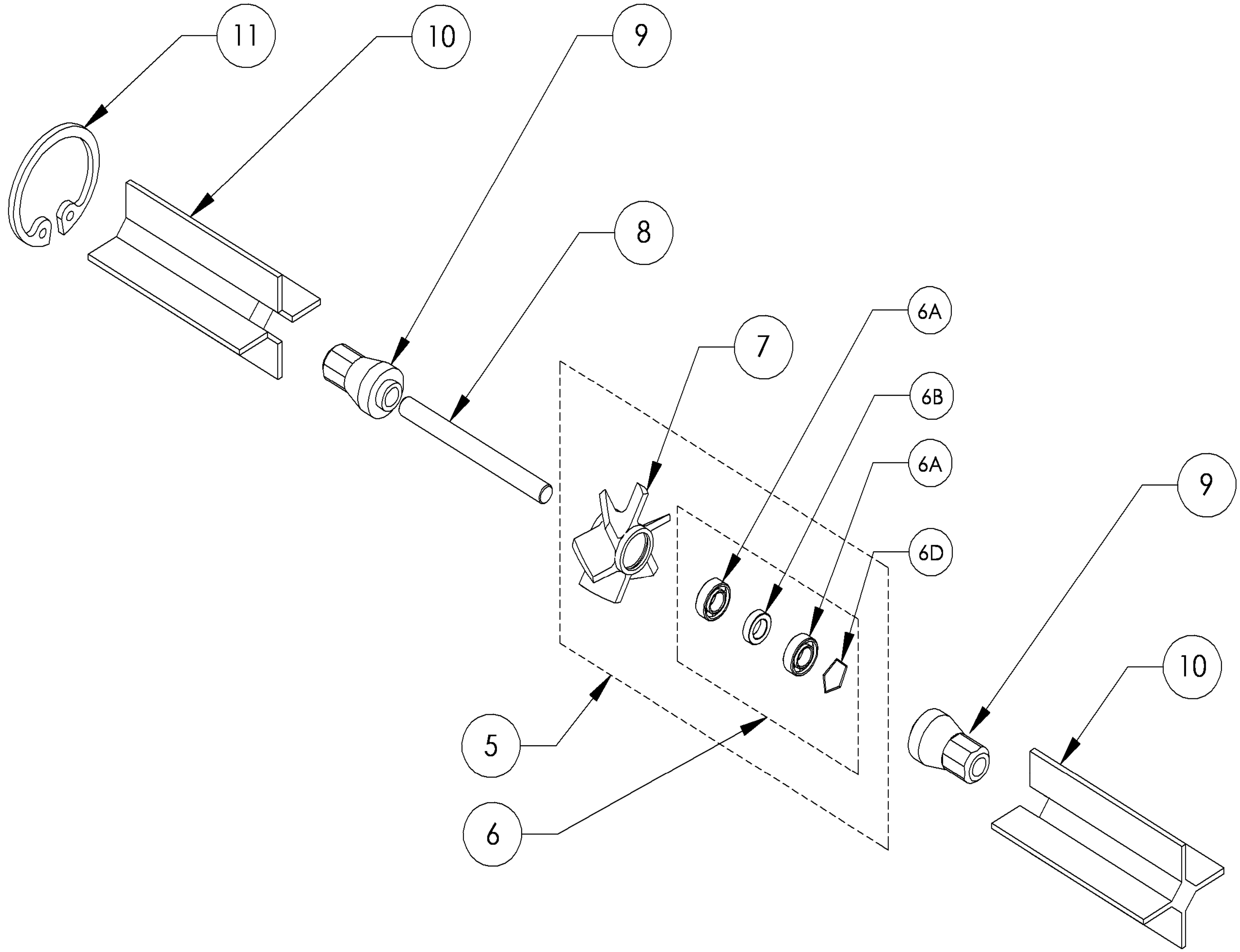


Figure 9 – HS-10 thru HS-24 Ball Bearing Internal Assembly (Bearing Code A)

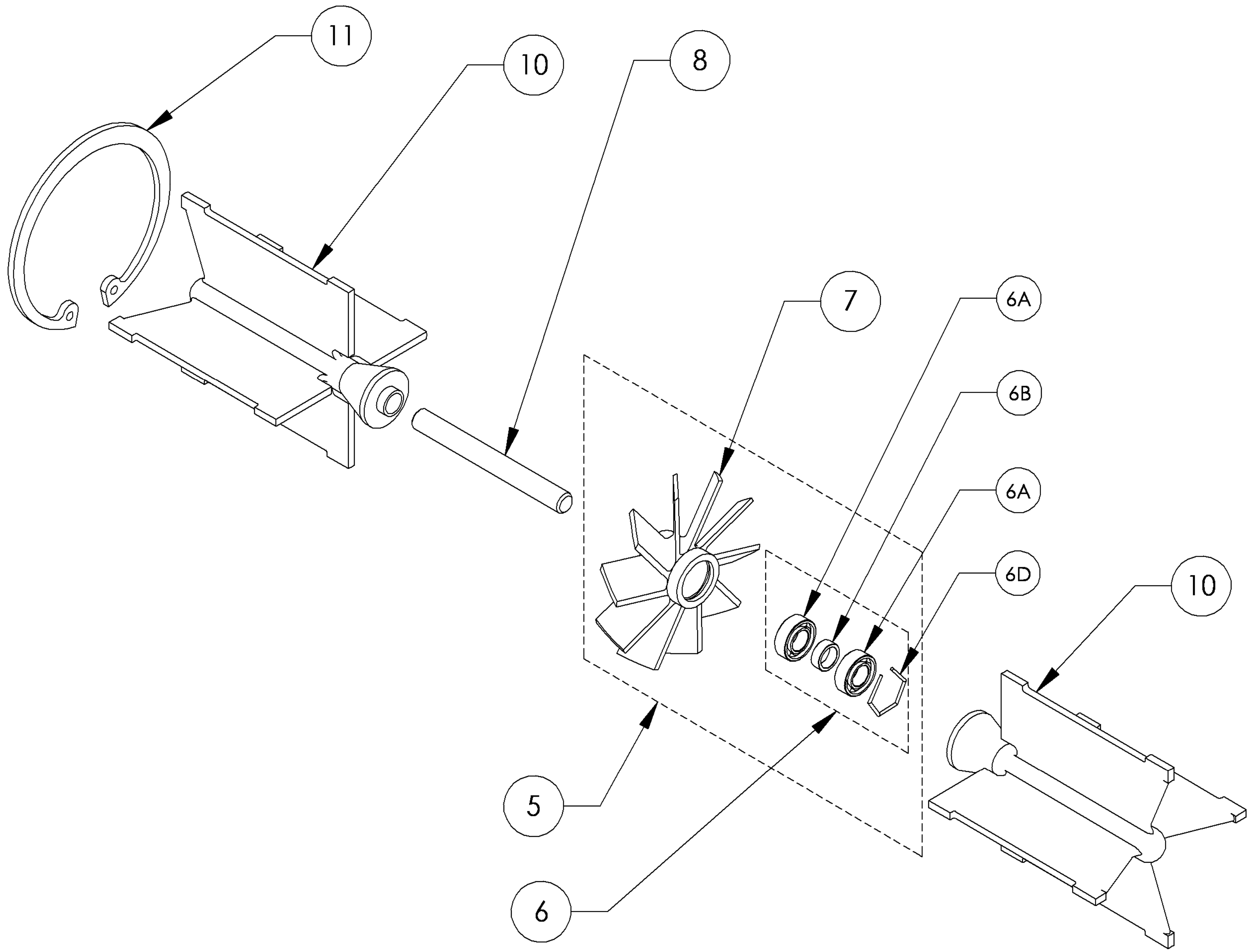


Figure 10 – HS-32 Ball Bearing Internal Assembly (Bearing Code A)

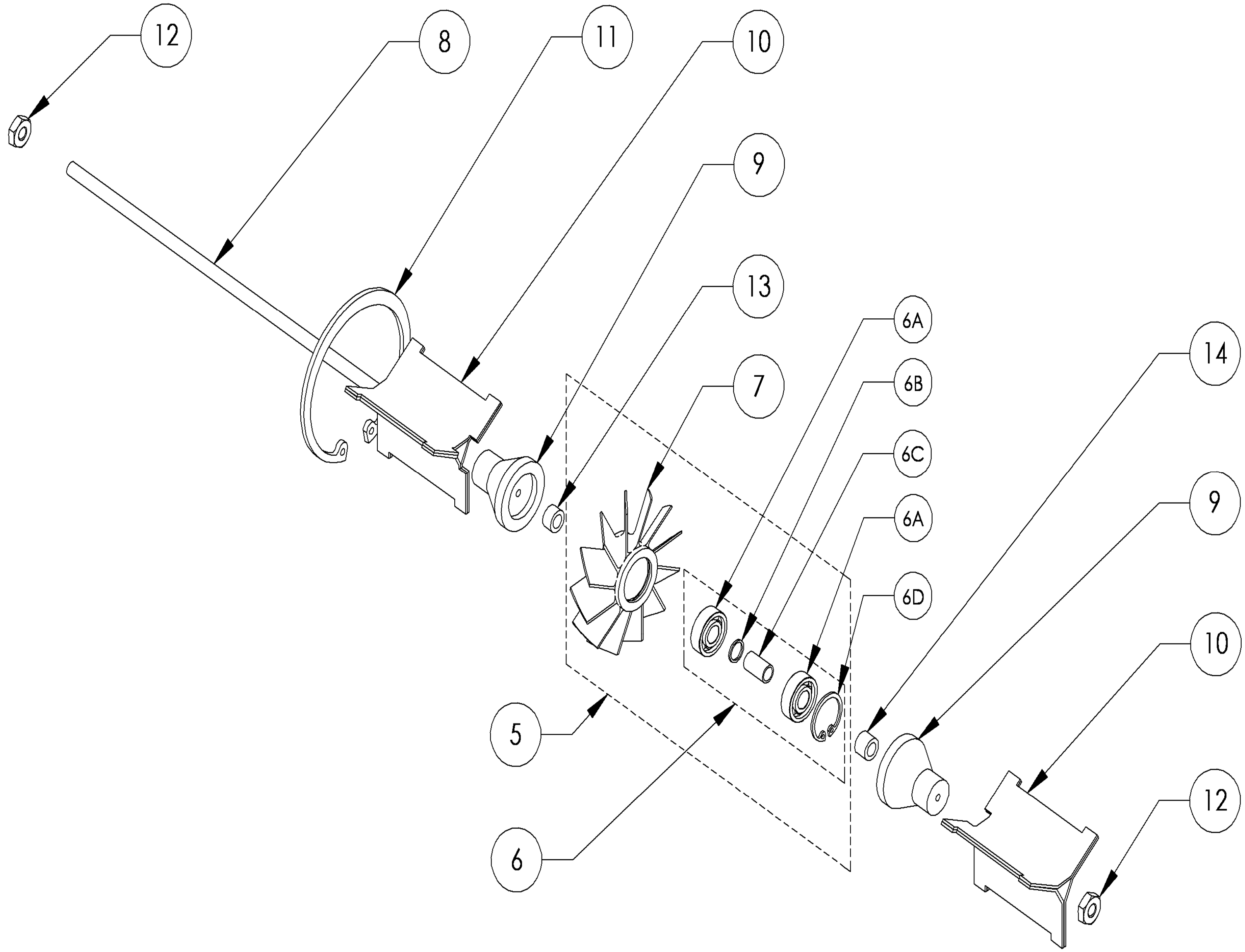


Figure 11 - HS-40 Ball Bearing Internal Assembly (Bearing Code A)

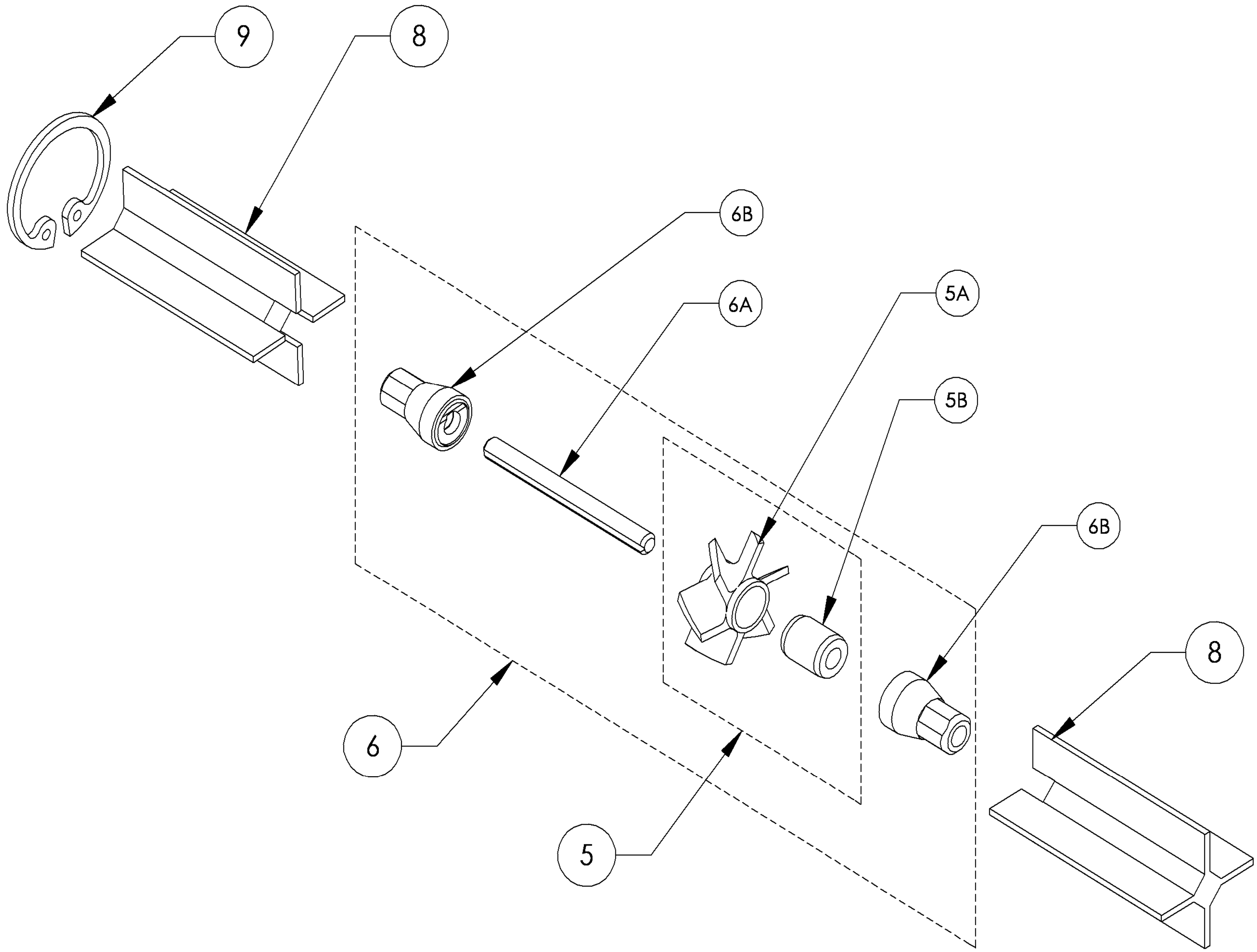


Figure 12 – HS4-6 thru HS-24 Journal Bearing Internal Assembly (Bearing Code D)

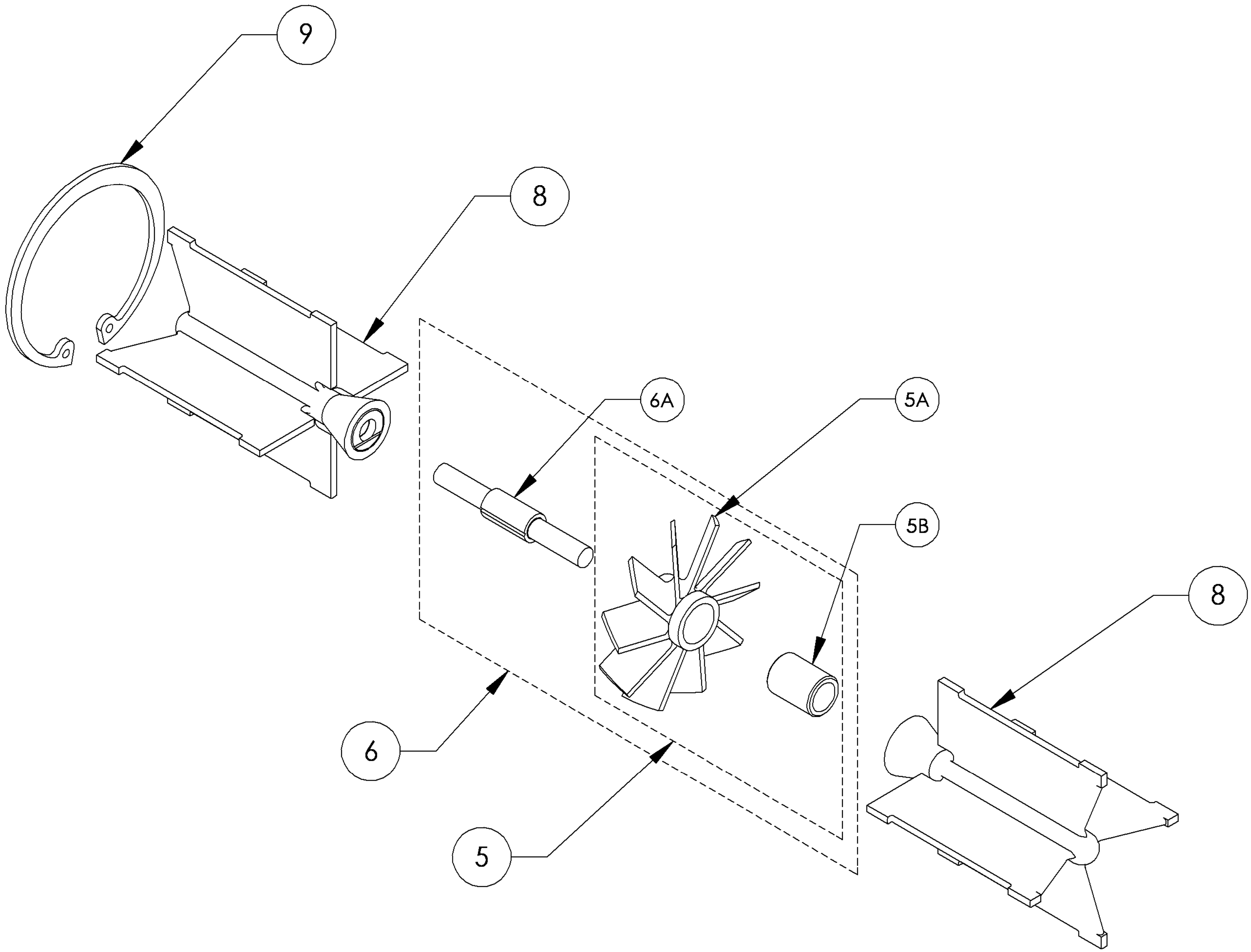


Figure 13 – HS-32 Journal Bearing Internal Assembly (Bearing Code D)

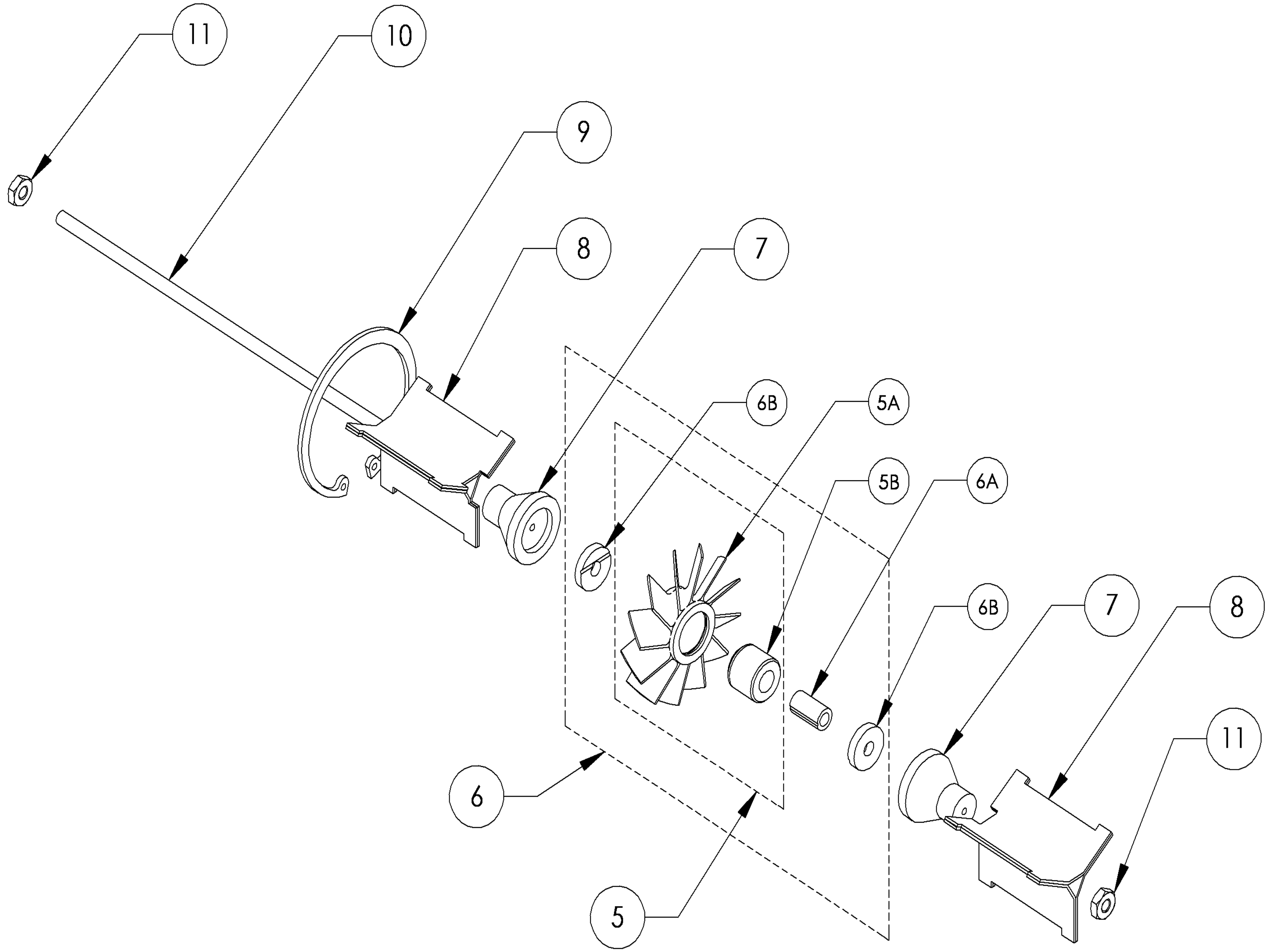


Figure 14 – HS-40 Journal Bearing Internal Assembly (Bearing Code D)