ROCKET RESEARCH

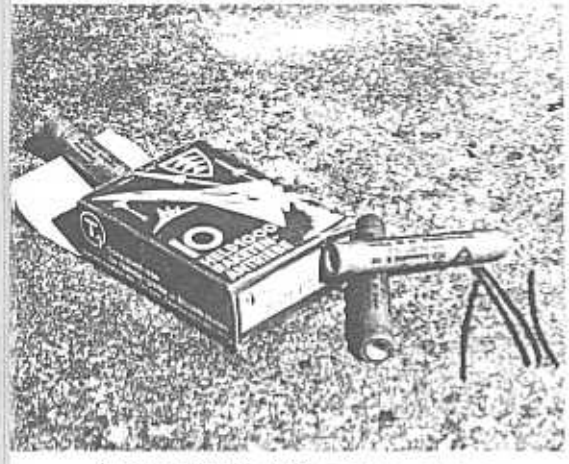
NUMBER 40

HELD ROCKET MOTORS

These West German manufactured model rocket motors have been in circulation since about the Summer of 1983. There are two different sizes - the 'HELD-1000 Raketen-Antriebe' and the HELD-5000.

Both the rockets are unusual in that they can be physically altered by deepening the perforation by drilling/lathing. Guidance for these operations is provided by the manufacturer. This facility enables two 'Conditions' for the HELD-1000 and three for the HELD-5000, making this a five-motor series.

Despite having only eight HELD rocket firings to draw information from, all these variations of both motors have been observed, and this article summarizes the motors based on these firings.



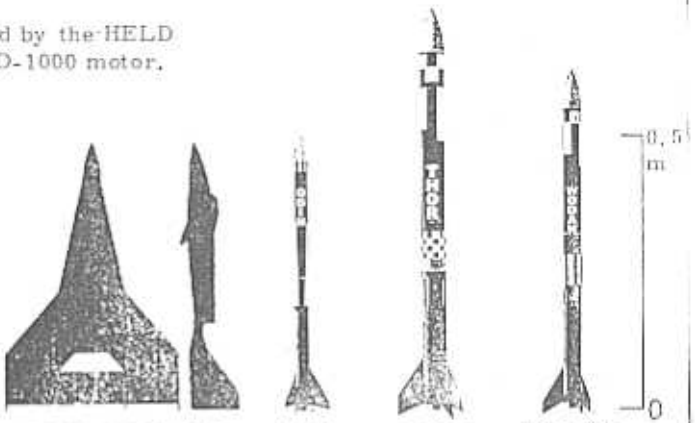
Above: HELD-1000 motors come in boxes of ten. String fuses at right.

The HELD-1000 rocket motor seems to be intended primarily to launch a small balsa model aircraft(length;0.49m :1'7.3", span: 0.31m:12.2") using a bungee boost system. The aircraft being released by the igniting rocket pushing on a levered plate near the motor.

Other rocket models produced specifically for use with the HELD-1000 include the "ODIN", "THOR" and the "WOGAN".

The HELD-1000 motor as supplied is 93.2mm long and 15mm in diameter with internal diameter 10.3mm. It weighs 20.9 grammes with 12.6 grams of this consisting of black powder propellant.

Rocket models produced by the HELD company, for the HELD-1000 motor.

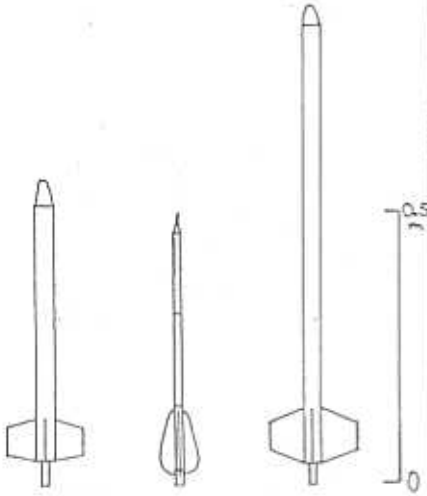


ROCKET PLANE ODIN THOR WODAN

The stated "boost" thrust is as being between 820 and 1000 grammes, but our firing as STATIC-598 on 29th Aug. 1983, was quite outside this range at 1,459 grammes. The sustain thrust level was 180 grammes. The total burn time of this firing was 4.25 seconds, against the stated time of 5.5 seconds.

Two flights of the as-supplied HELD-1000 rocket motor were observed, that of XRC-537 and the Paisley Rocketeers'

Test rockets using HELD-1000 motors



XRC-537 RR-99(Mk 4) XRC-611

Above: John D. Stewart with RR-99 (Mk 4) during launch preparation.

Society RR-99(Mk 4) of 31st Aug. 1983 and 11th September, 1983 respectively.

The effective square-wave exhaust velocity of the motor used on XRC-537 was 117.6m/s (386 ft/sec) while the 65 gramme rocket was sent 380 feet into the sky with impact at 174 yards.

The exhaust value from the RR-99 (Mk 4) was 129.6m/s (425 ft/sec), and the 37 gramme rocket went to 860 ft altitude with range about 195 yards.

The motor was ejected either during flight, or on impact.

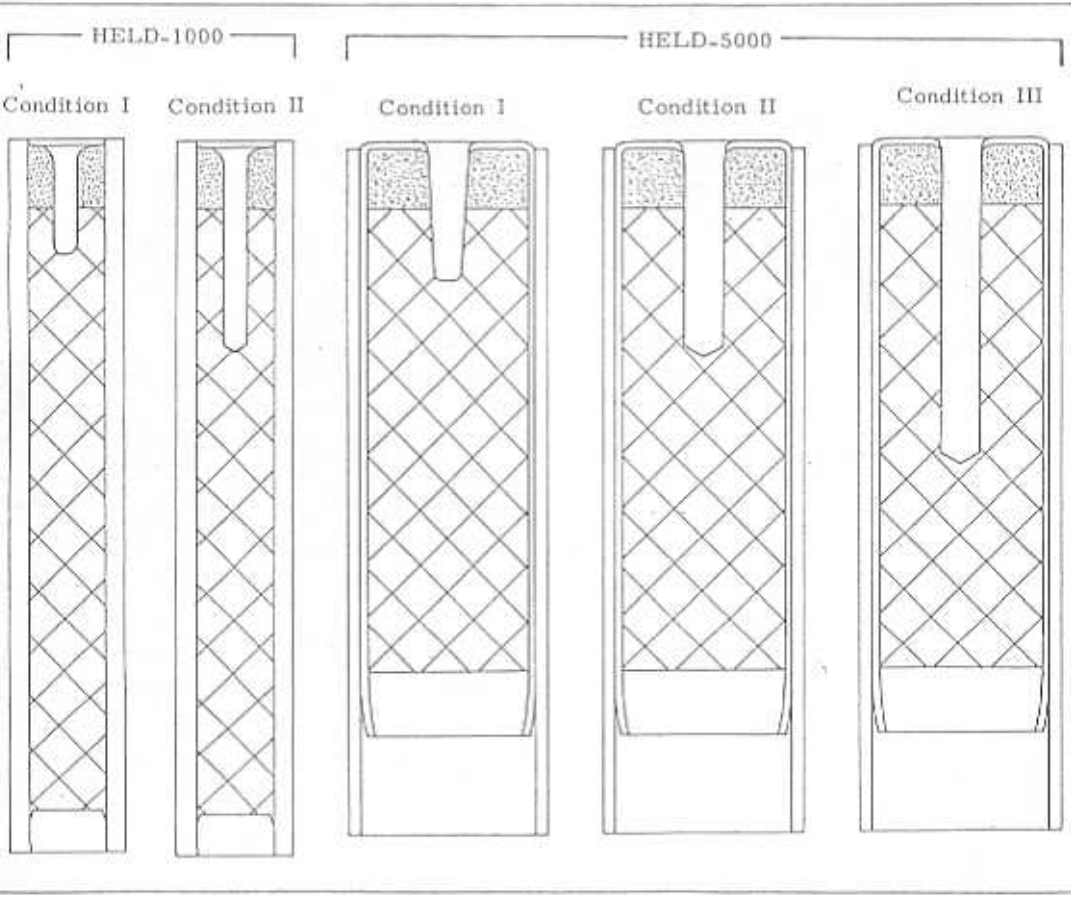
The modification of the HELD-1000 to 'Condition II' involves increasing the depth of the perforation from 15mm to 27.5mm using a 2.5mm drill bit. The immediate effect of this modification is an increase in stated 'boost' thrust. This value rising to 2,030 grammes and total burn time reduced to 5.2 sec.

When a 'Condition II' motor was fired as STATIC-696 on 10th April, 1984, a maximum thrust of 3,637 grammes was registered with total burn time 4.75 sec.

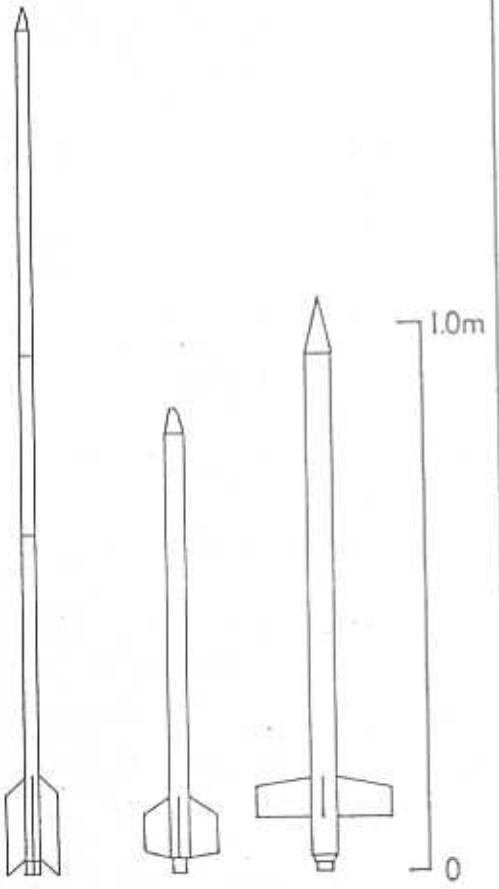
Another Condition-II HELD-1000 was flight tested in the 87.5 gramme XRC-611 on 21st April, 1984. It soared to 950 feet altitude and 164 mph, while impact took place at 88 yards. The mean exhaust velocity came out as 249m/s (817 ft/sec) or 201% of the average 'Condition-I' value.

The considerably larger HELD-5000 rocket motor is 90.0mm long and is 26.3mm in diameter overall. This motor has an aluminium internal sleeve into which the 36 grammes of black powder is packed. A thin cardboard outer case completes the motor which in total weighs 63 grammes.

Three HELD-5000 motors have been studied - all at different recommended 'Conditions' (I, II, and III). All of these rockets were flown, so then the thrust readings stated are those given by the manufacturer alone.

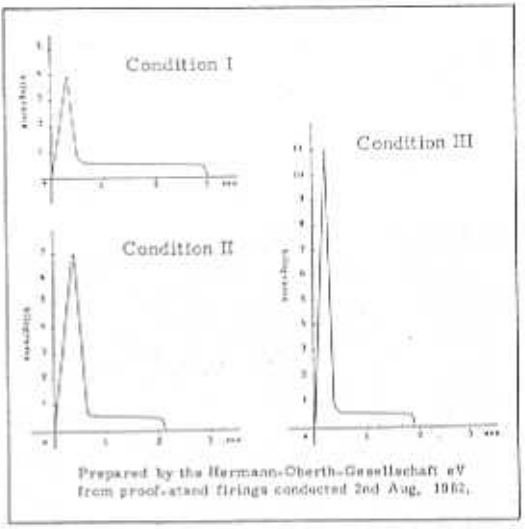


Test rockets powered by HELD-5000



The first HELD-5000 motor was used by the Paisley Rocketeers' Society to fly their RR-100 mail-rocket at Walls Hill, outside Paisley on 11th Sept, 1983. No additional perforation depth was made to the motor which propelled this 318 gramme rocket. Launched at 50°, the rocket curved across the valley reaching 250 feet altitude above the high launch point. Maximum velocity was 141 mph, while the rocket crashed through a row of trees at a ground range of about 300 yards. Effective square-wave exhaust velocity attained was 276m/s (906.8 ft/sec).

Below: The stated performance of the three versions of the HELD-5000 motor.



The second HELD-5000 motor was lathe-drilled to 'Condition II' which involved adding an extra 10mm depth using a 5.0mm drill-bit. It was built into the XRC-559 test rocket launched on 27th November, 1983. Launched at

Above: Paisley Rocketeers prepare RR-100 mail rocket for flight.

HELD rocket motors (all stated values)

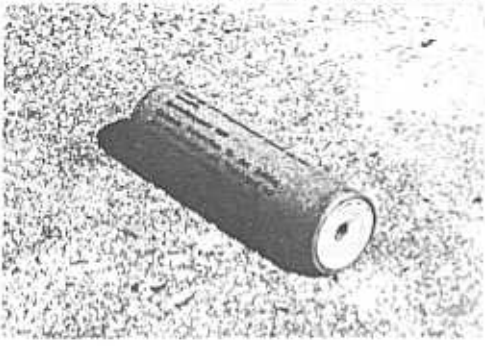
Motor	Condition	Length mm	Dia mm	Perforation depth mm	Weight gr	Fuel wt. gr	Boost thrust gr	Sustain thrust gr	Completion of boost, sec	Total burn sec
1000	I	93.2	15	15.0	20.9	12.6	910	225	1.5	5.5
1000	II	93.2	15	27.5	20.8	12.5	2030	250	3.0	5.2
5000	I	90.0	26.3	18.0	63.0	36.0	4000	550	0.8	3.0
5000	II	90.0	26.3	28.0	62.6	35.6	7000	550	0.65	2.1
5000	III	90.0	26.3	42.0	62.1	35.1	11000	550	0.5	1.9

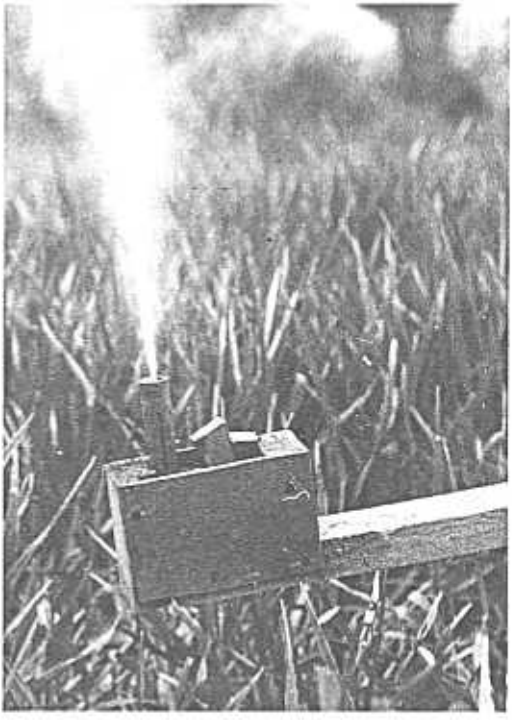
Above: RR-100 roars away from the top of Walls Hill, Scotland.

45^{0}, the rocket reached 222mph in just 2.1 seconds and attained an apogee of 330 feet, before impacting at 565 yds range. The rocket weighed 159 grams at launch. Mean exhaust velocity was mesured as 275m/s (904 ft/sec), while the the flight itself was considerably quieter than expected.

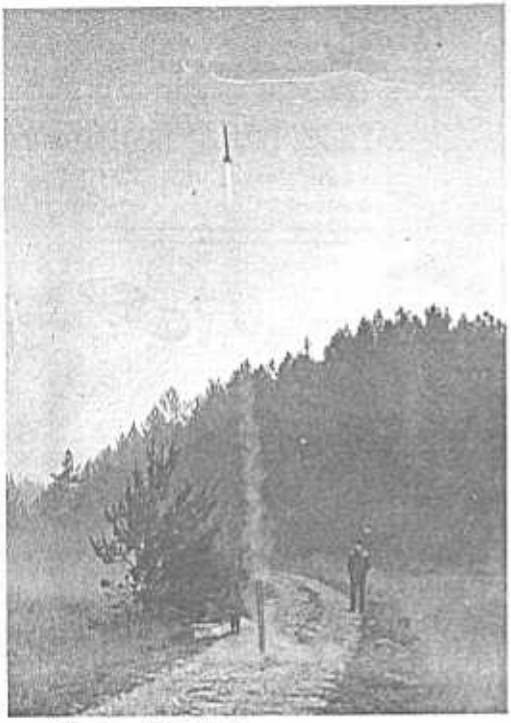
Most recent firing was a HELD-5000, 'Condition III' rocket motor used to propel XRC-616 on 21st April, 1984. Amazing acceleration during the boost phase sent the rocket to 145 mph in 1.9 seconds of total burn. The rocket coasted on to an altitude of about 700 ft before turning and descending broadside, how it gently landed at just 23 yards range. This method of descent invalidated the exhaust velocity calculation method used in this case despite the rockets exciting flight.

Below: The HELD-5000 rocket motor



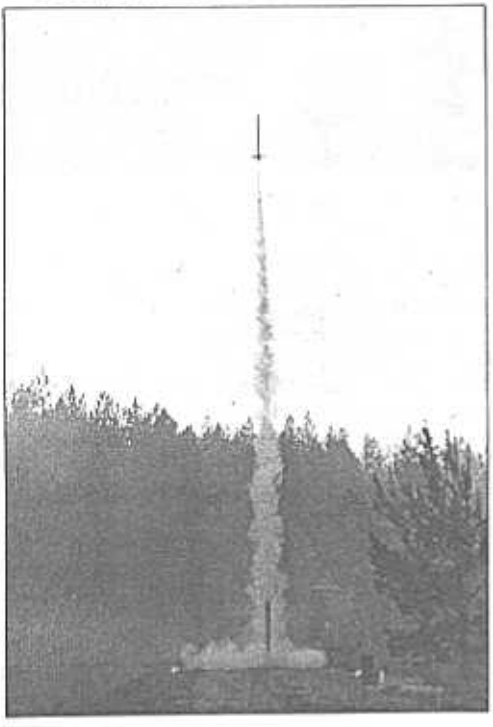


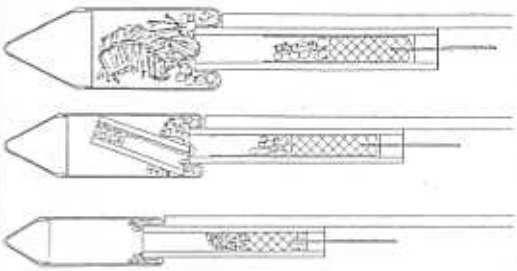
Above: A Condition-II HELD-1000 rocket motor having its thrust mesured on Thrust-Stand-1 as the STATIC-696 experimental firing.



Above: XRC-611

Below: XRC-616





1983 'Weco' firework rockets; very similar to the HELD rocket motors.

In the autumn of 1983 a series of German firework rockets were studied for the 'Firework Rocket Survey'. Of those tested, three motors were seen to be of the same kind as the HELD motors. Manufacturer is Weco. □