



*MiniSShot*

*ProtoSShot-M Mark II*

and

*ProtoSShot-M Short Stack*

**Propellant Casting Guide for use with Titanium Casting Tubes**

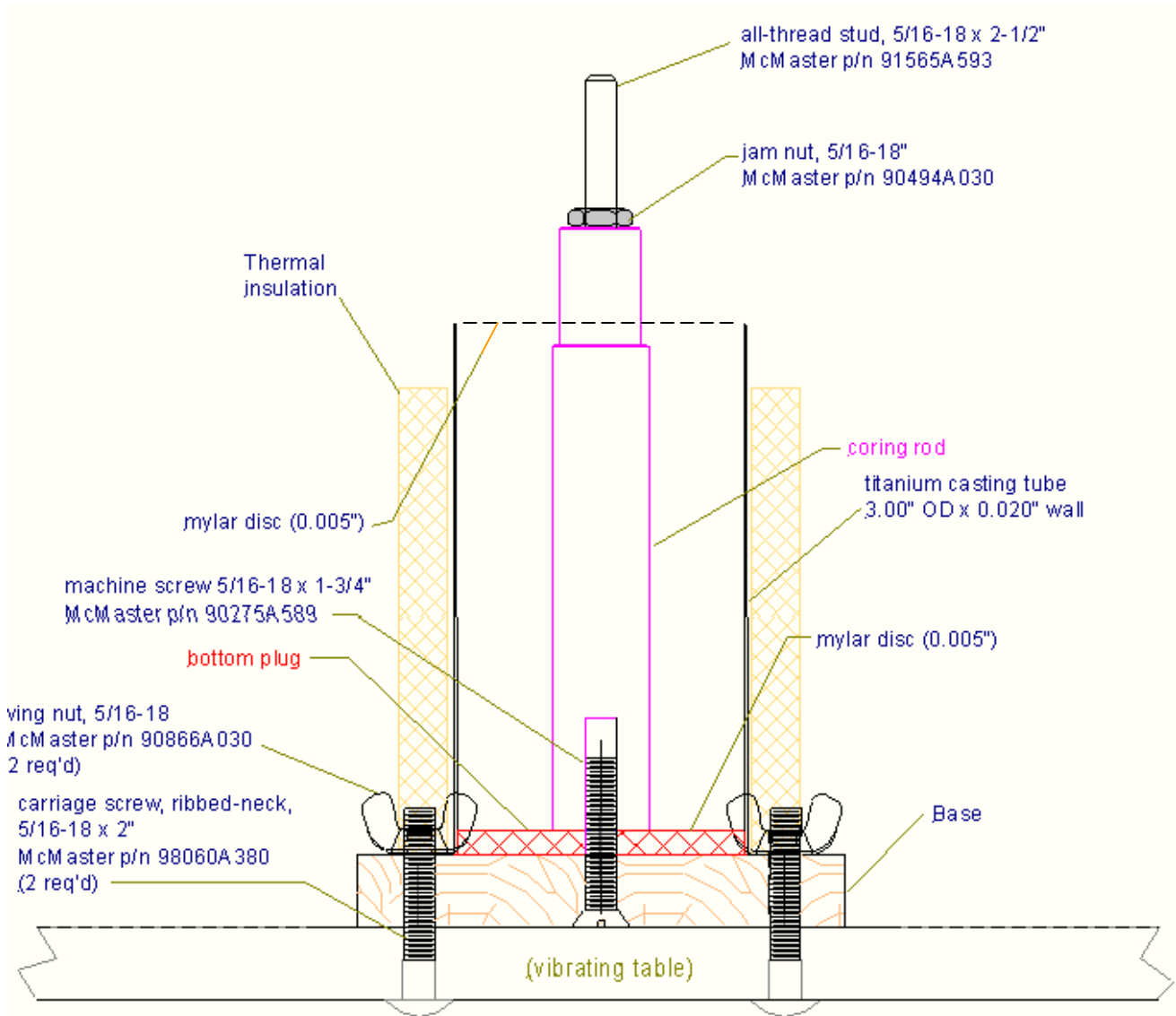
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## General information

This document is intended to serve as a guide for casting propellant for the aft chamber of the *ProtoSShot-M Mark II* and *ProtoSShot-M Short Stack* rocket motors. The aft chamber uses commercially pure (CP, grade 2) titanium casting tubes for thermal robustness.

### Pre-casting setup & tasks

1. Paint 2 coats of insulating (*not* intumescent) paint on interior of each casting tube.  
Leave bare ¼” from both top and bottom ends.  
Allow drying between coats.  
Allow several hours drying before casting propellant.
2. Mark serial number on each casting tube to identify. Accurately weigh all casting tubes individually and use Table 2 to record data.
3. Pre-blend KN/sorbitol powders to proportions shown in Table 1. Mix a minimum of 1 hour per batch of 1 or 2 grains.
4. Prepare coring rods by applying a light coat of suitable mould release.
5. Prepare casting apparatus for propellant loading as illustrated in Figure 1. Make sure and apply thread-locking compound to the machine screw that fastens the coring rod to the Base. Mount onto vibrating table.



**Figure 1** – Setup for propellant loading operation  
(top mylar disc to be added after loading with propellant).

### Propellant casting preparations and procedure

6. Use only thermostatically controlled heating vessel(s). Preheat vessel to temperature range of 250°F (120°C) to 295°F (145°C).  
Do not allow temperature of propellant to exceed 300°F (150°C) for extended duration.
7. Weigh out enough powdered mixture for one or more segments (Table 1) and add to heating vessel a little at a time. Allow melted slurry to reach desired casting temperature 265°F (130°C) to 285°F (140°C).
8. Power up the vibrating table.
9. Pour & scoop slurry, with use of the spatula, into casting mould. Fill level to the top of the casting tube.
10. Allow vibrating table to run for a minimum duration of two minutes before powering off.
11. Remove casting setup from vibrating table by undoing two wing nuts.
12. Slip mylar disc into place over coring rod and onto surface of propellant.
13. Slide Top Cap into place over coring rod and press down gently, allowing Top Cap to seat on top of propellant surface. Press down until top surface of Cap is flush with top of casting tube, as shown in Figure 2.
14. As is shown in Figure 2, place spring and spacer over coring rod.  
Loosely install washer and wing nut.

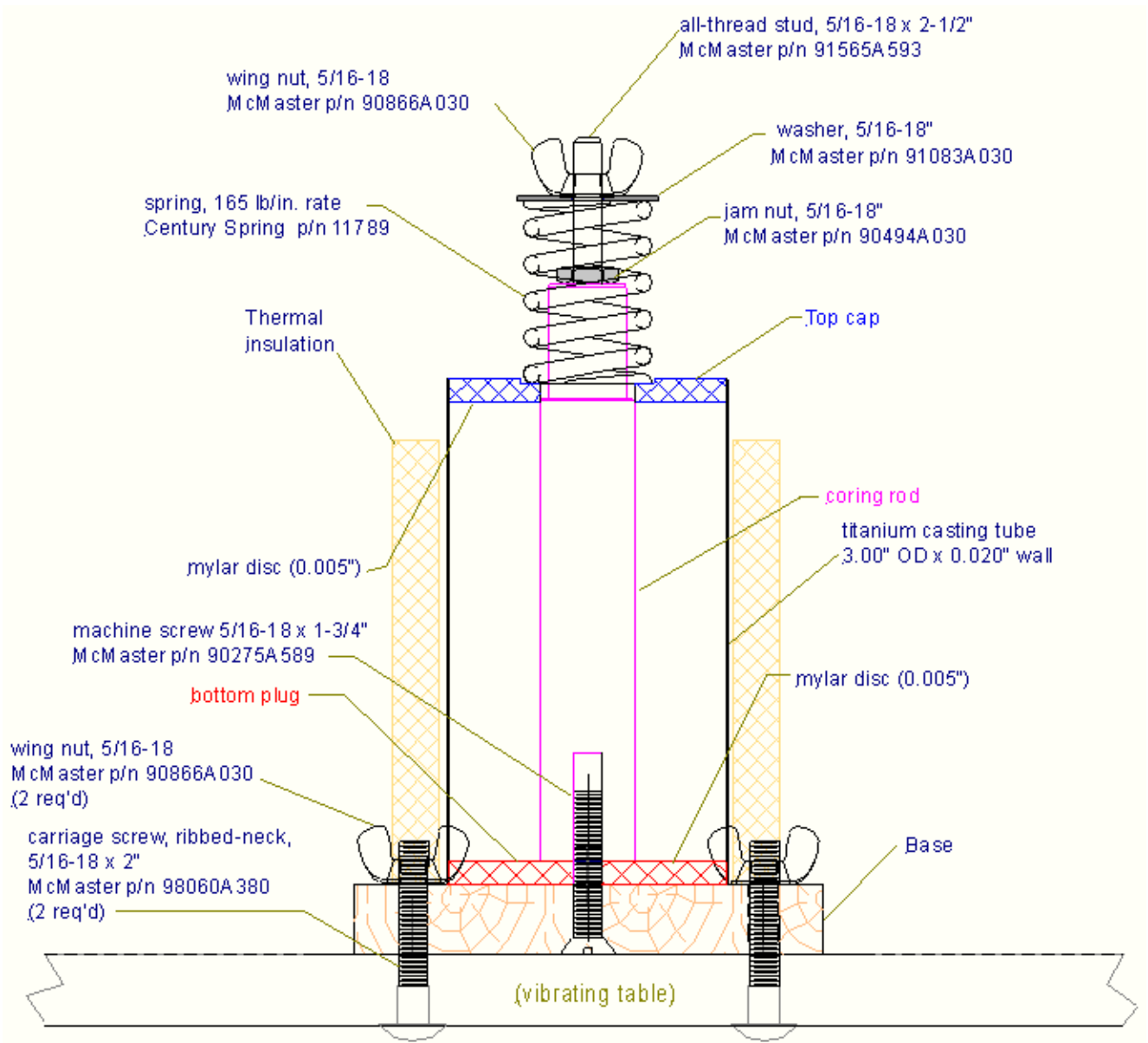


Figure 2 – Casting mould arrangement.

15. Slowly tighten wing nut to compress spring. Continue tightening, but stop if
  - a) propellant begins to ooze out of mould
  - b) Top Cap sinks down more than approximately 1/8".
16. Allow to cool approximately one hour, then tighten wing nut fully until spring is fully compressed.
17. Allow cooling to ambient temperature. This will take several hours.
18. Make sure and record order of casting.

Disassembly and post-casting procedures.

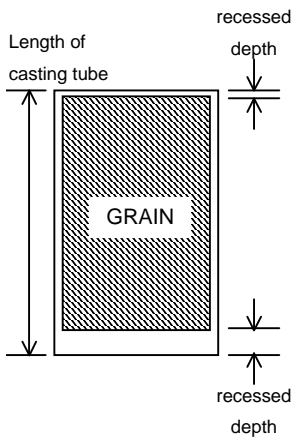
19. Allow propellant to fully harden prior to releasing spring pressure.
20. Disassemble casting setup. A  $\frac{3}{4}$ " or  $\frac{1}{2}$ " diameter wooden dowel may be used to aid removal of the Bottom Plug. After inserting dowel into core, use a mallet to gently tap on top end of the dowel.
21. Weigh each grain segment and record individual weights using Table 2. Measure and record depths of each recessed end, and casting tube lengths, as shown in Figure accompanying Table 2.
22. Perform a quality control "tap" test. Using a coin or similar tool, gently tap around the casting tube to search for any areas of disbanding, identified by a "hollow" rather than "ringing" sound. The hollow sound may be identified by tapping the upper or lower  $\frac{1}{4}$ " regions of the casting tube which are devoid of propellant.
23. Store finished grains in sealed containers or poly bags, in a secure location or locations.

IMPORTANT NOTE: The scope of this document does not include complete information on safety precautions that must be followed. Refer to other sources for such information. Recommended safety wear, as a minimum, are protective glasses, clear faceshield, leather gloves, and leather or heavy jacket (long sleeves).

	Basic formula KNSB	Amount per grain segment *
<b>Potassium Nitrate</b>	65%	635 grams
<b>Sorbitol</b>	35%	342 grams
	100%	977 grams

\* includes 70 grams for wastage.

Table 1 – Propellant formulas and constituent masses required per segment.



Grain s/n	Mass of casting tube (grams)	Mass of casting tube + propellant (grams)	Length of casting tube (mm)	Recessed depth Top (mm)	Recessed depth Bottom (mm)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
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20					
21					
22					
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24					

Table 2 – Recording sheet for grain masses and dimensions.