WASC 2271

Description of
K Round

THE K-ROUND.

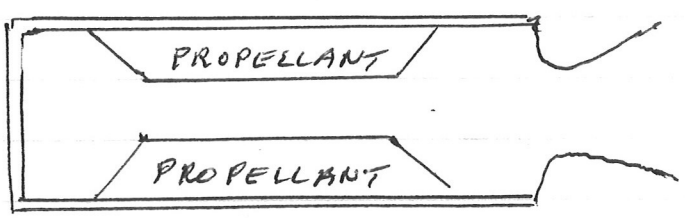
INITIAL PROPELLANT ASSESSMENT USED THE TRADITIONAL CRAWFORD STRAND BURNER TO MEASURE BURNING RATES OVER A RANGE OF PRESSURES UP TO 40MPa (APPROX 6000psi)

ANY PROMISING CANDIDATES WOULD THEN BE TESTED, STILL IN STRAND FORM, ~~OVER~~ AT +60°C AND −40°C.

AS STRANDS WERE ONLY 3mm IN DIAMETER AND ABOUT 120mm LONG ONLY A SMALL AMOUNT OF PROPELLANT WAS NEEDED.

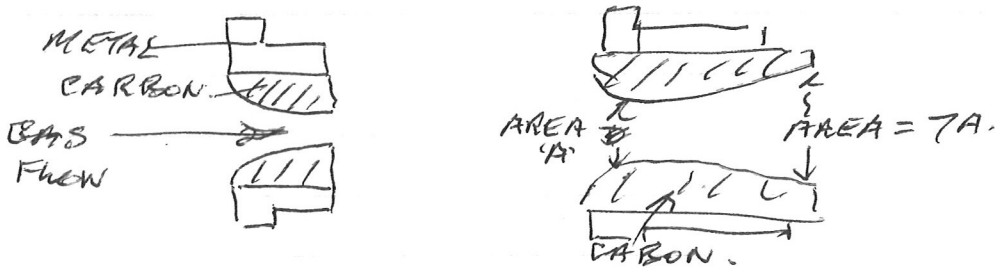
THE NEXT STAGE WAS THE 'K' ROUND WHICH WOULD USE A CHARGE OF ABOUT 450gm (1 POUND) A K-ROUND CHARGE OF AN EXTRUDED DOUBLE BASE (EDB) WAS A LOOSE-LOADED TUBULAR SHAPE WITH THE ENDS INHIBITED WITH ETHYL CELLULOSE (EC DISCS AND WITH SMALL EC DISCS TO ENSURE EVEN BURNING ROUND THE OUTSIDE OF THE CHARGE. IN ADDITION, TO EQUALISE PRESSURE BETWEEN THE CENTRE ~~HOLE~~ AND OUTSIDE OF THE CHARGE THREE EQUALLY SPACED HOLES WERE DRILLED ALONG THE LENGTH AT 120° TO EACH OTHER.

FOR CAST DOUBLE BASE (CDB) AND COMPOSITE PROPELLANTS A CASE-BONDED DOUBLE-CONE CHARGE WAS USED.



K-ROUND HARDWARE CONSISTED OF A TUBE CLOSED AT THE HEAD END BY AN END CAP SEALED WITH EITHER A 'COPANDAS' WASHER (A DEFORMABLE

COPPER SEAL, OR A PLAIN COPPER WASHER. A QUARTZ 'KISTLER' ~~GAUGE~~ PRESSURE GAUGE WAS ALSO FITTED TO THE HEAD END. THE 'NOZZLE' COULD BE EITHER A 'CHOKE' WITH A RADIUSSED INLET INTO A PARALLEL-SIDED HOLE OR A VENTURI WITH A 7:1 EXPANSION CONE



CHOKES WERE USED TO DEFINE THE APPROX RESTRICTION TO DEVELOP A SPECIFIC CHAMBER PRESSURE.

$$\text{RESTRICTION RATIO} = \frac{\text{PROPELLANT SURFACE AREA}}{\text{THROAT AREA OF NOZZLE}}$$

RATE OF GAS GENERATION $= \dot{m} = R_b A_s \rho$.

WHERE R_b IS BURNING RATE

A_s IS " SURFACE AREA

ρ IS PROPELLANT DENSITY

THE RATE OF GAS DISCHARGE THROUGH THE VENTURI MUST EQUAL THE RATE OF GAS GENERATION. IF THE NOZZLE IS TOO SMALL THE MOTOR COULD BURST AND IF THE NOZZLE IS TOO BIG THE PROPELLANT MAY BURN ERRATICALLY, CALLED 'CHUFFING' OR COMPLETELY EXTINGUISH.

RATE OF GAS GENERATION, $\dot{m} = A_t P_c C_D$

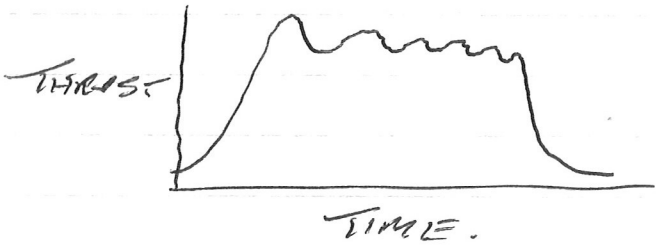
A_t = THROAT AREA, P_c = CHAMBER PRESSURE

C_D = DISCHARGE COEFFICIENT, DEPENDENT ON THE PROPELLANT.

$1/C_D$ IS KNOWN AS C-STAR.

$$\dot{m} = R_b A_s \rho = A_t P_c C_D.$$

AT WALTHAM ABBEY ONLY CHAMBER PRESSURES WERE MEASURED. CLEARLY, IT IS ESSENTIAL TO KNOW WHAT THRUST IS GENERATED BUT THE RESPONSE OF A THRUST GAUGE GIVES A DAMPED WAVEFORM.



THE OSCILLATIONS ARE A FUNCTION OF THE RIG WHICH 'RINGS' LIKE A BELL. MODERN COMPUTER PROGRAMMES COULD SUBTRACT THIS RINGING WAVEFORM FROM THE RAW DATA TO GIVE THE 'TRUE' THRUST-TIME CURVE.

IGNITION OF A K-ROUND USED A 'PERSPEX' BURSTER DISC WITH, TYPICALLY A 3gm OR 5gm PYROTECHNIC IGNITER.

B. C. HOWARD
5. AUG 2009

ADD : 1. SPIDER FOR LOOSE K-ROUND CHARGE
2. CHOKE – THIN CARBON TO ACT AS A SAFETY FEATURE – BLOWN OUT BY OVER-PRESSURE
3. THIN WALL & THICK WALL MOTORS
4. JOCK PLUMMER CLEANED MOTORS FOR RE-USE (IN HOBBIT ISLAND). – HE GOT AN AWARD FOR SUGGESTING THE METHOD.