



# Hydraulic Bow Spring Centralizer

**MAN-TTT-912 (R0' )**

## Thru-Tubing Technology

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## Description

The Hydraulic Bow Spring Centralizer is designed to pass through the production tubing, packers, and nipples, and then centralize inside of the casing below, to assist in fishing, cutting, milling, under-reaming, or washing over.

## Operation

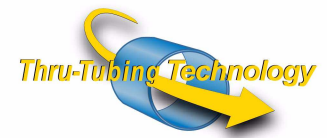
When the circulation is initiated and the required psi for the tool is achieved, the centralizer will expand, centralizing the tool string. As long as there is the recommended flow rate through the tool, the springs will stay expanded, but once the flow rate is dropped, the springs will collapse and the BHA can be retrieved from the hole. Care should be taken when running in and out through the restricted diameters to prevent any damage to the springs.



**Note:** *Unless otherwise indicated, all the strength figures given in this manual, are the result of calculations based on the yield strength of the material used in the manufacture of this product. These strength calculations are considered accurate within plus or minus 20% and are to be used only as a guide. They do not constitute a guarantee, actual or implied. In use, appropriate allowance should be made as a safety factor.*

Product Number	OD (inches)	Spring Width x Thickness (inches)	Pressue Differential Held Across Tool (preferred)
TT0912-168D	1.688	0.75 x 0.093 0.75 x 0.125	700 psi - 850 psi
TT0912-181D	1.813	0.75 x 0.093 0.75 x 0.125	475 psi - 550 psi
TT0912-213D	2.125	0.75 x 0.093 0.75 x 0.125	475 psi to 550 psi
TT0912-225D	2.25	0.75 x 0.093 0.75 x 0.125	475 psi - 550 psi
TT0912-288D	2.875	0.75 x 0.093 0.75 x 0.125	475 psi - 550 psi
TT0912-300D	3	0.75 x 0.093 0.75 x 0.125	475 psi - 550 psi
TT0912-313D	3.125	0.75 x 0.093 0.75 x 0.125	475 psi - 550 psi

# Hydraulic Bow Spring Centralizer



## Stop Sleeve Chart (1-11/16" - 2-1/8")

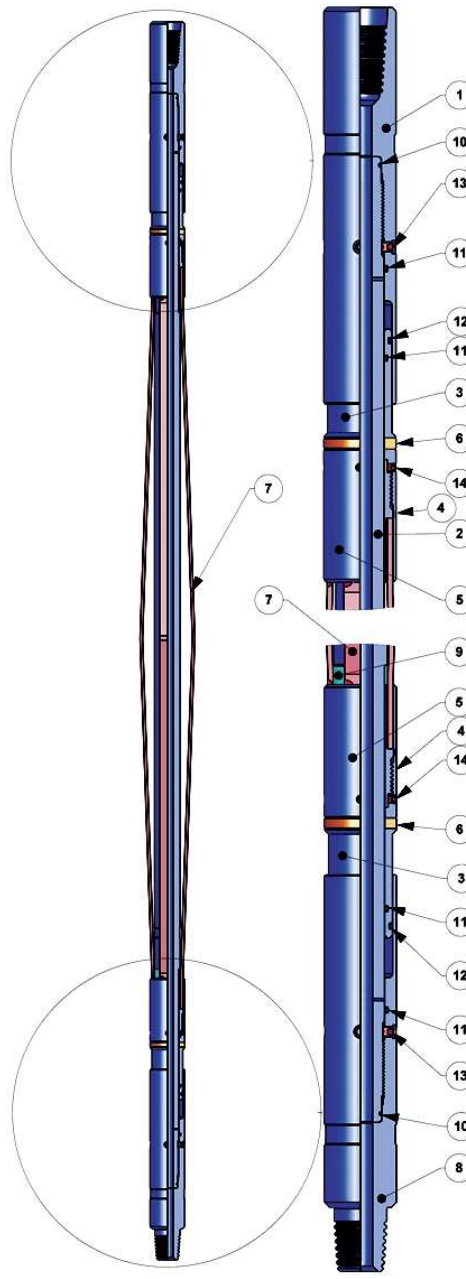
PART NUMBER	CASING SIZE	STOP SLEEVE LENGTH	CENTRALIZER OD
TT0912-168D-A09	4"	1.063"	1.68" - 1.81"
TT0912-168D-B09	5.5"	0.98"	1.68" - 1.81"
TT0912-168D-C09	7"	0.730"	1.68" - 1.81"
NO SLEEVE	9" OR LARGER	N/A	1.68" - 1.81"

PART NUMBER	CASING SIZE	STOP SLEEVE LENGTH	CENTRALIZER OD
TT0912-213D-A09	4"	1.220"	2.06" - 2.25"
TT0912-213D-B09	5.5"	1.156"	2.06" - 2.25"
TT0912-213D-C09	7"	1.063"	2.06" - 2.25"
TT0912-213D-D09	9.625"	0.781"	2.06" - 2.25"

## Stop Sleeve Chart (2-7/8")

PART NUMBER	APPR EXPANSION	STOP SLEEVE LENGTH	CENTRALIZER OD
TT0912-288D-B09	3.74"	1.145"	2.88" - 3.00"
TT0912-288D-C09	6.05"	1.00"	2.88" - 3.00"
TT0912-288D-D09	7.52"	0.800"	2.88" - 3.00"
NO SLEEVE	10.5" - 11.5"	N/A	2.88" - 3.00"

## TT0912-168D BOM, Schematic and Specs



ITEM	QTY	TOOL PARTS DESCRIPTION	PART NUMBER
1	1	Top Sub	TT0912-168D-001
2	1	Mandrel	TT0912-168D-002
3	2	Pistons	TT0912-168D-003
4	2	Spring Carriers	TT0912-168D-004
5	2	Spring Covers	TT0912-168D-005
6	2	Bearing Rings	TT0912-168D-006
7	4	Bow Springs	TT0912-168D-007
8	1	Bottom Sub	TT0912-168D-008
9	1	Stop Sleeve (various sizes available)	TT0912-168D-XXX
10	2	2-020 O-Rings 7/8" x 1" x 1/16"	PUR-TORV000-020
11	4	2-122 O-Rings 1 1/8" x 1 5/16" x 3/32"	PUR-TORV000-122
12	2	2-125 O-Rings 1 15/16" x 1 1/2" x 3/32"	PUR-TORV000-125
13	8	Steel Allen Set Screws 1/4-20 x 1/4"	PUR-TSAS160-016
14	8	Steel Allen Set Screws 10-32 x 3/16"	PUR-TSAS121-012

**Tool Name:** 1.688 in. Hydraulic Bow Spring Centralizer

**Product Code:** TT0912-168D    **Tool OD:** 1.688 in.    **Tool ID:** 0.563 in.

**Material:** AISI 4140 HT 285-341 BHN    **Tool Length:** 59.0 in. w/1 in. MT

**Minimum Yield:** 100,000 psi

**Strength Properties of Tool:**

**Minimum Yield Point and Load to Yield:** The thread relief groove at either end of the Mandrel, 56,600 lbs.

**Burst Point and Burst Pressure:** Piston seal bore are on Top and Bottom Sub, 10,690 psi and 10,470 psi collapse pressure.

**Torsional Weak Point and Ft-Lbs to Yield:** 507 ft-lbs as a function of torsional yield of either pin end of the Mandrel, at the thread relief groove.

**Recommended Make Up Torque:**

**1st Connection:** The Top Sub - Mandrel Stub Acme connection - 297 ft-lbs then tighten the 1/4"- 20 steel Allen set screws – 85 in-lbs.

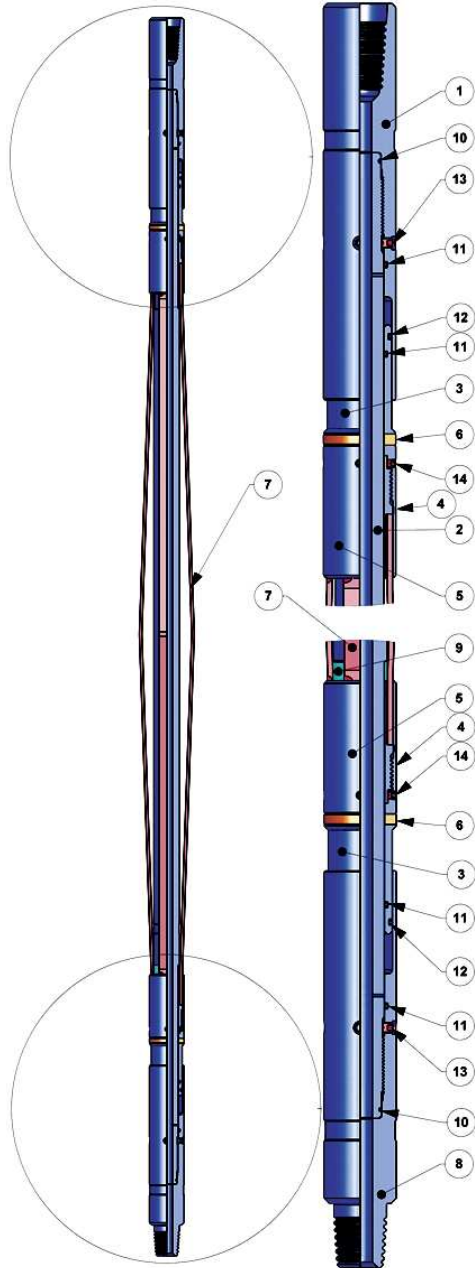
**2nd Connection:** The Mandrel - Bottom Sub Stub Acme connection – 297 ft-lbs then tighten the 1/4"- 20 steel Allen set screws – 85 in-lbs.

**3rd Connection:** Spring Carrier & Spring Cover Stub Acme connection - Hand Tighten or 15 ft-lbs then tighten the 10-32 steel Allen set screws - 40 in-lbs.

# Hydraulic Bow Spring Centralizer



## TT0912-181D BOM, Schematic and Specs



ITEM	QTY	TOOL PARTS DESCRIPTION	PART NUMBER
1	1	Top Sub	TT0912-181D-001
2	1	Mandrel	TT0912-168D-002
3	2	Pistons	TT0912-181D-003
4	2	Spring Carriers	TT0912-168D-004
5	2	Spring Covers	TT0912-168D-005
6	2	Bearing Rings	TT0912-181D-006
7	4	Bow Springs	TT0912-168D-007
8	1	Bottom Sub	TT0912-181D-008
9	1	Stop Sleeve (various sizes available)	TT0912-168D-XXX
10	2	O-Rings 7/8" x 1" x 1/16" 2-020	PUR-TORV000-020
11	4	O-Rings 1 1/8" x 1 5/16" x 3/32" 2-122	PUR-TORV000-122
12	2	O-Rings 1 7/16" x 1 5/8" x 3/32" 2-127	PUR-TORV000-127
13	8	Steel Allen Set Screw 1/4-20 x 5/16"	PUR-TSAS160-020
14	8	Steel Allen Set Screw 10-32 x 1/4"	PUR-TSAS121-016

**Tool Name:** 1.813 in. Hydraulic Bow Spring Centralizer

**Product Code:** TT0912-181D    **Tool OD:** 1.813 in.    **Tool ID:** 0.563 in.

**Material:** AISI 4140 HT 285-341 BHN    **Tool Length:** 59.0 in. w/1 in. MT

**Minimum Yield:** 100,000 psi

**Strength Properties of Tool:**

**Minimum Yield Point and Load to Yield:** The thread relief groove at either end of the Mandrel, 56,600 lbs.

**Burst Point and Burst Pressure:** Piston seal bore are on Top and Bottom Sub, 18,720 psi and 15,770 psi collapse pressure.

**Torsional Weak Point and Ft-Lbs to Yield:** 507 ft-lbs as a function of torsional yield of either pin end of the Mandrel, at the thread relief groove.

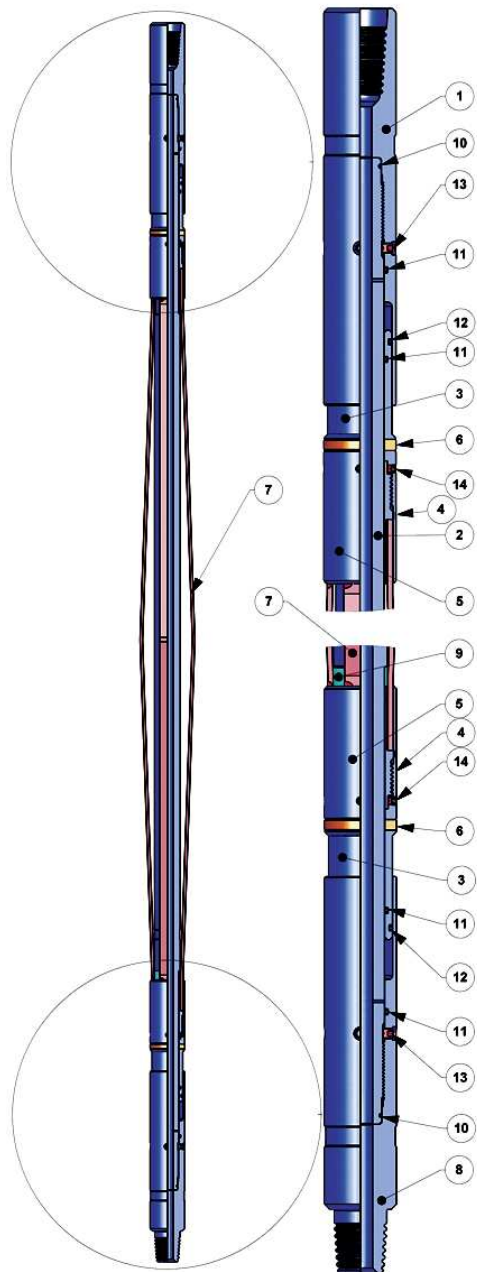
**Recommended Make Up Torque:**

**1st Connection:** The Top Sub - Mandrel Stub Acme connection - 297 ft-lbs then tighten the 1/4"- 20 steel Allen set screws – 85 in-lbs.

**2nd Connection:** The Mandrel - Bottom Sub Stub Acme connection – 297 ft-lbs then tighten the 1/4"- 20 steel Allen set screws – 85 in-lbs.

**3rd Connection:** Spring Carrier & Spring Cover Stub Acme connection - Hand Tighten or 15 ft-lbs then tighten the 10-32 steel Allen set screws - 40 in-lbs.

## TT0912-213D BOM, Schematic and Specs



ITEM	QTY	TOOL PARTS DESCRIPTION	PART NUMBER
1	1	Top Sub	TT0912-213D-001
2	1	Mandrel	TT0912-213D-002
3	2	Pistons	TT0912-213D-003
4	2	Spring Carriers	TT0912-213D-004
5	2	Spring Covers	TT0912-213D-005
6	2	Bearing Rings	TT0912-213D-006
7	5	Bow Springs	TT0912-168D-007
8	1	Bottom Sub	TT0912-213D-008
9	1	Stop Sleeve (various sizes available)	TT0912-213D-XXX
10	2	O-Rings 1 1/8" x 1 1/4" x 1/16" 2-024	PUR-TORV000-024
11	4	O-Rings 1 3/8" x 1 9/16" x 3/32" 2-126	PUR-TORV000-126
12	2	O-Rings 1 11/16" x 1 7/8" x 3/32" 2-131	PUR-TORV000-131
13	12	Steel Allen Set Screws 1/4-20 x 5/16"	PUR-TSAS160-020
14	8	Steel Allen Set Screws 10-32 x 1/4"	PUR-TSAS121-016

**Tool Name:** 2.125 in. Hydraulic Bow Spring Centralizer

**Product Code:** TT0912-213D    **Tool OD:** 2.125 in.    **Tool ID:** 0.563 in.

**Material:** AISI 4140 HT 285-341 BHN    **Tool Length:** 61.5 in. w/1-1/2 in. MT

**Minimum Yield:** 100,000 psi

**Strength Properties of Tool:**

**Minimum Yield Point and Load to Yield:** The thread relief groove at either end of the Mandrel, 99,680 lbs.

**Burst Point and Burst Pressure:** Piston seal bore are on Top and Bottom Sub, 9,130 psi and 8,370 psi collapse pressure.

**Torsional Weak Point and Ft-Lbs to Yield:** 1043 ft-lbs as a function of torsional yield of either pin end of the Mandrel, at the thread relief groove.

**Recommended Make Up Torque:**

**1st Connection:** The Top Sub - Mandrel Stub Acme connection - 641 ft-lbs then tighten the 1/4"- 20 steel Allen set screws - 85 in-lbs.

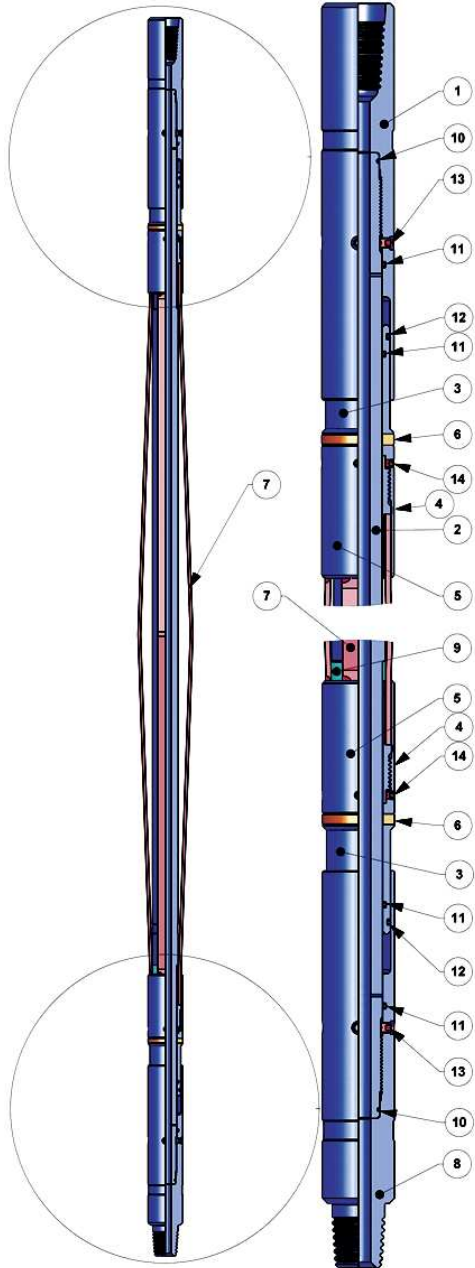
**2nd Connection:** The Mandrel - Bottom Sub Stub Acme connection - 641 ft-lbs then tighten the 1/4"- 20 steel Allen set screws - 85 in-lbs.

**3rd Connection:** Spring Carrier and Spring Cover Stub Acme connection - Hand Tighten or 15 ft-lbs, then tighten the 10-32 steel Allen set screws - 40 in-lbs.

# Hydraulic Bow Spring Centralizer



## TT0912-225D BOM, Schematic and Specs



ITEM	QTY	TOOL PARTS DESCRIPTION	PART NUMBER
1	1	Top Sub	TT0912-225D-001
2	1	Mandrel	TT0912-213D-002
3	2	Pistons	TT0912-225D-003
4	2	Spring Carriers	TT0912-213D-004
5	2	Spring Covers	TT0912-225D-005
6	2	Bearing Rings	TT0912-225D-006
7	5	Bow Springs	TT0912-168D-007
8	1	Bottom Sub	TT0912-225D-008
9	1	Stop Sleeve (various sizes available)	TT0912-213D-XXX
10	2	O-Rings 1 1/8" x 1 1/4" x 1/16" 2-024	PUR-TORV000-024
11	4	O-Rings 1 3/8" x 1 9/16" x 3/32" 2-126	PUR-TORV000-126
12	2	O-Rings 1 7/8" x 2 1/16" x 3/32" 2-134	PUR-TORV000-134
13	12	Steel Allen Set Screws 1/4-20 x 3/8"	PUR-TSAS160-024
14	8	Steel Allen Set Screws 10-32 x 1/4"	PUR-TSAS121-016

**Tool Name:** 2.250 in. Hydraulic Bow Spring Centralizer

**Product Code:** TT0912-225D    **Tool OD:** 2.250 in.    **Tool ID:** 0.563 in.

**Material:** AISI 4140 HT 285-341 BHN    **Tool Length:** 61.5 in. w/1-1/2 in. MT

**Minimum Yield:** 100,000 psi

**Strength Properties of Tool:**

**Minimum Yield Point and Load to Yield:** The thread relief groove at either end of the Mandrel, 99,680 lbs.

**Burst Point and Burst Pressure:** Piston seal bore are on Top and Bottom Sub, 14,770 psi and 12,870 psi collapse pressure.

**Torsional Weak Point and Ft-Lbs to Yield:** 1043 ft-lbs as a function of torsional yield of either pin end of the Mandrel, at the thread relief groove.

**Recommended Make Up Torque:**

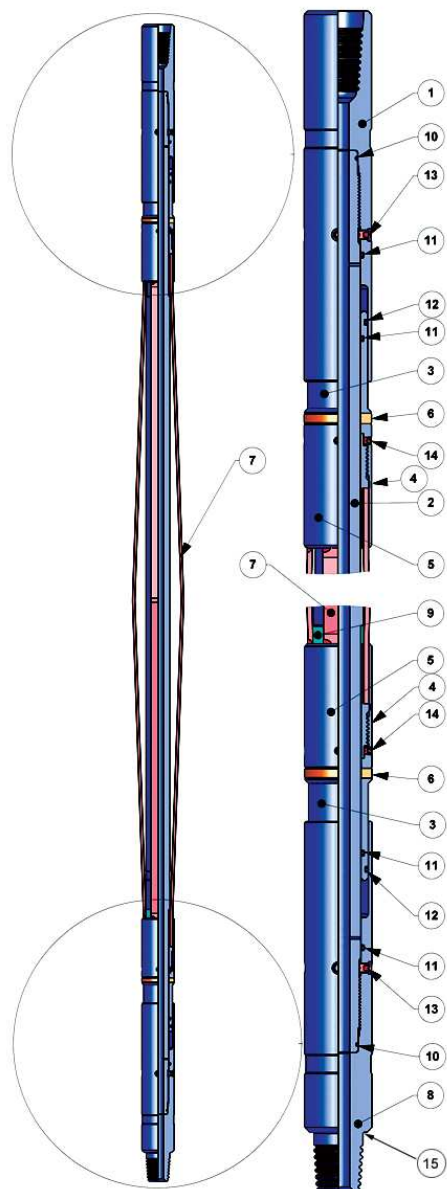
**1st Connection:** The Top Sub - Mandrel Stub Acme connection - 641 ft-lbs then tighten the 1/4"- 20 steel Allen set screws - 85 in-lbs.

**2nd Connection:** The Mandrel - Bottom Sub Stub Acme connection - 641 ft-lbs then tighten the 1/4"- 20 steel Allen set screws - 85 in-lbs.

**3rd Connection:** Spring Carrier and Spring Cover Stub Acme connection - Hand Tighten or 15 ft-lbs, then tighten the 10-32 steel Allen set screws - 40 in-lbs.



## TT0912-288D BOM, Schematic and Specs



ITEM	QTY	TOOL PARTS DESCRIPTION	PART NUMBER
1	1	Top Sub	TT0912-288D-001
2	1	Mandrel	TT0912-288D-002
3	2	Pistons	TT0912-288D-003
4	2	Spring Carriers	TT0912-288D-004
5	2	Spring Covers	TT0912-288D-005
6	2	Bearing Rings	TT0912-288D-006
7	7	Bow Springs	TT0912-168D-007
8	1	Bottom Sub	TT0912-288D-008
9	1	Stop Sleeve (various sizes available)	TT0912-288D-XXX
10	2	O-Rings 1 5/8" x 1 13/16" x 3/32" 2-130	PUR-TORV000-130
11	4	O-Rings 2 1/16" x 2 1/4" x 3/32" 2-137	PUR-TORV000-137
12	2	O-Rings 2 7/16" x 2 5/8" x 3/32" 2-143	PUR-TORV000-143
13	12	Steel Allen Set Screw 3/8-16 x 7/16"	PUR-TSAS240-028
14	8	Steel Allen Set Screw 10-32 x 1/4"	PUR-TSAS121-016
15	1	O-Ring 2 1/16" x 2 3/8" x 1/8" 2-227	PUR-TORV000-227

**Tool Name:** 2.875 Hydraulic Bow Spring Centralizer

**Product Code:** TT0912-288D    **Tool OD:** 2.875 in.    **Tool I D:** 1.00 in.

**Material:** AISI 4140 HT 285-341 BHN    **Tool Length:** 62.9 in. w/2-3/8 in. PAC DSI Connections

**Minimum Yield:** 100,000 psi

**Strength Properties of Tool:**

**Minimum Yield Point and Load to Yield:** The thread relief groove at either end of the Mandrel, 200,800 lbs.

**Burst Point and Burst Pressure:** Piston seal bore are on Top and Bottom Sub, 8,800 psi and 8,250 psi collapse pressure.

**Torsional Weak Point and Ft-Lbs to Yield:** 3370 ft-lbs as a function of torsional yield of either pin end of the Mandrel, at the thread relief groove.

**Recommended Make Up Torque:**

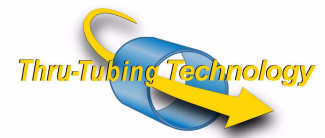
**1st Connection:** The Top Sub - Mandrel Stub Acme connection - 990 ft-lbs then tighten the 3/8" - 16 steel Allen set screws - 288 in-lbs.

**2nd Connection:** The Mandrel - Bottom Sub Stub Acme connection - 990 ft-lbs then tighten the 3/8" - 16 steel Allen set screws - 288 in-lbs.

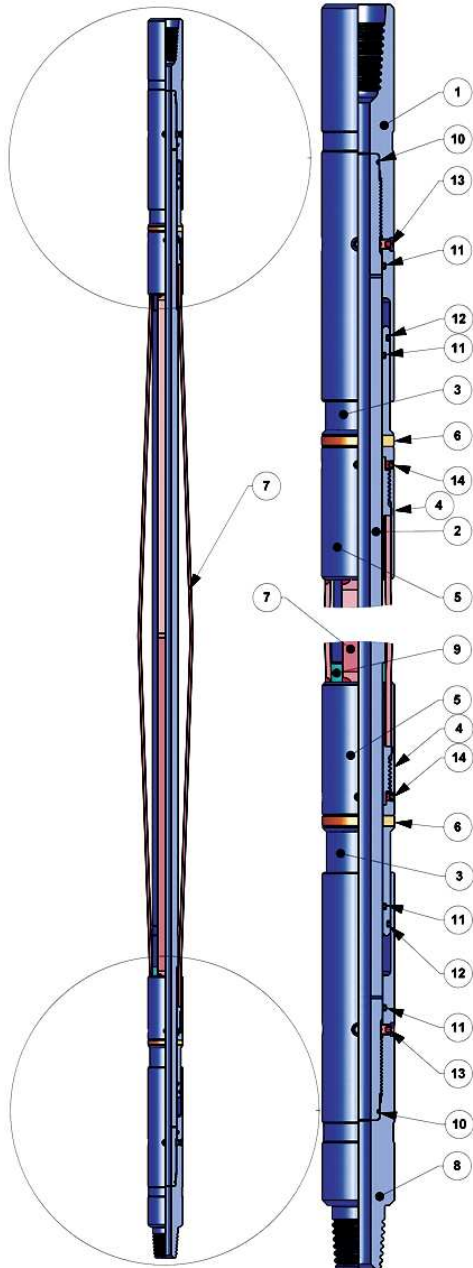
**3rd Connection:** Spring Carrier and Spring Cover Stub Acme connection - Hand Tighten or 15 ft-lbs, then tighten the 10-32 steel Allen set screws - 40 in-lbs.



# Hydraulic Bow Spring Centralizer



## TT0912-300D BOM, Schematic and Specs



ITEM	QTY	TOOL PARTS DESCRIPTION	PART NUMBER
1	1	Top Sub	TT0912-300D-001
2	1	Mandrel	TT0912-288D-002
3	2	Pistons	TT0912-288D-003
4	2	Spring Carriers	TT0912-288D-004
5	2	Spring Covers	TT0912-288D-005
6	2	Bearing Rings	TT0912-288D-006
7	7	Bow Springs	TT0912-168D-007
8	1	Bottom Sub	TT0912-300D-008
9	1	Stop Sleeve (various sizes available)	TT0912-288D-XXX
10	4	O-Rings 2 1/16" x 2 1/4" x 3/32" 2-137	PUR-TORV000-137
11	2	O-Rings 1 5/8" x 1 13/16" x 3/32" 2-130	PUR-TORV000-130
12	2	O-Rings 2 7/16" x 2 5/8" x 3/32" 2-143	PUR-TORV000-143
13	12	Steel Allen Set Screw 3/8-16 x 7/16"	PUR-TSAS240-028
14	8	Steel Allen Set Screw 10-32 x 1/4"	PUR-TSAS121-016

**Tool Name:** 3.00 in. Hydraulic Bow Spring Centralizer

**Product Code:** TT0912-300D    **Tool OD:** 3.000 in.    **Tool ID:** 1.00 in.

**Material:** AISI 4140 HT 285-341 BHN    **Tool Length:** 62.9 in. w/2-3/8 in. PAC DSI Connections

**Minimum Yield:** 100,000 psi

**Strength Properties of Tool:**

**Minimum Yield Point and Load to Yield:** The thread relief groove at either end of the Mandrel, 200,800 lbs.

**Burst Point and Burst Pressure:** Piston seal bore are on Top and Bottom Sub 13,200 psi and 11,660 psi collapse pressure.

**Torsional Weak Point and Ft-Lbs to Yield:** 3370 ft-lbs as a function of torsional yield of either pin end of the Mandrel, at the thread relief groove.

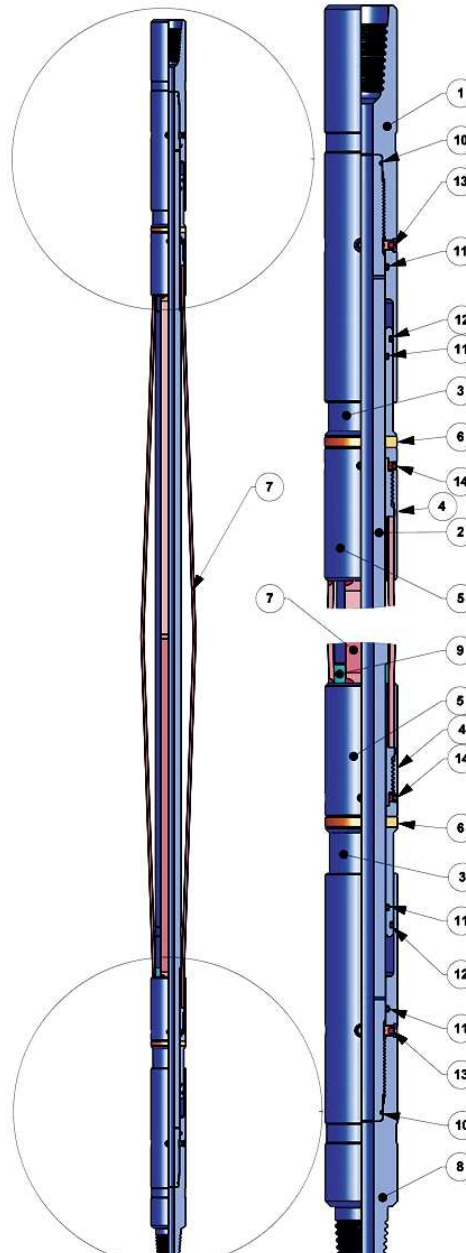
**Recommended Make Up Torque:**

**1st Connection:** The Top Sub - Mandrel Stub Acme connection - 990 ft-lbs then tighten the 3/8"- 16 steel Allen set screws – 288 in-lbs.

**2nd Connection:** The Mandrel - Bottom Sub Stub Acme connection – 990 ft-lbs then tighten the 3/8"- 16 steel Allen set screws – 288 in-lbs.

**3rd Connection:** Spring Carrier and Spring Cover Stub Acme connection - Hand Tighten or 15 ft-lbs, then tighten the 10-32 steel Allen set screws - 40 in-lbs.

## TT0912-313D BOM, Schematic and Specs



ITEM	QTY	TOOL PARTS DESCRIPTION	PART NUMBER
1	1	Top Sub	TT0912-313D-001
2	1	Mandrel	TT0912-288D-002
3	2	Pistons	TT0912-313D-003
4	2	Spring Carriers	TT0912-288D-004
5	2	Spring Covers	TT0912-313D-005
6	2	Bearing Rings	TT0912-313D-006
7	7	Bow Springs	TT0912-168D-007
8	1	Bottom Sub	TT0912-313D-008
9	1	Stop Sleeve (various sizes available)	TT0912-288D-XXX
10	2	O-Rings 1 5/8" x 1 13/16" x 3/32" 2-130	PUR-TORV000-137
11	4	O-Rings 2 1/16" x 2 1/4" x 3/32" 2-137	PUR-TORV000-130
12	2	O-Rings 2 9/16" x 2 3/4" x 3/32" 2-145	PUR-TORV000-143
13	16	Steel Allen Set Screws 3/8-16 x 7/16"	PUR-TSAS240-028
14	8	Steel Allen Set Screws 10-32 x 3/8"	PUR-TSAS121-024

**Tool Name:** 3.125 in. Hydraulic Bow Spring Centralizer

**Product Code:** TT0912-313D    **Tool OD:** 3.125 in.    **Tool I.D.:** 1.00" in.

**Material:** AISI 4140 HT 285-341 BHN    **Tool Length:** 62.5 in. w/2-3/8 in. API Reg. Connections

**Minimum Yield:** 100,000 psi

**Strength Properties of Tool:**

**Minimum Yield Point and Load to Yield:** The thread relief groove at either end of the Mandrel, 200,800 lbs.

**Burst Point and Burst Pressure:** Piston seal bore are on Top and Bottom Sub 10,400 psi and 9,430 psi collapse pressure.

**Torsional Weak Point and Ft-Lbs to Yield:** 3370 ft-lbs as a function of torsional yield of either pin end of the Mandrel, at the thread relief groove.

**Recommended Make Up Torque:**

**1st Connection:** The Top Sub - Mandrel Stub Acme connection - 990 ft-lbs then tighten the 3/8"- 16 steel Allen set screws – 288 in-lbs.

**2nd Connection:** The Mandrel - Bottom Sub Stub Acme connection – 990 ft-lbs then tighten the 3/8"- 16 steel Allen set screws – 288 in-lbs.

**3rd Connection:** Spring Carrier and Spring Cover Stub Acme connection - Hand Tighten or 15 ft-lbs, then tighten the 10-32 steel Allen set screws - 40 in-lbs.

## 1.0 Pre-Assembly



**Warning:** *Make sure all tool parts and components have been thoroughly cleaned or serious damage and/or injury could occur!*



**Note:** *Verify that the correct O-ring redress kit and quantities are used as specified on the Bill Of Materials (for example, 5 each etc....). Lay out all redress kit components on a clean surface.*



**Note:** *Make sure to lubricate all O-rings and threaded surfaces.*



**Note:** *Visually inspect all parts for damage or wear. Thread parts together without the O-rings to check fit. Repair or replace damaged parts.*



**Caution:** *Always file wrench marks or burrs and clean off debris!*



**Caution:** *This tool should always be disassembled, cleaned thoroughly, inspected and reassembled after each job!*

## 2.0 Assembly

**2.1** Put the O-ring (item #11) onto the Bottom Sub (item #8). Grease the entire ID of the sub, then put it into a vise.

**2.2** Put 2 O-rings (item #10) onto the Mandrel (item #2).

**2.3** Put an O-ring in the ID (item #11) and on the OD (item #12) of each Piston (item #3).

**2.4** Put the O-ring (item #11) in the Top Sub (item #1).

**2.5** Put a Piston, O-ring first, into the Bottom Sub. Use a rubber mallet to tap it in half way.

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**2.6** Grease one end of the Mandrel. Put on a Spring Carrier (item #4), threads up, onto the greased end of the Mandrel. Next install the Spring Cover (item #5) onto the Mandrel and half way onto to the carrier. Slip the Bearing Ring (item #6) onto the Mandrel and snug up to the cover.

**2.7** Thread the Mandrel, greased end first, into the Bottom Sub about half way.

**2.8** Grease the other end of the Mandrel, then install the Stop Sleeve (item #9).



**Note:** *9 in. Casing does not use a Stop Sleeve.*

**2.9** Repeat step 2.6 for the other carrier/cover/ring.

**2.10** Grease the entire ID of the Top Sub (item #1) and the OD of the Piston (item #3). Tap the Piston into the sub about half way.

**2.11** Thread the Top Sub/Piston onto the Mandrel half way.

**2.12** Starting at one end of the Mandrel, put a Bow Spring (item #7) into one of the slots on the Spring Carrier (item #4), then screw on the Spring Cover (item #5) 1/4 of a turn. Repeat for the other end of the spring.

**2.13** Repeat step 2.12 for the other springs.



**Note:** *Hold on to the other springs when you loosen the Spring Cover so they do not fall out.*

**2.14** After the last Bow Spring has been installed, tighten both of the Spring Covers.

**2.15** Using a backup wrench, make all of the connections wrench tight.



**Caution:** *Do not wrench on the Mandrel areas above the springs! It is OK to wrench on the middle of the Mandrel!*

**2.16** Install the 8 Set Screws (item #14) into the Spring Covers and tighten.

2.17 Install the 8 Set Screws (item #13) into the Top and Bottom Subs and tighten.

## 3.0 Disassembly

3.1 Put the tool in a vise on the Bottom Sub (item #8).

3.2 Remove the 8 Set Screws (item #13) from the Top and Bottom Subs (item #1 and #8).

3.3 Remove the 8 Set Screws (item #14) from the Spring Covers (item #5).

3.4 Loosen the Top Sub about half way.

3.5 Unscrew one of the Spring Covers and while holding on to the other springs, remove one spring from the slot in the Spring Carrier (item #4). Screw cover back on 1/4 of a turn. Repeat on other end of Mandrel.

3.6 Repeat step 3.5 until all of the Springs have been removed.

3.7 Remove the Top Sub, then remove the Piston from the sub.

3.8 Remove the Spring Carrier (item #4)/Spring Cover from the Mandrel and the Stop Sleeve (item #9) if present. Take the assembly out of the vise and remove the other carrier and cover from the Mandrel.

3.9 Finally, remove the Bottom Sub from the vise, then remove the Piston from the sub.



**Note:** Remove and discard all O-rings. Replace O-rings after each use. Thoroughly clean tool parts in a cleaner approved by state and/or local laws.



**Note:** Visually inspect tool for swelling after each use. Damaged or swelled components must be replaced.



**Note:** It is recommended that a Magnetic Particle Inspection (MPI) be completed on all components after each job.