

# kaseum<sup>®</sup>

K-PUNCH (PATENT APPLIED FOR)



# What is The 'K-Punch'. Hydraulic Punch Tool.

'A Hydraulic Press'. A hydraulic system that will provide the required forces needed to push a Punch Button through the tubing/casing wall, allowing hydraulic communication into the annular space.

K-Punch uses a one, or multiple, floating pistons (Punch Pistons) to provide mechanical work. These Punch Pistons are fitted with hardened sacrificial Punch Buttons that will be pushed through the tubing wall once enough hydraulic pressure has been applied.

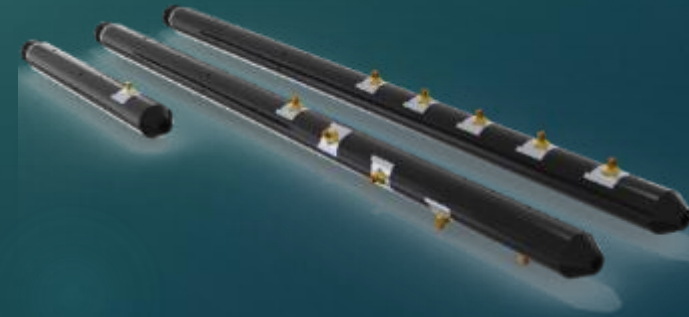
- ▶ 'Punch' – Slowly Push a hardened steel Punch Button against the tubing wall with enough force to cause the tubing to yield, pushing the Button through the tubing and creating a hole.
- ▶ The K-Punch is fitted to the K-Set. The linear stroke of the K-Set will directly pressure up or down the K-Punch assembly.

## Theory of operation

- ▶ The tool string is assembled and run to depth. The 'Punching Cycle' is electronically initiated.
  - ▶ K-Set Pulls and the K-Punch pressure increases. The Punch Buttons are pushed outward to contact the tubing wall.
  - ▶ Pull continues until enough pressure has been reached to push the Button through the tubing, allowing annular communication. This process continues until all Punch Buttons have penetrated.
  - ▶ Pull continues. Once all Buttons are deployed the tool is now constrained and the pressure continues to rise. Once the pressure exceeds the rating primary pressure safety device the pressure is vented into the wellbore. The Pull command continues until the end of the K-Set Stroke is reached.
  - ▶ The Retract phase begins. The K-Set Pushes back to the start position, this allows for a negative pressure differential in the K-Punch and for the Punch Pistons to retract below the tool OD with the aid of hydrostatic pressure.

## The K-Punch consists of 2 main sections

- ▶ Hydraulic Actuator. Fixed piston that governs the hydraulic pressure within the system.
- ▶ Punch Head(s). Floating Pistons used to produce mechanical work



# K-Punch Features

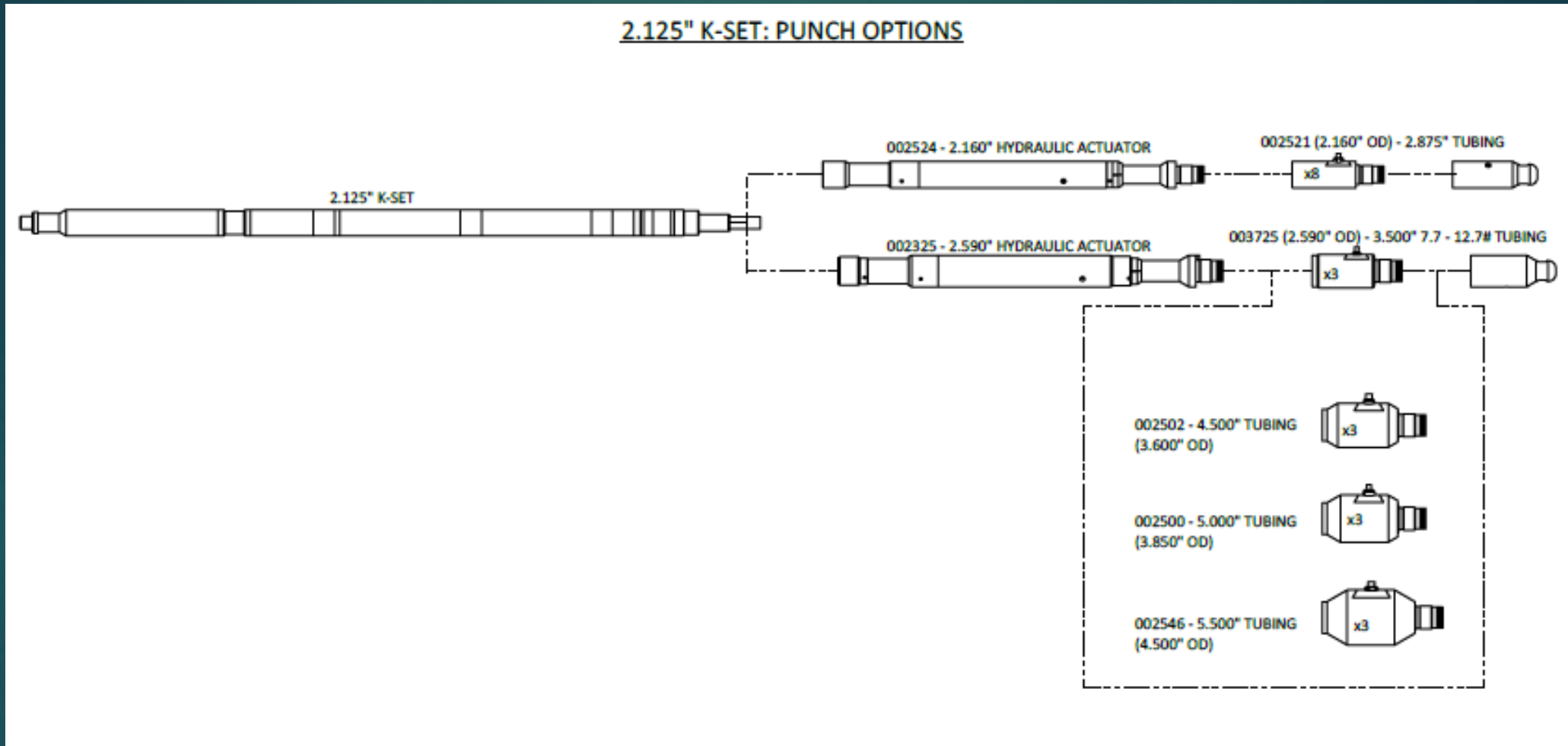
## Features

- ▶ Non-explosive, safe system - Initiated using alkaline battery power and internally generated hydraulic pressure. No internal pressure on return to surface.
- ▶ Retrofittable - The K-Punch is retrofitted to the K-Set, utilising existing tool fleet.
- ▶ Electronic control - Electronic control using a Timer in Slickline mode, or can be initiated directly over E-Line.
- ▶ Modular - Only 3 Hydraulic Actuator types cover sizes from 2-7/8" Tubing to 9-5/8" Casing.
- ▶ Single Punch and/or Multi-punch options – Multiple Punch Heads can be used to maximise achievable flow area. (volume dependant)
- ▶ Oriented punching – The Punch Heads can be phased to ensure holes are made on different planes.
- ▶ Multiple built in safety systems –
  - ▶ Primary Safety device - to ensure that the system cannot be over pressurised - Relief Shear Disc
  - ▶ Secondary Safety device - to allow internal pressure to be bled off safely – A.F.O Plug
  - ▶ Emergency Safety device - if tool fails while anchored in hole - Emergency Shear Ring

The K-Punch can be fitted to all 3 sizes of K-Set depending on the required punching application. A K-Punch running string will consist of:

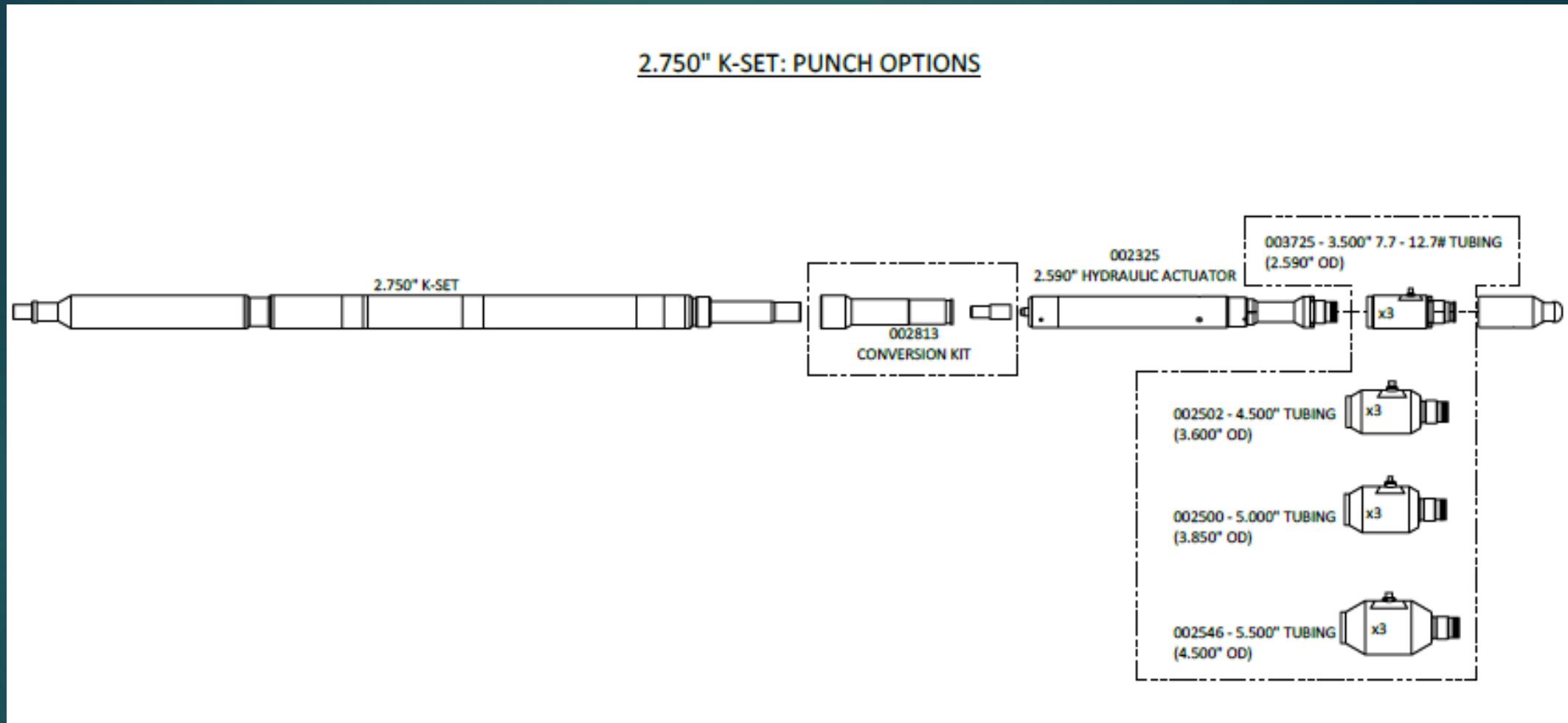
- ▶ A K-Set.
- ▶ A K-Punch Hydraulic Actuator - 3 sizes available (2.1260" OD, 2.590" OD, 3.6" OD) to cover from 2-7/8" tubing to 9-5/8" casing.
- ▶ One, or Multiple Punch Heads. Punch heads are tubing/casing specific and cannot be used for multiple pipe sizes. (i.e. a Punch Head can only be used in one size of tubing).
  - ▶ From 2-7/8" to 5.5" each Punch Head has 1 Floating Punch Piston.
  - ▶ From 7" to 9-5/8" each Punch Head has a 3 fin design and contains 3 Floating Pistons. Only 1 is used for Punching, the other 2 are Stabilising Pistons (i.e. not fitted with Punch Buttons) these aid the process by providing casing standoff.

# K-Punch from 2.875" to 5.5" Tubing using 2.125" K-Set



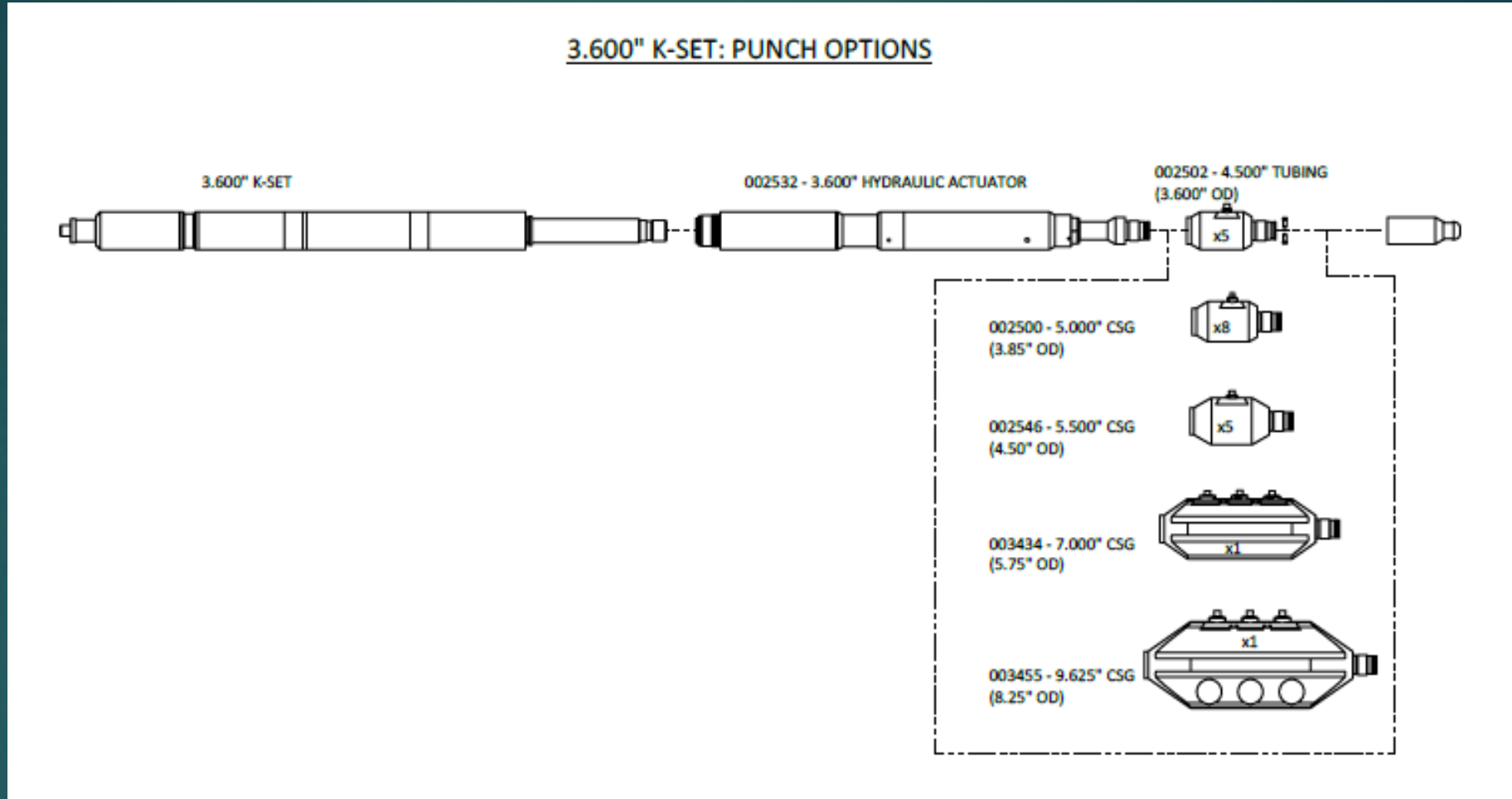
Max. Hydrostatic operating Pressure 15,000 Psi (1034 Bar)  
Temperature rated to 135°C

# K-Punch from 3.5" to 5.5" Tubing using 2.75" and 2.72" K-Set



Max. Hydrostatic operating Pressure 15,000 Psi (1034 Bar)  
Temperature rated to 135°C

# K-Punch from 4.5" to 9.625" Casing using 3.6" K-Set



Max. Hydrostatic operating Pressure 15,000 Psi (1034 Bar)  
Temperature rated to 135°C

# K-Punch Identification



Hydraulic Actuator

Punch Head

# K-Punch Identification

Punch Heads are fitted between the Outlet Sub and End Sub of the Hydraulic Actuator



Hydraulic Actuator

Punch Head

End Sub  
Part of Hyd. Act.

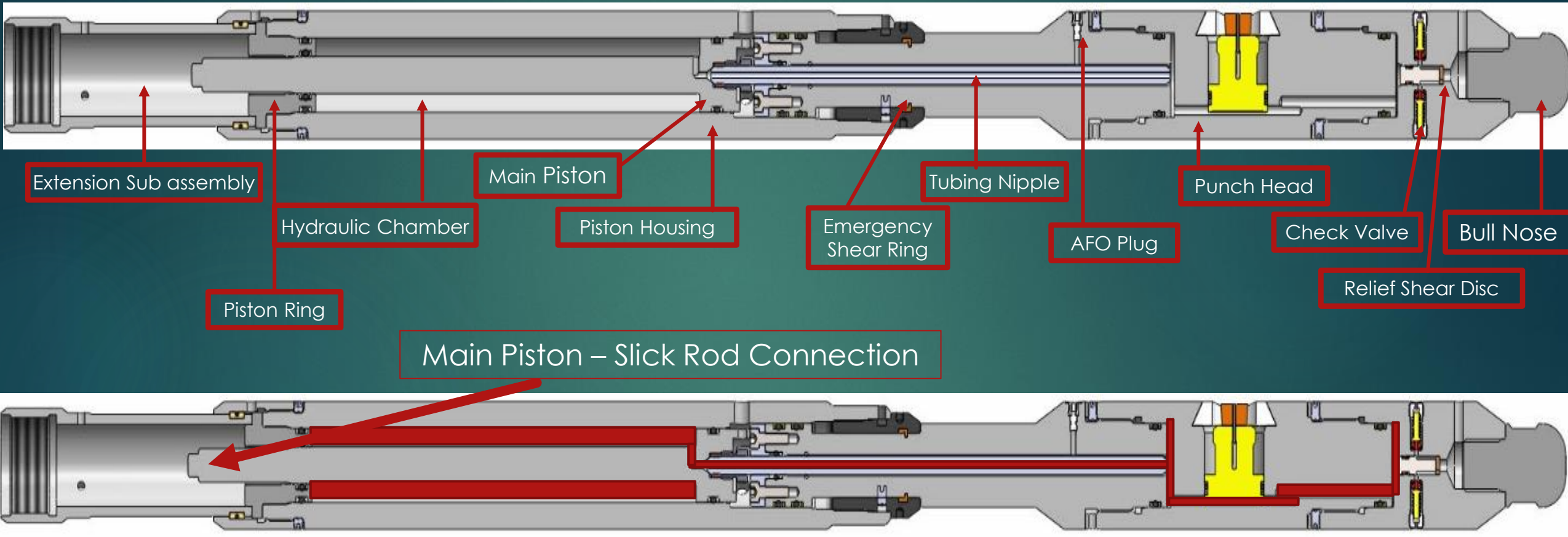


Hydraulic Actuator

Punch Head

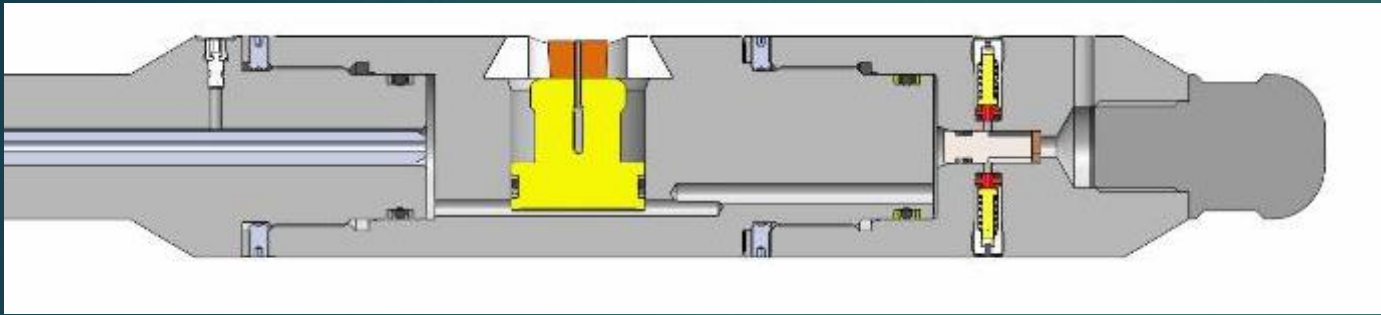
End Sub  
Part of Hyd. Act.

# K-Punch Identification

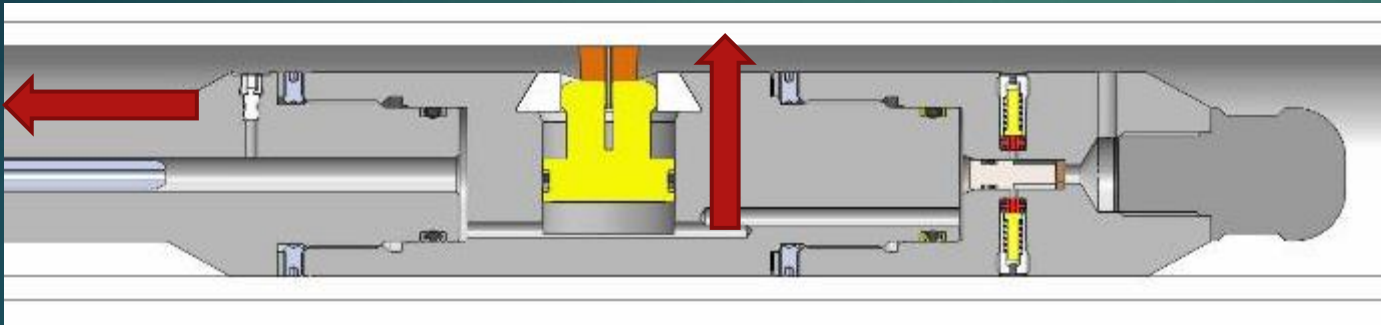


Hydraulic Chamber

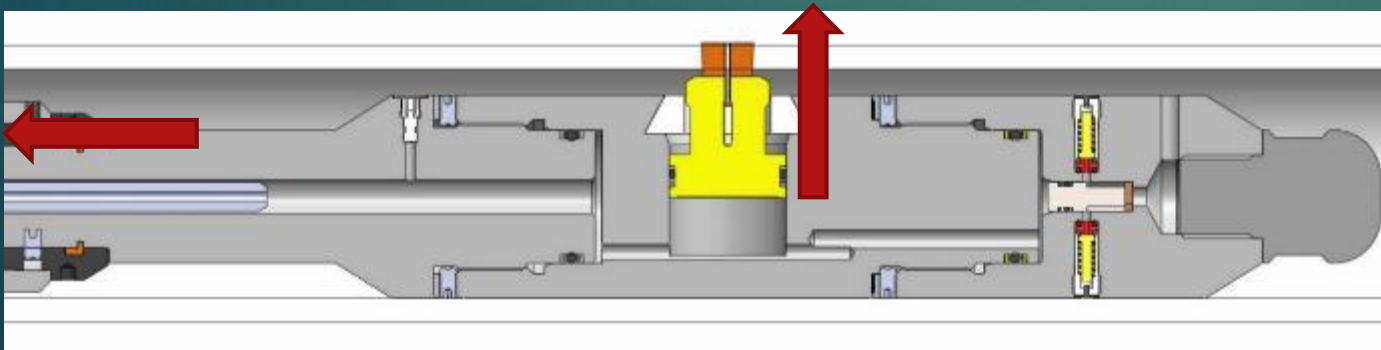
# K-Punch Punching Cycle.



Step 1  
RIH config. Tool is oil filled with thermal gap. Button fitted. Run in to Punch depth

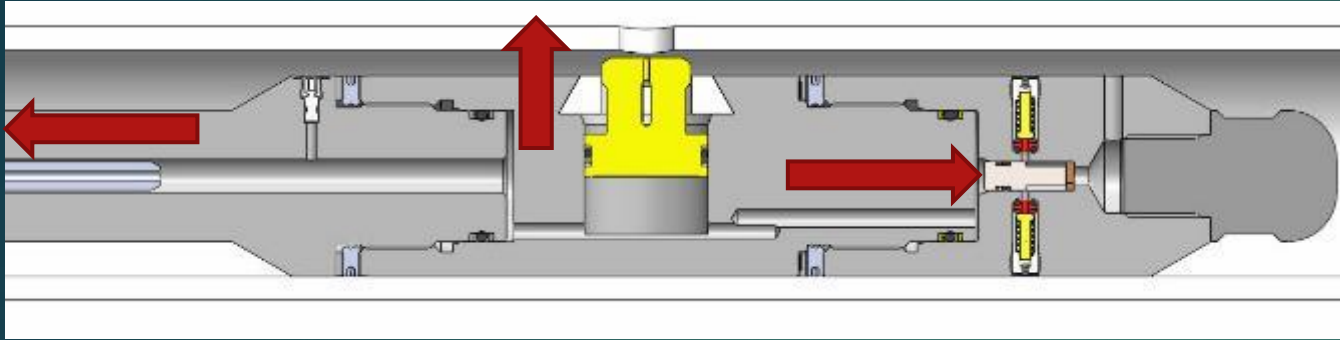


Step 2  
Run to depth. Initiate Punch command, pressure increases and Punch Piston extends outward to contact tubing wall.

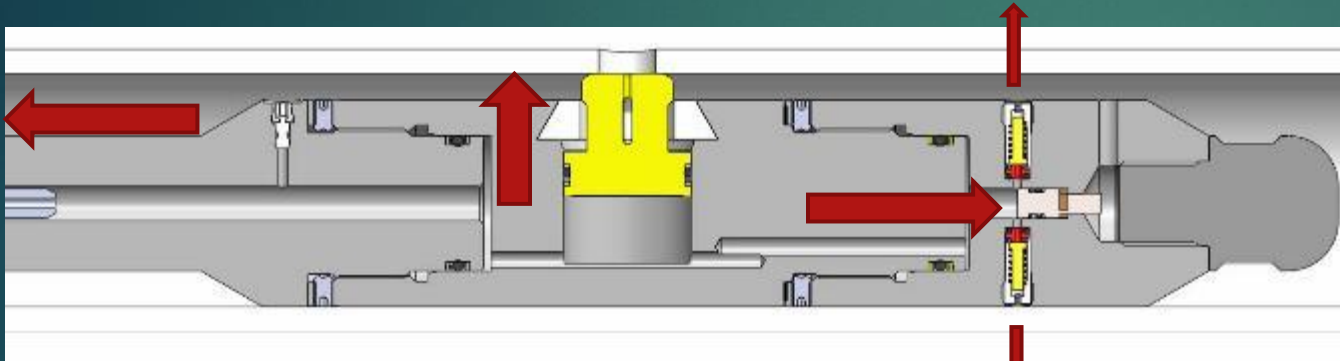


Step 3  
Punch command continues. Pressure increases enough to yield tubing and Button is pushed through creating communication hole

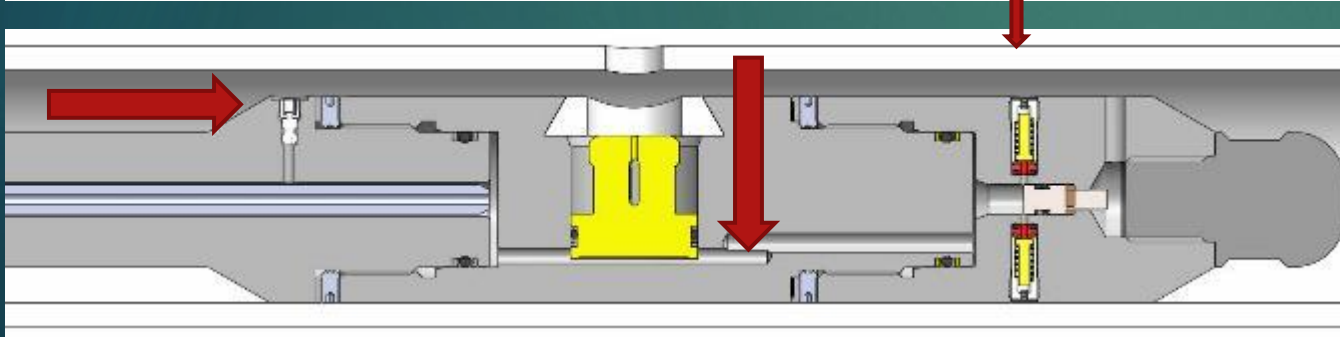
# K-Punch Punching Cycle contd.



**Step 4**  
Punch command continues. Button is ejected into annular space. Pressure continues to increase, loading the Relief Shear Disc.



**Step 5**  
Punch command continues. Relief Shear Disc rating is exceeded and disc ruptures. This opens the chamber to the Check Valves and the hydraulics are vented into the wellbore. Punch command continues till the end of the stroke is reached.

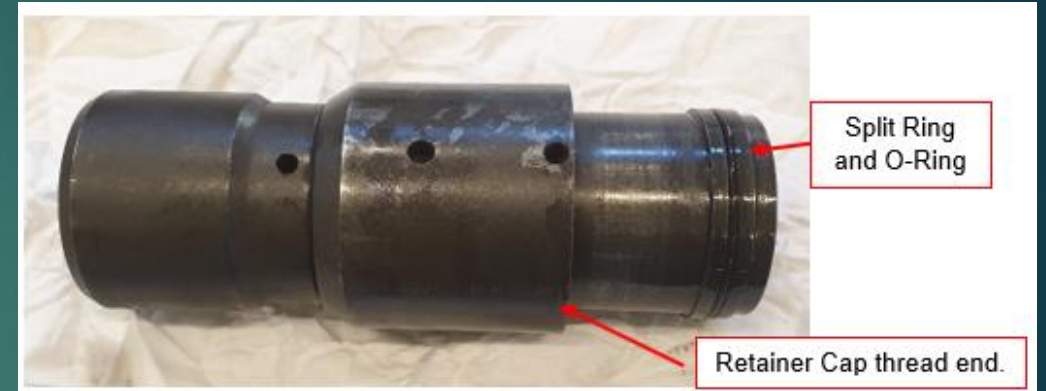


**Step 6**  
Retract command is initiated. Check Valves seat. Tool creates a negative pressure differential and the Punch Piston is retracted back under the tool OD. Once command is complete the tool is recovered to surface.

# K-Punch, Extension Sub assembly.

## The Extension Sub assembly

- ▶ The Extension Sub assembly is the main mechanical interface to mount the K-Punch The K-Set.
- ▶ Main Piston is made up first, then Spin Collar is made up at the end.
- ▶ Spin Collar for easy make up.
- ▶ Retained with 2 x Set Screws.



## 3.6" Hyd. Act. only

- ▶ 2 additional Crossover required.
- ▶ K-Set Lower Outer Adaptor (L.O.A) must be removed. Ensure the tool is pulled up by at least 2" before removing the L.O.A.
- ▶ Slick Rod Crossover. 2 off retaining Screws.

## 2.125" K-Set

- ▶ If using the 2.125" K-Set remove the K-Set Lock Ring



# K-Punch, Piston Assembly

The Piston Assembly Consists of:

## The Main Piston



- ▶ Main Connection to Slick Rod.
- ▶ Fixed Piston. Directly Energises the Hydraulic Chamber.
- ▶ Directly controlled by the K-Set.
- ▶ Dynamic Seal Surface.
- ▶ Make Up Shoulder
- ▶ Seal Arrangement. Internal Autoclave seal face



## Tubing Nipple



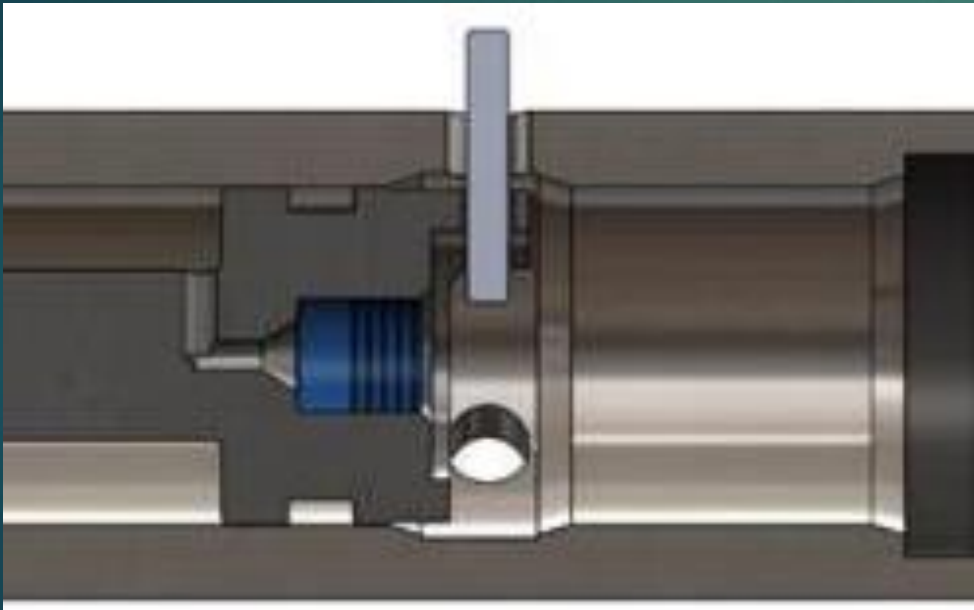
- ▶ Dynamic Seal Surface
- ▶ Metal Seal face
- ▶ Tubing Gland and Nut. Space out critical.

**DYNAMIC SEALING SURFACES. NO DAMAGE/TOOLING PERMITTED. NO EXCEPTIONS.**

**THE TUBING NIPPLE AND MAIN PISTON CONNECTION MUST BE TIGHT. (Tubing Nipple must be tight, not just the Nut) CHECK PRIOR TO EACH ASSEMBLY**

# K-Punch, Piston Housing

- ▶ Main Body of the Hyd. Act.
- ▶ Through Holes to allow engaging of Main Piston and make up to K-Set.



# K-Punch, Piston Ring

- ▶ The Piston Ring is fitted with 2 seal sets.
  - ▶ One static External Seal
  - ▶ One Dynamic Internal Seal
- ▶ Piston Ring is removed for the oil filling procedure.
- ▶ Scalloped Sides (lever points) to allow for tooling entry to aid in removal.



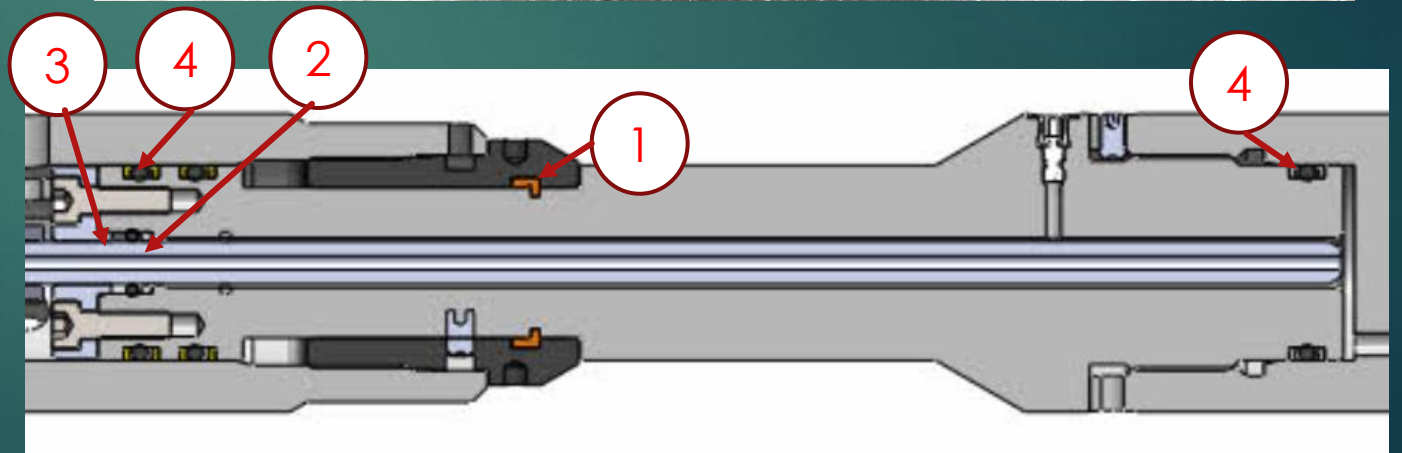
Lever Point



# K-Punch, Outlet Sub

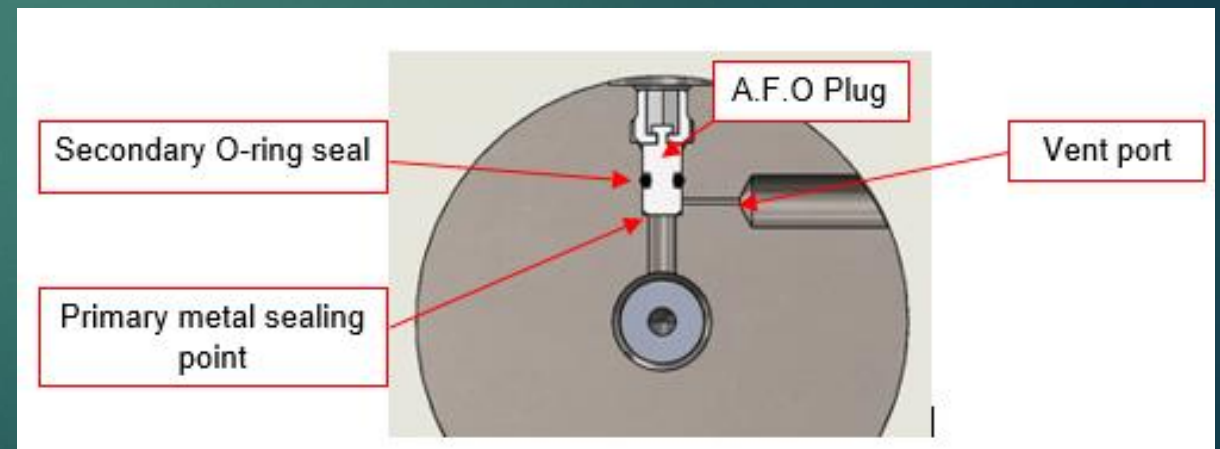
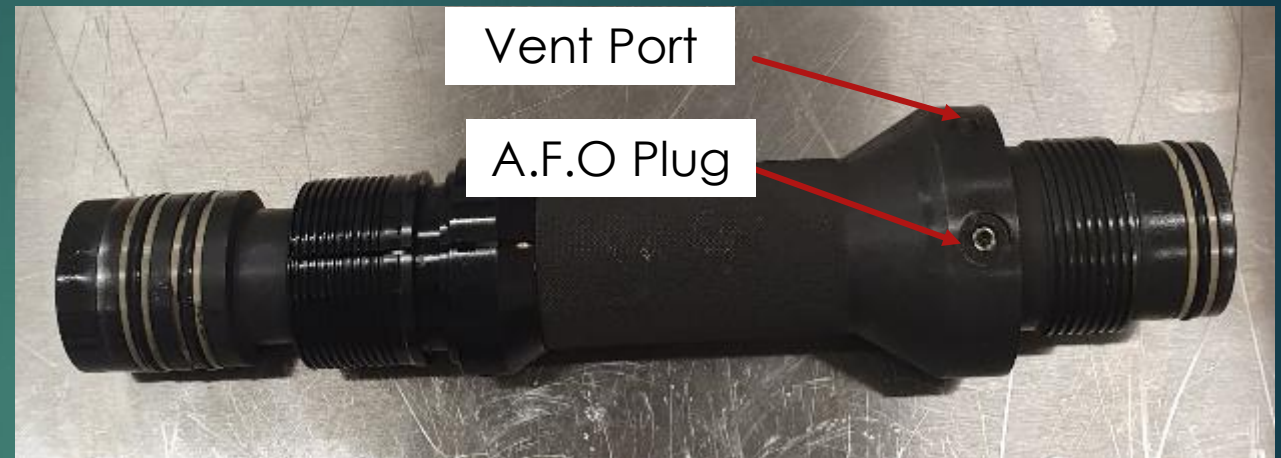
The Outlet Sub extends the hydraulic chamber to the Punch Heads. Consists of:

1. Emergency Safety Device.  
Disconnect Shear Ring – standard rating of 20 000lbs.  
If tool failure occurs and tool is anchored, **JAR UP** to break Shear Ring and vent hydraulics. Can only be fitted in one orientation.
2. Inner Dynamic Seal arrangement.
3. Retainer plate spigot placement - During assembly ensure spigot is facing inwards to compress inner Seal Arrangement.
4. Outer Seal arrangements.



# K-Punch, A.F.O Plug

- ▶ Secondary Safety Device. AFO Plug - Direct access to hydraulic chamber - Crack open to safely vent hydraulics.
- ▶ Can be used during oil fill procedure to help expel air.
- ▶ Best practise to ensure it you always leave it tight. And double check.
- ▶ Does not need to be removed. Only cracked/unseated.
- ▶ Imperial Hex Key (1/8" AF)

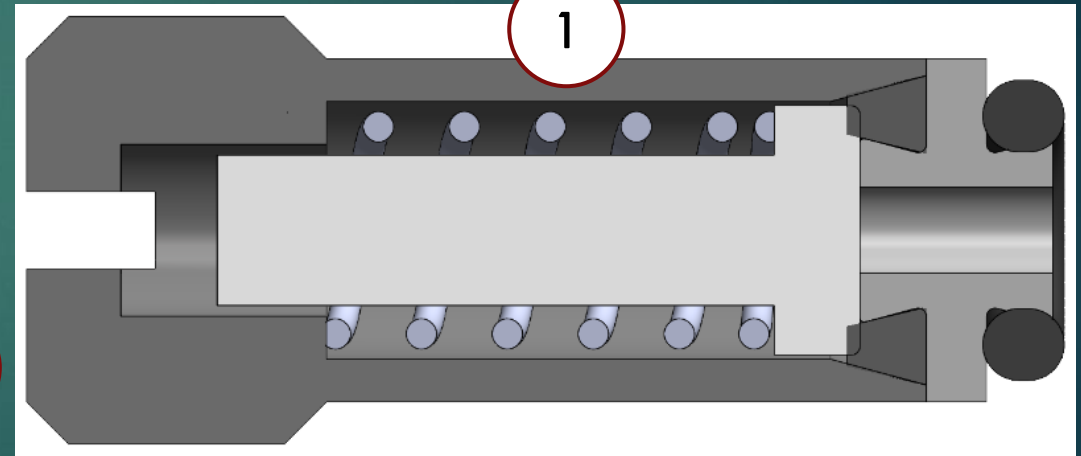
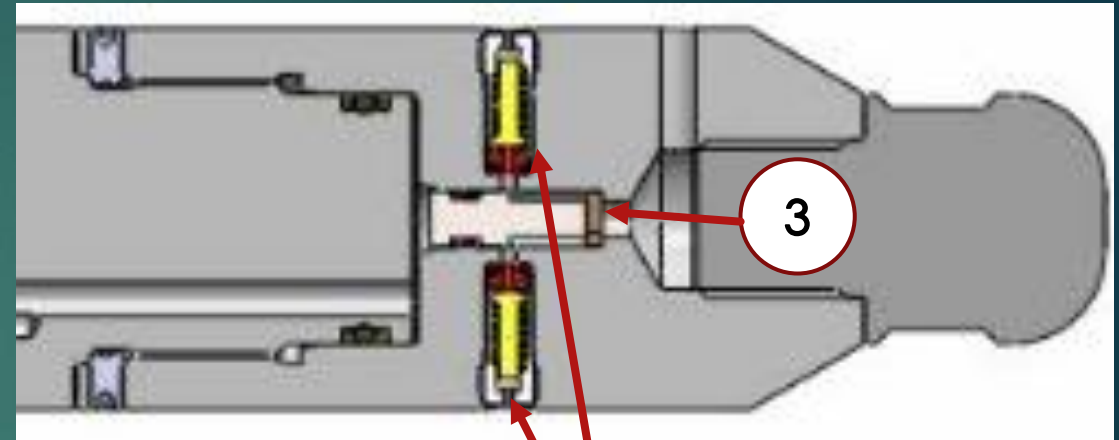
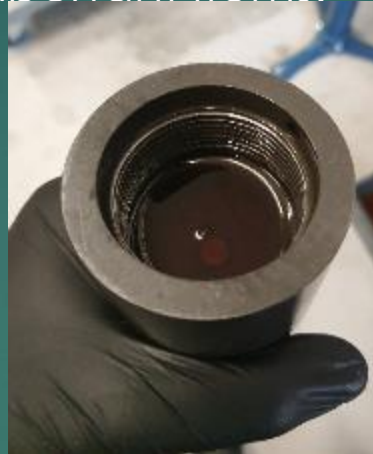


# K-Punch, End Sub

The End Sub houses of the following important items:

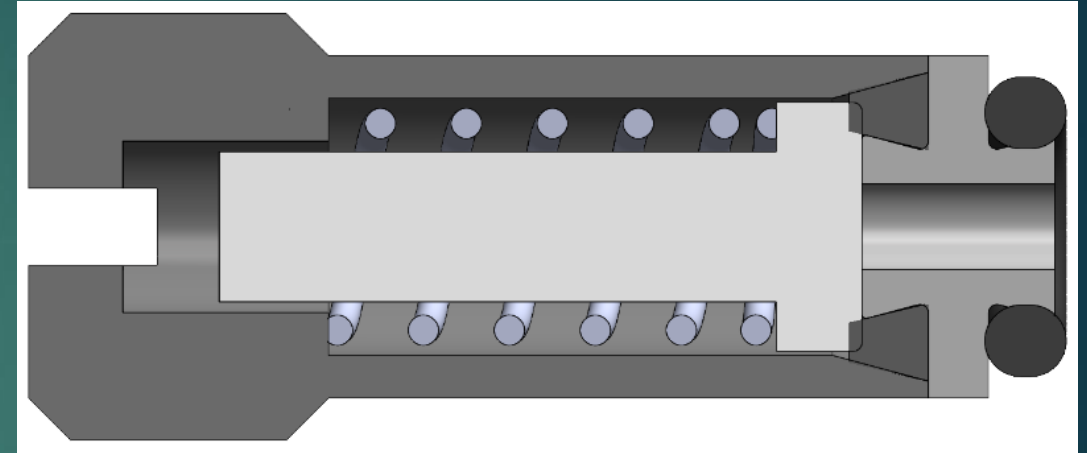
1. Check Valves.
2. Relief Piston.
3. Relief Shear Disc.

- ▶ Best practise to fill the End Sub with a small volume of oil prior to fitting to the running string.
- ▶ Bull Nose with Sucker Rod thread to allow make up to additional tooling below.



# K-Punch, Check Valves

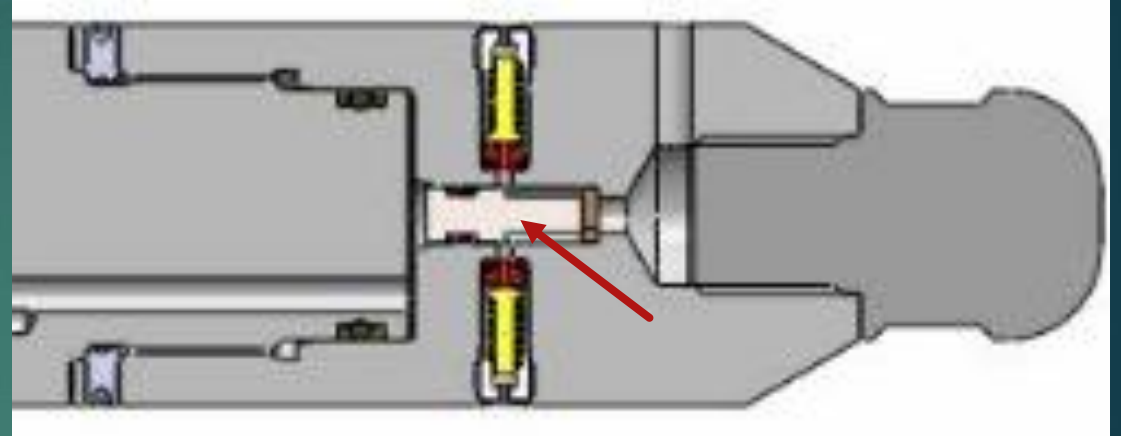
- ▶ The Check Valve has 2 primary functions.
  - ▶ To release the hydraulic fluid once they are opened to the chamber.
  - ▶ Once opened to the chamber and equalised between the internal and external atmosphere, it will seat, stopping the ingress of well fluid (and allowing the K-Punch to generate a negative pressure differential (i.e. vacuum condition) when Retracting)
- ▶ When Running in hole the Check Valves are isolated from the Hydraulic Chamber (i.e. only see well pressure).
- ▶ Only when the Relief Shear Disc ruptures and the Relief Piston travels down do the Check Valves become part of the Hydraulic Chamber.
- ▶ Once open to the Hydraulics, and if the internal pressure is greater than the external pressure, it will attempt to equalise (i.e. vent the internal fluid to the external atmosphere.)
- ▶ Once the pressure is balanced across the Check Valve it will seat with the aid of spring tension.
- ▶ The Check Valves will only allow fluid travel from internal to external.
- ▶ 1 x O-Ring and 1 x Seal. Ensure Correct Orientation.
- ▶ Bubble Test. Ensures that the Valves are seating correctly.



# K-Punch, Relief Piston

The Relief Piston's primary function is to isolate the Check Valves until a predetermined internal pressure has been exceeded. Once exceeded, it will travel downwards and open the Hydraulic Chamber to the Check Valves, allowing the system to vent.

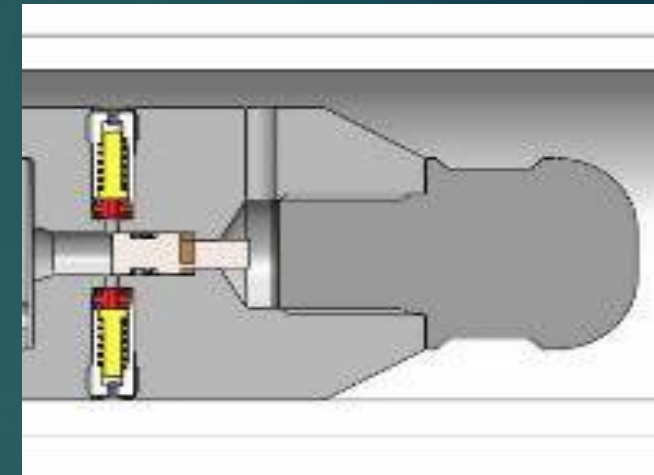
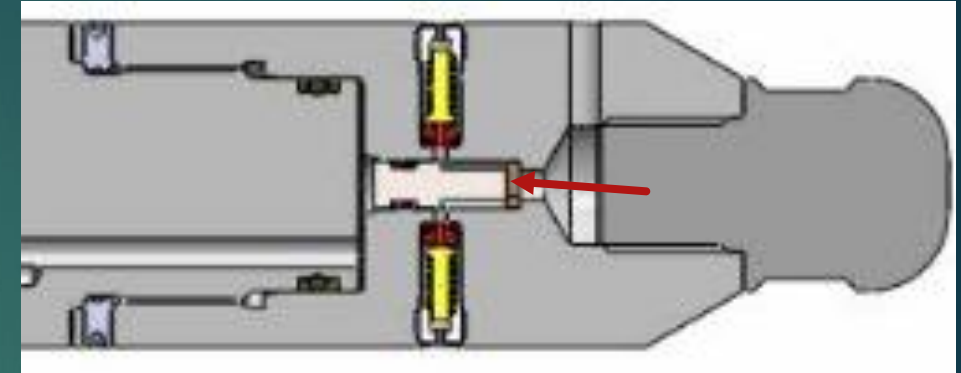
- ▶ O-Ring and both back-up rings must be changed after each deployment.



# K-Punch, Relief Shear Disc

The Relief Shear Disc must mechanically support the Relief Piston until a pre-determined pressure (and therefore force) has been exerted on it. Once this force has been exceeded the Relief Shear Disc will rupture and then remove all mechanical support for the Relief Piston, allowing it to travel downwards.

- ▶ Primary Safety Device. Ensures that the hydraulic pressure never exceeds a known value.
- ▶ CONSUMABLE, SINGLE USE ITEM.
- ▶ Provides mechanical support to the Relief Piston, isolates the Check Valves from the Hydraulic Chamber.
- ▶ All punching must be performed below this pressure.
- ▶ 3 different ratings available. Ensure the correct one is used for the selected application.
- ▶ After operation remove all fragments left behind (3 sections below Piston, 1 section in Bull Nose cavity)



# K-Punch, Punch Housing

- ▶ Punch Housing contains the Floating Pistons.
- ▶ Hydraulic chamber. Flow path from top to bottom. Ensure there are no blockages.
- ▶ The Punch Housing consists of
  - ▶ Punch Housing. Tubing/Casing Specific. Ensure correct Housing is chosen for the Tubing/Casing.
  - ▶ Retainer Plate. Contain the floating Piston. Slide fitment, ensure Punch Piston is fully seated first. Split/ 1,2,4 screw variant.
  - ▶ Retaining Cap Screws.



# K-Punch, Punch Piston Assembly

The Punch Piston Assembly is the Floating Piston that produces mechanical work. It also retains the Button assembly during deployment

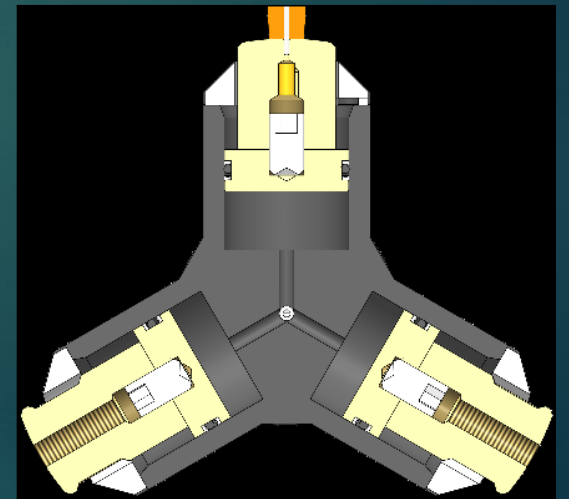
- ▶ Punch Piston and Punch Holder. One piece and two piece variants depending on size.
- ▶ The Holder can be removed to gain access to remove Spring Pin remnants after each operations (if no access Hole)
  - ▶ Some Holders have access windows. If so then the Holder does not need to be removed



# K-Punch, Punch Housing 3 Fin Design

The 7" and 9-5/8" Punch Heads are of a 3 fin design.

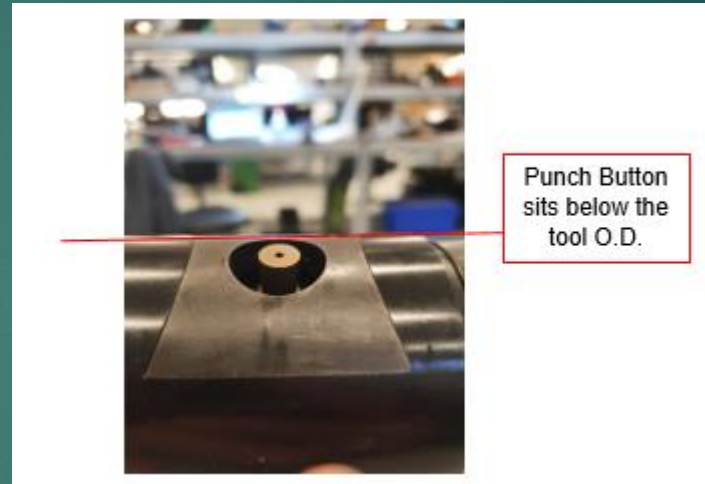
- ▶ 3 Floating Pistons per head.
  - ▶ 1 off Punch Piston for Punching.
  - ▶ 2 off Stabilising Pistons for stand off.
- ▶ Cannot have more than 1 Punch Piston per Punch Head.



# K-Punch, Button Assembly

The Button Assembly consists of

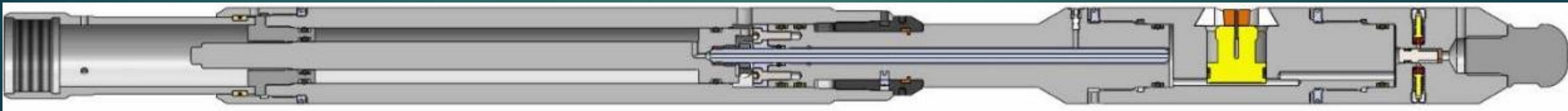
- ▶ Punch Button.
  - ▶ CONSUMABLE, SINGLE USE ITEM
  - ▶ SIZE CRITICAL. Use only designated Punch Buttons for Punch Heads. Different Buttons will cause failures (pressure variations).
  - ▶ **Orientation critical. Large face to tubing.**
  - ▶ Button must be flush or below flush with the Retainer Plate once fitted.
  - ▶ Cavity can be packed with grease to protect from well fluid.
- ▶ Spring Pin.
  - ▶ CONSUMABLE, SINGLE USE ITEM
  - ▶ Interference Fit. Should be a snug fit. Don't run if the Spring pin is loose
  - ▶ Size by pushing through the Punch Button.
  - ▶ Has a shear rating of 100lbs.
  - ▶ Remove old remnants from Punch Holder after each operation. 2mm Pin Punch.



# K-Punch Running String Assembly

When assembling the K-Punch the following needs to be performed/considered.

- ▶ Running String Selection - Size of K-Set, Size of Actuator. How many Punch Heads? Check manuals/matrix?
- ▶ Punch Head Phasing - Correct size Punch Housings. Inline or equispaced\* (7" and 9-5/8" should have Punch Buttons in-line **only**).
- ▶ Assemble the K-Punch
  - ▶ Check Valve 'Bubble Test' - Ensure Check Valves are correctly assembled.
  - ▶ Punch Button install - Right Size Buttons, right orientation, interference (Snug) Fit. Fill cavity with grease?
  - ▶ Fill Hydraulic Chamber with fluid - Piston space out to allow for thermal gap. Check manual for thermal gap dimension (2" or 1-1/2")?. Bleed all Air. Vertical Oil fill. AFO Plug tight afterwards. Check for leaks.
- ▶ Make up to K-Set - K-Set Surface Test first. Crossovers required? Lock ring to remove?
- ▶ Punching Cycle command – How to initiate the tool.



# Punch Head Phasing

## Orientation of the Punch Heads

- Phasing The Punch Heads can be positioned to the required phasing by adding Shim Washers in between each Punch Head - as per figures 55 & 56 (Note - shim washers are provided as standard parts of all Punch Head Kits)
- Kaseum recommends the Punch heads be aligned (0 Degree Phased) or equispaced – refer to below table as example with 6 Punch heads. (7" and 9-5/8" should have Punch Buttons in-line **only**).



Figure 55 - Image showing 5 Punch Heads phased at 0°

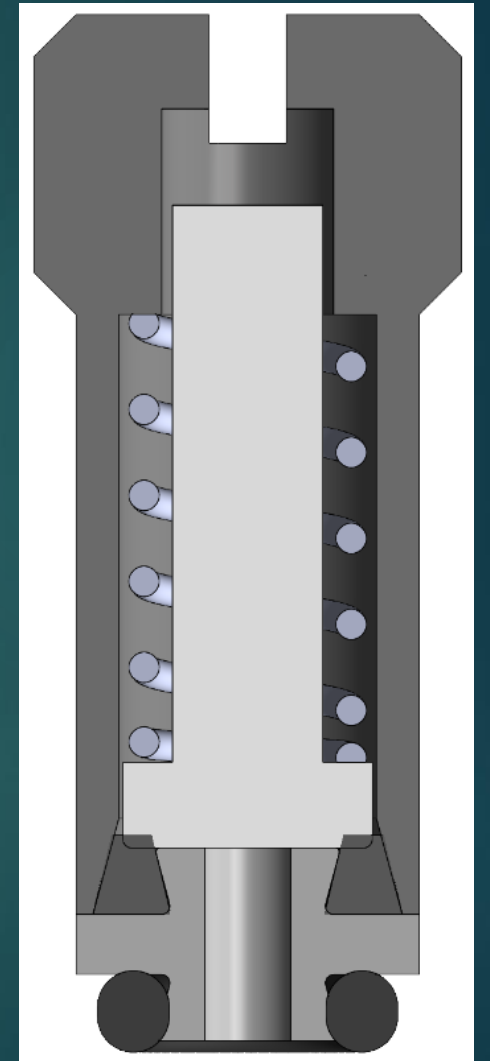


Figure 56 - Image showing 5 Punch Heads phased at 72°

Number of Heads	Recommended phasing angle
1	N/A
2	0° or 180°
3	0° or 120°
4	0° or 90°
5	0° or 72°
6	0° or 60°

# Bubble Test

Build End Sub without Relief Shear Disc. Insert Relief Piston fully. Bubble test. ENSURE RELIEF SHEAR DISC IS FITTED AFTERWARDS.



# Piston Space Out

The Hydraulic fluid will expand when heated, therefore a gap to accommodate for this needs to be factored in. This will allow for the Hydraulic fluid to expand without forcing the Punch Piston out.

**ALWAYS CHECK RELEVANT MANUAL TO ASCERTAIN THERMAL GAP REQUIRED. (it varies)**

- ▶ Ensure Main Piston is fully seated and measure distance to Housing End Face.
- ▶ Pull Main Piston Up to the required distance to allow for thermal expansion.



# Oil Fill

The K-Punch is gravity filled. Remove Piston Ring and position tool vertically. Remove End Sub to aid in air evacuation. Attempt to expel as much air as possible.

1. Assemble the Hyd. Act. And all Punch Heads. Remove Piston Ring, Ensure thermal gap is maintained, Fill Piston Housing allowing the fluid to fill the system. Use suitable rated hydraulic fluid/SAE 10W40/ISO 32 Fluid.
2. Once Oil is seen Exiting the lowest Punch Head the Tool is fill.
3. Fill the End Sub with Oil and fit to lowest Punch Head.
4. Top off Oil level. Fill ½" below the top of the Piston Housing.
5. Refit Piston Ring. Ensure Thermal Gap remains (don't push Main Piston in with Piston Ring.) Once Piston Ring is fitted the Hydraulic Chamber is sealed at atmospheric condition (14.7psi) When the Main Piston is pushed fully in (closing the gap) the internal pressure will be <14.7psi. This will allow for oil expansion during R.I.H.

## If this not possible.

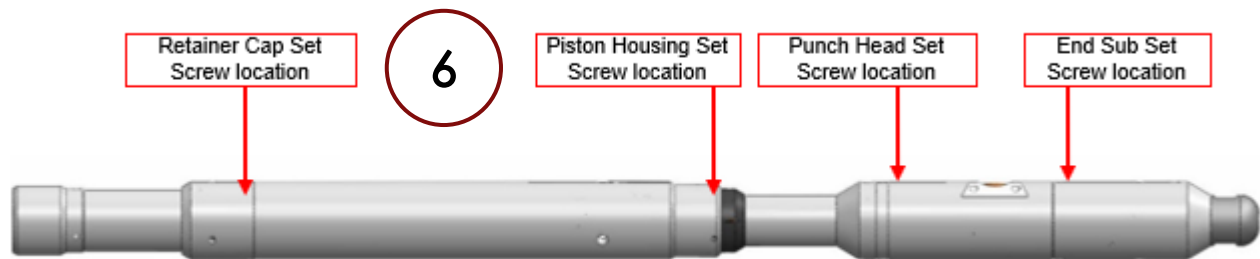
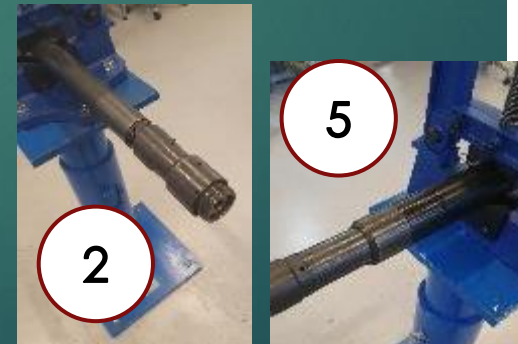
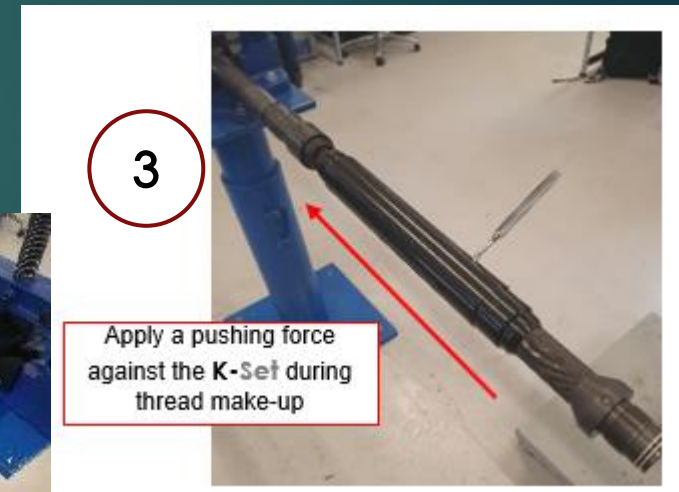
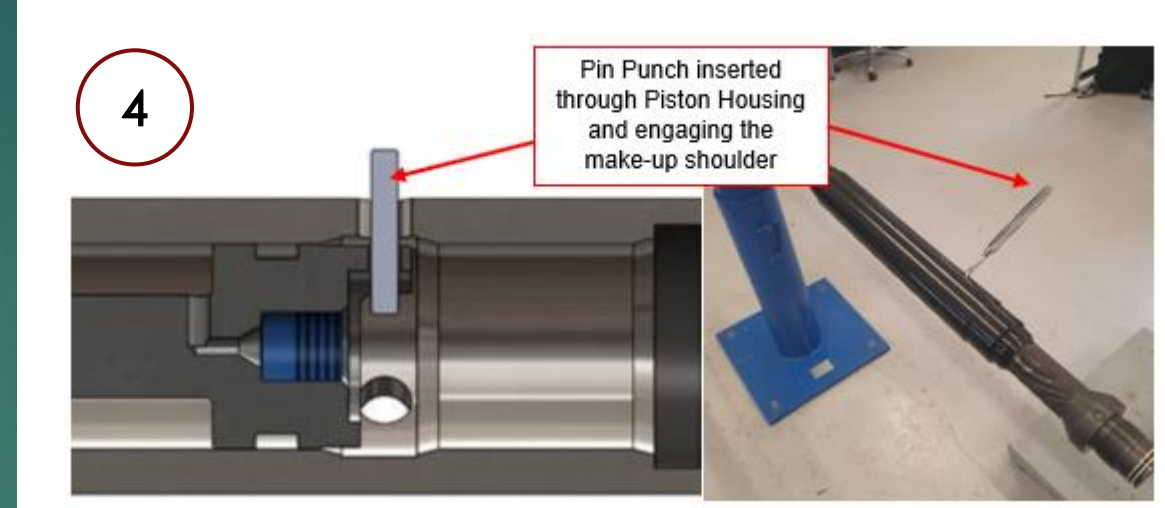
- ▶ Assemble running string.
- ▶ With thermal gap in place, Fill End Sub with Oil, Fit to lower Punch Head.
- ▶ Place tool vertical and fill with oil.
- ▶ Crack AFO Plug until constant stream of oil.
- ▶ Tighten AFO, top off oil and refit Piston Ring



# Make Up to K-Set

When Fitting the K-Punch to the K-Set.

1. Surface Test K-Set first.
  - A. If Using 2.125" K-Set remove Lock Ring if fitted.
  - B. If using 3.6" Hyd. Act. Pull Slick Rod up by 2" min. Fit both Crossovers.
2. Fit Extension Sub assembly to K-Set.
3. Engage Main Piston Thread to Slick Rod. Push up to seat Main Piston and allow access to make up shoulder.
4. Using a Pin Punch through the Piston Housing, make up Main Piston and Slick Rod thread fully.
5. Make up Extension Sub assembly Spin Collar.
6. Fit all Retaining Set Screws.

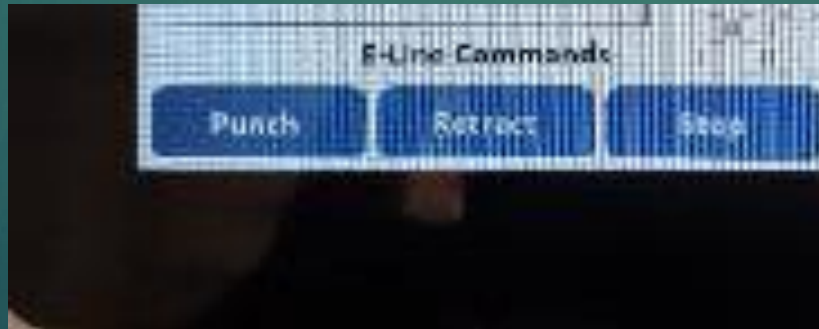


# Punching Cycle

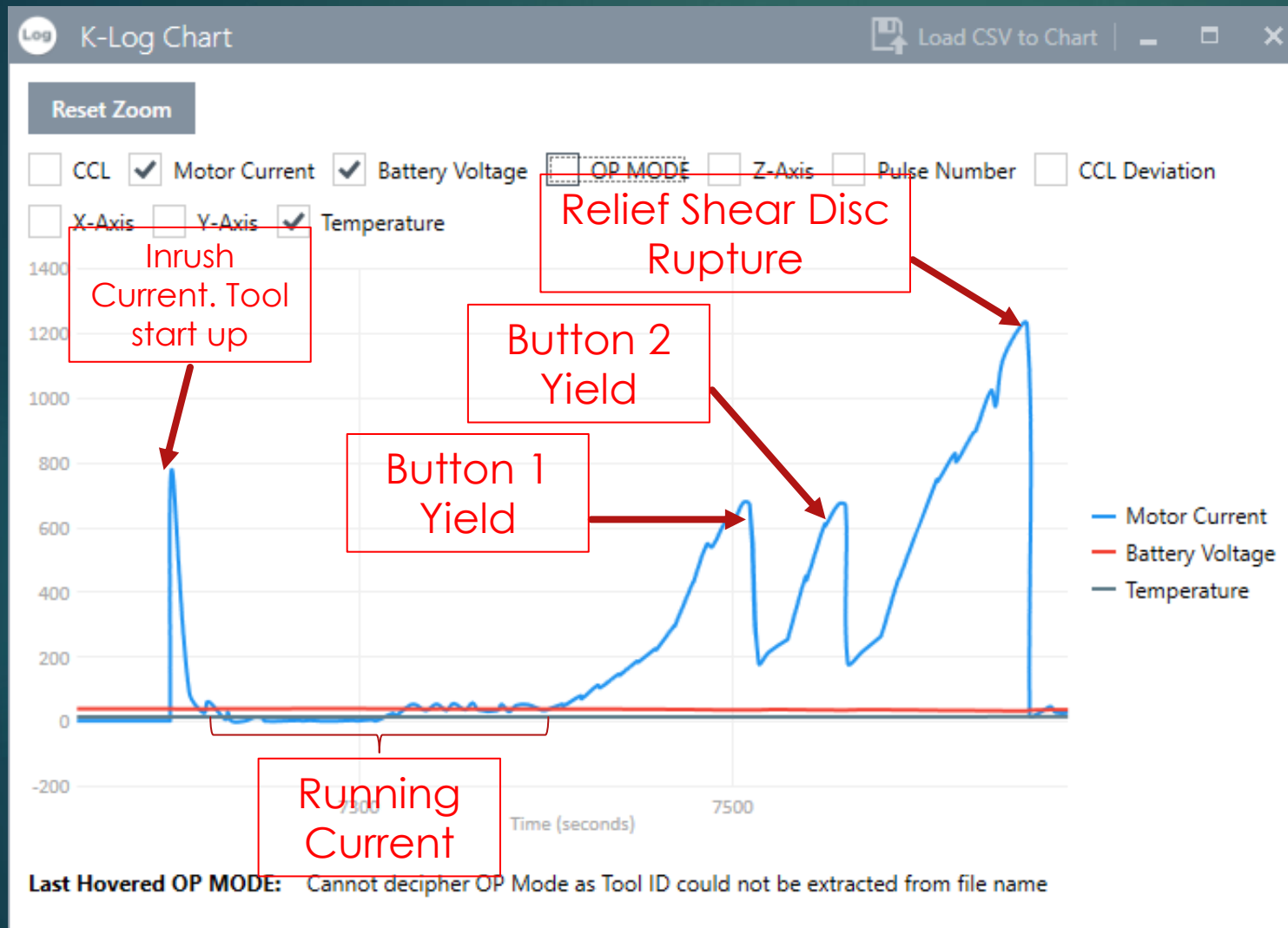
The 'Punching Cycle' is split into 2 Parts. 'Punch' full stroke and 'Retract' full stroke.

## PUNCHING CYCLE IS INITIATED DIFFERENTLY IN SLICKLINE AND E-LINE MODE

- ▶ SLICKLINE MODE – The complete Punching Cycle is Automatically programmed. (Punch AND Retract). Punching Cycle initiated after Countdown Timer Delay
  - ▶ E-LINE MODE – The 'Punch' command must be manually initiated to full stroke. Then the 'Retract' command must be manually initiated to full stroke
- ▶ Remain stationary during the full Punching Cycle sequence. Punch and Retract (can take at least 40 minutes)
  - ▶ During the operation look for sudden drops in tool current. This indicates a pressure relief event (Punch Button penetrating (sudden partial drop in current) or Relief Shear Disc rupture (sudden full scale drop back to running current)).
  - ▶ 'Retract' allows for Piston to push under tool OD (min 200psi hydrostatic to aid)
  - ▶ Back at surface, check for trapped pressure, (tight connections, Punch Pistons partially extended) vent AFO if required.



# Punch data interpretation



Example of a K-Punch with 2 Punch heads. Successfully punched 2 holes and ruptured Relief Shear Disc.

- ▶ Hydrostatic assistance will aid during Punch phase of Punching Cycle. Running current will be low.
- ▶ Hydrostatic Resistance will need to be overcome during retract phase. Running current will be high.

# Maintaining the K-Punch

- ▶ New consumables after each run. Punch Button, Spring Pin, Relief Shear Disc.
- ▶ Remove Relief Shear Disc Fragments and Spring Pin Fragments.
- ▶ Change O-Rings after each run. Back up rings on Relief Shear Disc.
- ▶ Check Tubing Nipple is Tight (Nipple and Nut).
- ▶ Check dynamic Sealing Surfaces for damage.
- ▶ Check Emergency Shear Ring condition and orientation.
- ▶ AFO Plug, always leave AFO Plug Tight. Double check its tight. Leaks?

# Golden Rules

- ▶ **If in doubt. Stop and seek assistance.**
- ▶ Thermal expansion gap is critical. Failure to set the gap will cause failures, potential to anchor string. Try to expel as much air as possible.
- ▶ Always use the correct size of Punch Heads for operation.
- ▶ Always use the correct size of Punch Buttons. Larger face to the tubing wall. Spring Pin interference fit. Ensure they are fitted prior to RIH.
- ▶ Good O-Ring maintenance. Hydraulic integrity is critical. Due to the high pressures required and small volume any leak may cause operational failures. No damage to the dynamic seal surfaces.
- ▶ Correct Relief Shear Disc. Re-fit after bubble test.
- ▶ When performing the Punching Cycle keep the tool string stationary throughout.
- ▶ DO NOT run the K-Punch in tubing/casing it is not intended for. Limited travel, fresh air set will cause catastrophic failure.
- ▶ Punching Cycle for Slickline and E-Line is different. In E-Line mode make sure both commands are initiated.
- ▶ If there is any concern in regards to possible trapped pressure within the tool when at surface then open the A.F.O. Plug.

