

Ballistic Timed Delay Fuse Streamlines CT
Perforating with Improved Safety and
Reliability

IPS 16-04

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AGENDA/INTRODUCTION

- Ballistic Timed Delay Fuse (BTDF)
- Through Bulkhead Initiator (TBI)
- Module Delay and Output
- BTDF Highlights
- Field Results
- Questions

Ballistic Timed Delay Fuse

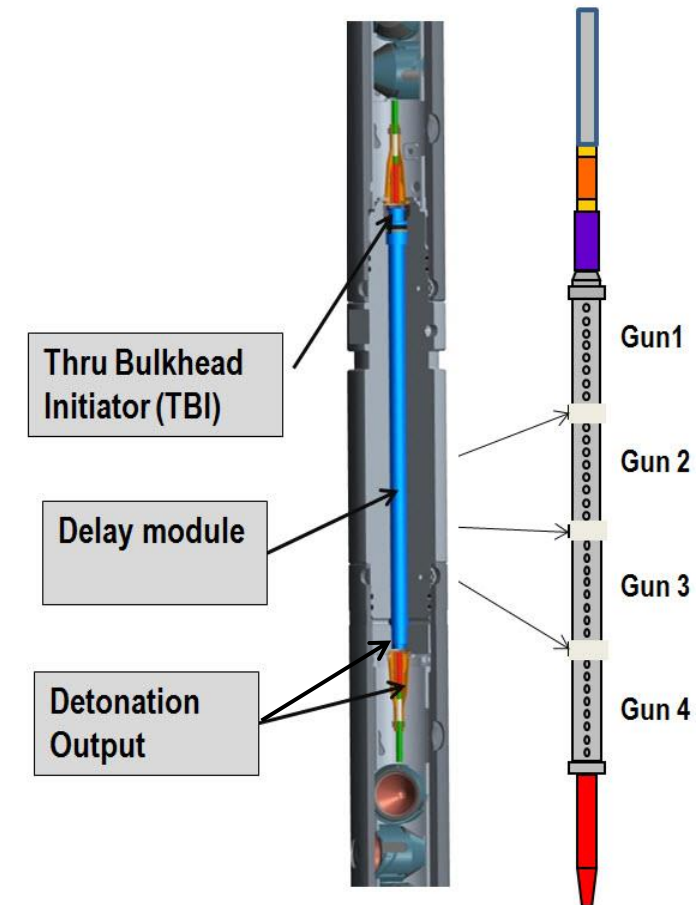
A device that will permit individual guns within a gun string to sequentially initiate after a given delay. Providing one trip timed perforating in a multi-zone formation

Drivers:

- Safety
 - None-pressure activated (pressuring up on the deployment stack or lubricator)
 - No firing pin (impact sensitive)
 - No trapped pressure during disassembly at the well site
- Other
 - More accurate delay times
 - Cost of overall assembly

Applications:

- TCP, coiled tubing, slickline, wireline
- Perforate multiple intervals in a single run
- Initiate an on-time delay for DFH instead of HDF
- DUB enhancements
- Gun shock reduction in long perforating strings
- Completion insertion and retrieval under pressure (reverse deployment valve)/SBT



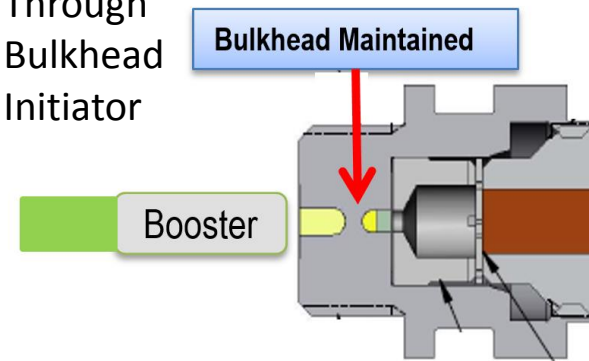
Through Bulkhead Initiator (TBI)

Ballistic Timed Delay Module

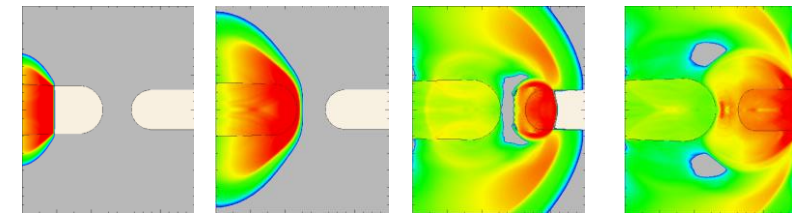
- Booster initiated explosive receptor pellet.
- Shock wave passes through steel bulkhead without breaking it.
- Shock wave initiates explosive on backside of bulkhead.
- Explosive/pyrotechnic propagates to next component.



Through Bulkhead Initiator



Simulation of TBI

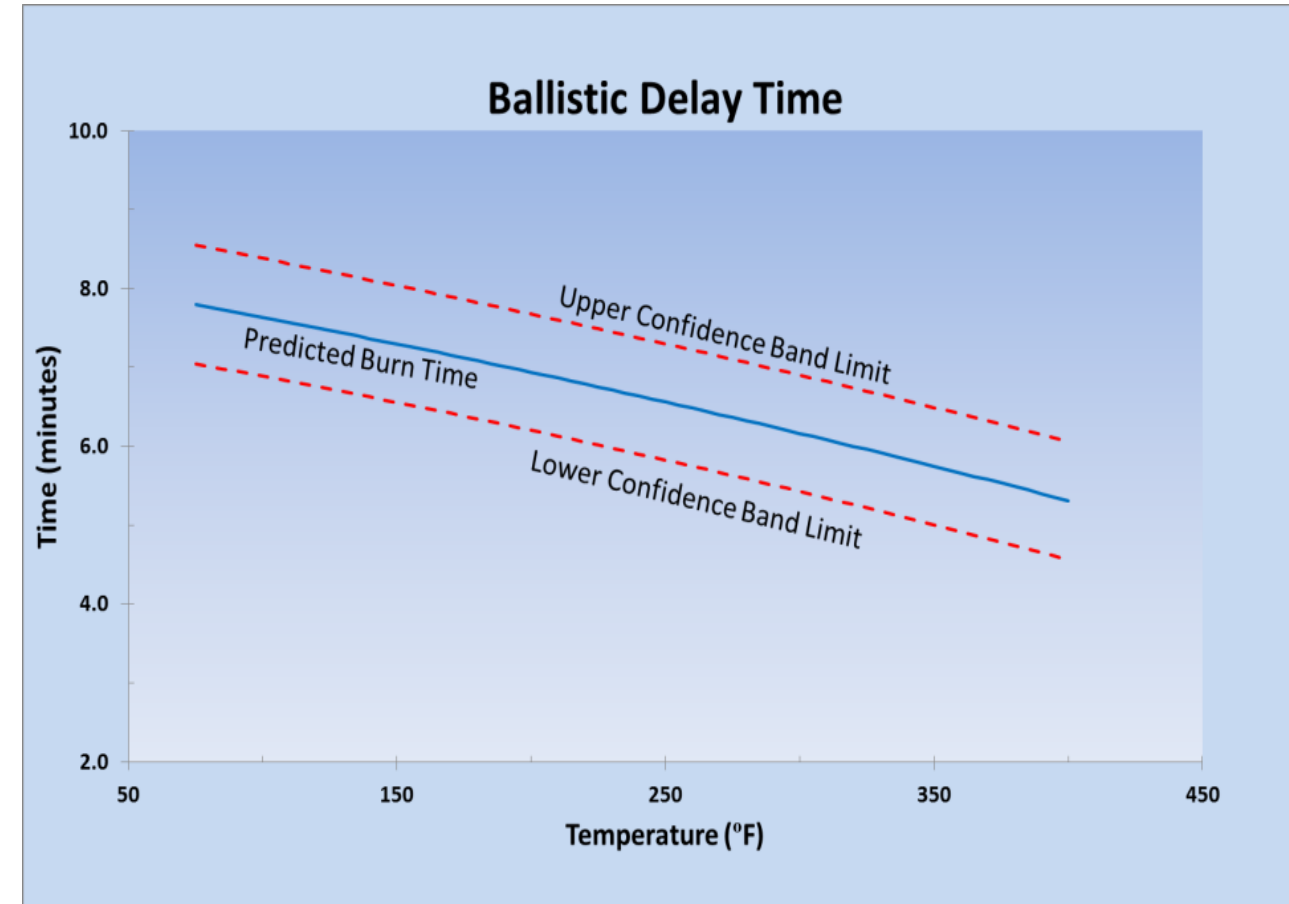


US Pat. No. 6,719,061

US Pat. No. 8,622,149

Delay and Output Module

- Proprietary delay mix provides minimum variation in timing
- Temperature dependent
- 400F/100 hours
- Output – high order detonation



TBI Delay Module



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Highlights

Maintains pressure integrity following detonation transfer

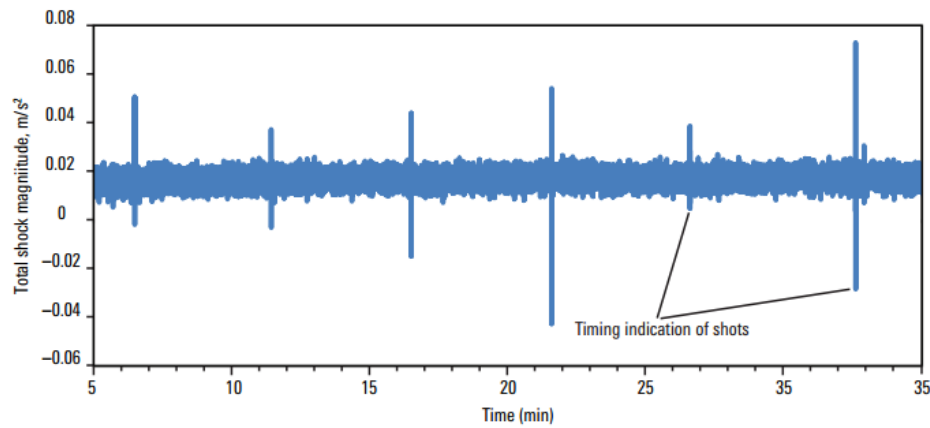
- Safe
 - No firing pin or moving parts
 - Will not initiate due to pressure
 - Requires high-order detonation to transfer
 - Eliminates possibility of trapped pressure
 - Low order or instantaneous flooded guns will not initiate the module/lower guns
- Reliable
 - Fewer parts and therefore fewer leak paths
 - Bottom-hole pressure not required for delay
 - Self-contained unit requiring no field assembly
- Efficient
 - Reduced BHA length and CT Rise Height
 - Time saving for loading
 - Compatible with Industry Standard Guns
- Rating
 - Delay: 6 minutes – temperature dependent
 - 400°F/25,000psi max. for 100 hours
 - Compact 15-1/2" Long



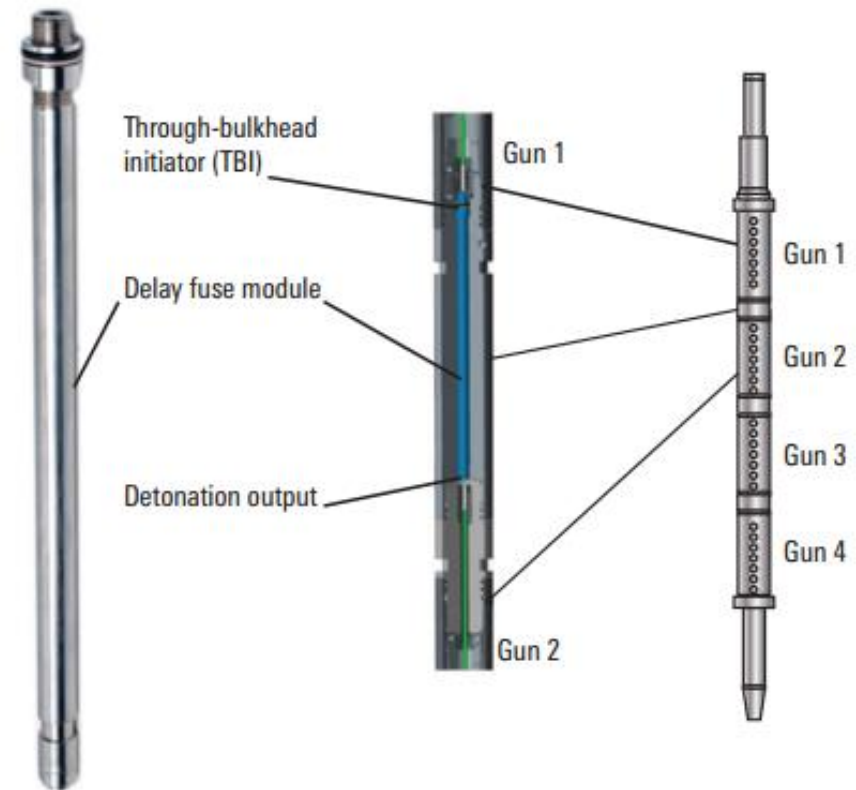
Field results

Case Study – 2014-1,

- Location: USA
- Horizontal well, Toe initiation
- Temperatures 321-327F,
- Pressures 9,000psi to 16,000psi
- All guns shots as planned
- Maximum recorded timing error 6% out of 10 shots



The measured shock magnitude precisely indicates when the shot occurred.

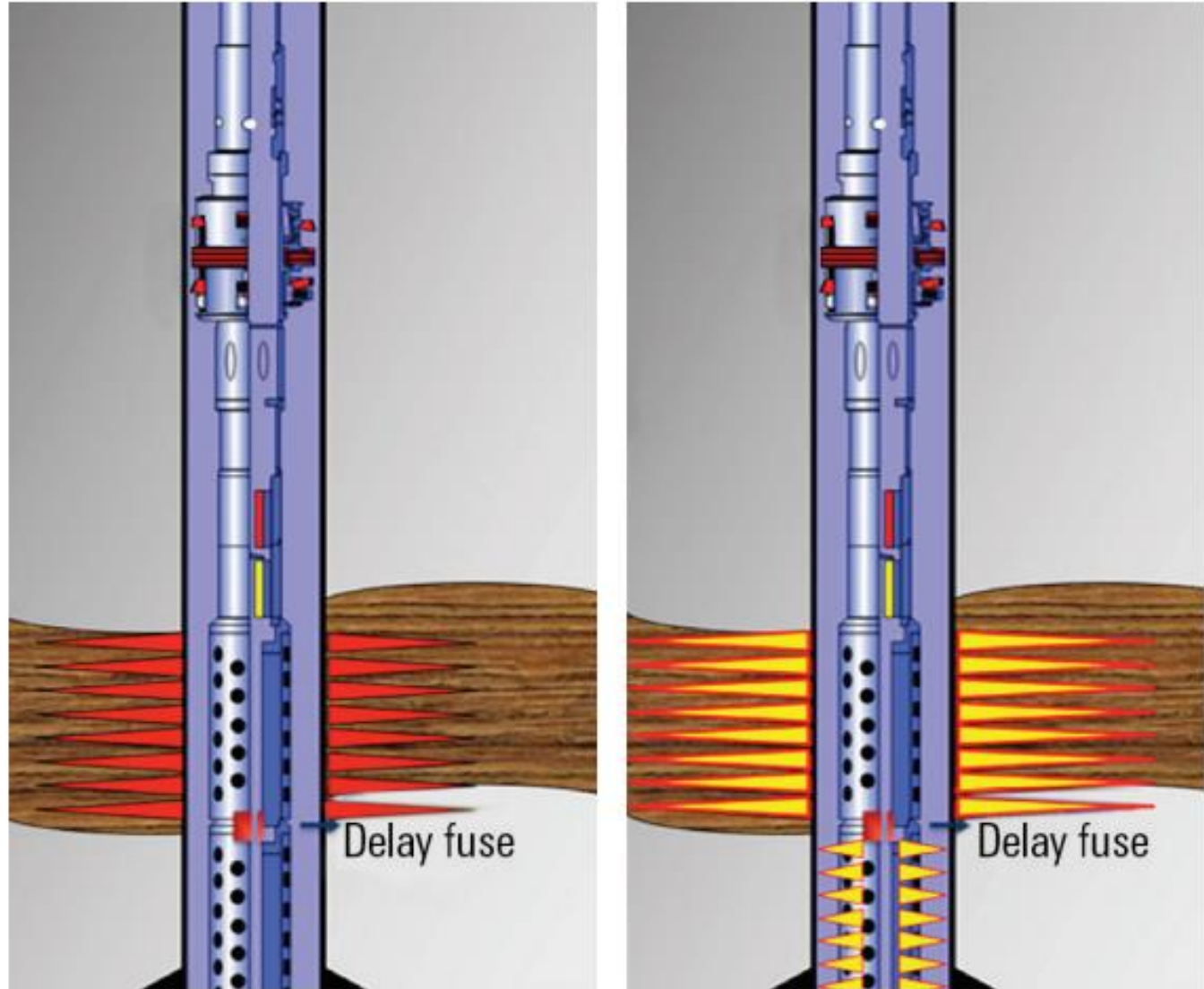


The delay fuse provides a reliable temperature-dependent delay time, eliminating the use of spacers for positioning guns.

Field Results

Case Study 2014-2

- Location: Ecuador
- BTDF positioned between perforating guns and dynamic underbalance implosion chamber
- Enabled perforating and cleanup in a single run
- Increased well productivity 51% over plan



Patent Pending

2016 INTERNATIONAL PERFORATING SYMPOSIUM GALVESTON

QUESTIONS? THANK YOU!

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