Journal of Aircraft and Spacecraft Technology

Review

Project HARP

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Article history
Received: 21-10-2017
Revised: 27-10-2017
Accepted: 06-11-2017

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Abstract: The HARP project, abbreviated from the High Altitude Project, was considered a joint project of the United States Department of Defense and Canada's Department of Defense, originally designed to study low-cost re-entry vehicles. Generally, such projects used rocket launchers to launch missiles, costly and often inefficient. The HARP project used a non-rocket space launch method based on a very large weapon capable of sending objects at high altitudes using very high speeds. Beginning in 1961, the HARP project was largely created due to the concerns and insistence of the talented engineer Gerald Bull, a controversial ballistics engineer and he and his project, but ultimately successful, the engineer who led the entire project. Bull developed the high-speed weaponry technique while working on the Ballistic Missile (ABM) and Intercontinental Ballistic Missile (ICBM) research at CARDE in the 1950s, firing high-speed interceptor rocket models, unlike other researchers who proposed to use the construction of higher wind tunnels, which would have been much more expensive. The ABM project eventually ended without providing a working system, but Bull was convinced that the missile systems he developed would have had potential and in this way, he began to look for other ways of using technology. He clearly needed the trust and funding of his project. Funding for this project came from the Defense Production Department in the form of a \$ 500,000 grant and a \$ 200,000 loan from the McGill Board of Governors. The United States has been testing new ICBM systems and has requested repeated testing of new reentry vehicles. Bull suggested that the program could be run through its method with much lower spending if the test vehicles would be lifted from a large cannon, unlike the classic rocket method. This would also allow the test program to be very accelerated since repeated pulling was easy to arrange compared to the repeated use of the missiles. The key concept was the use of an oversized gun that throws a sub-dimensional vehicle mounted in a shoe, allowing it to be pulled (thrown, ejected) with a very high acceleration, reaching very high speeds. The entire assembly of the test cannon was embedded in a mixture of sand and epoxy, proving more than capable of withstanding the launching rigors. The project was based on a flight line at Seawell Airport in Barbados at 13.077221 °N 59.475641 °W, of which the shells were pulled east to the Atlantic Ocean using a 16 inch (410 mm) long, (20.5 m); the cannula was then expanded (doubled) to the length of (41 m). In 1966, the third and final 16-inch cannon was installed at a new test site in Yuma, Arizona. On November 18, 1966, the Yuma pistol pulled a (180 kg) Martlet 2 projectile at a speed of 2100 m/s, sending it briefly into space and setting an altitude of 180 km (110 miles).

Keywords: Unmanned, US Army, The HARP Project, High Altitude Project, Very Large Weapon, Sending Objects at High Altitudes, Very High Speeds

Introduction

The HARP project, abbreviated from the High Altitude Project, was considered a joint project of the US Department of Defense and Defense, initially designed to study low-cost vehicles. Generally, such projects used rocket launchers to launch missiles, costly and often inefficient. The HARP project used a non-rocket space launching method based on a very large weapon capable of sending objects at high altitudes using very high speeds.

Since 1961, the HARP project has been created largely because of the preoccupations and insistence of talented engineer Gerald Bull, a controversial ballistic engineer and he and his project, but eventually the successful engineer who led the whole project. Bull developed high-speed weapon technology while working on ballistic missiles and intercontinental CARDS (ICBM) in the 1950s, designing high-speed interceptor rocket models, unlike other researchers, the tunnel would have been more expensive. The ABM project eventually ended without providing a working system, but Bull was convinced that the missile systems he developed would have had potential and so he started looking for other ways of using the technology. He clearly needed the trust and funding of his project. Funding for this project came from the Defense Production Department in the form of a $ 500,000 grant and a $ 200,000 loan from Governor McGill Council (HARP Project, Wikipedia), Fig. 1.

The United States is testing new ICBM systems and has called for repeated testing of new reentry vehicles. Bull suggested that the program could be executed by its method, with much lower costs if the test vehicles were lifted from a large cannon, unlike the classic rocket method. This would also allow the test program to be very accelerated, as repeated pulling was easy to arrange compared to a repeated use of missiles. The key concept was the use of an oversized weapon that throws a subdimensional vehicle mounted in a shoe, allowing it to be pulled (thrown, pulled out) with a very high acceleration, reaching very high speeds. The entire test channel assembly was incorporated into a mixture of sand and epoxy, proving more than capable of withstanding the rigidity of the launch.

The project is based on a flight line at Seawell Airport in Barbados at 13.077221 °N 59.475641 °W, when the shells were pulled east of the Atlantic using a 16.5 inches (415 mm) long double (20.5 m) (41 m) 1. In 1966, the third and last 16-inch cannon was installed at a new test site in Yuma, Arizona. On November 18, 1966, the Yuma pistol pulled an 84 kg Marlet 2 projectile at a speed of 2100 m/s, sending it briefly into space and setting an altitude of 180 km (110 miles), Fig. 2.

Fig. 1: HARP 16-inch (410 mm) gun in Barbados

Fig. 2: HARP 16-inch (410 mm) gun in Yuma, Arizona

Materials and Methods

The HARP project was designed to develop missiles and projectiles launched with high-altitude weapons and to obtain scientific and technical data on the upper atmosphere and vehicle-environment interactions. In this effort, the 5-inch pistols place 11.34kg at 250,000 feet, 7-inch pistols place 27,216 kilograms at 33,000 feet and the 16-inch arms reach 59,000 feet, with 83,916 kilograms of projectiles. In addition, parachutes and aluminized chemicals have been launched to produce luminous paths for measuring wind from 100,000 feet to 59,000 feet, since at that time on-board telemetry units with temperature and electronic density sensors were in a high- an advanced development state. The 7-inch and 16-inch rocket weapons are under development and an attitude control system is under development for the 16-inch rocket.

By the end of 1966, the primary developmental teeth of the 5 and 7-inch systems took place on Wallops Island, Virginia and the only 16-inch vertical cannon was located on the Indian island of Western Barbados. Since all these tests involved the impact of water on the return of the projectiles, recovery of the useful tasks for development was very difficult when it was possible.

This was a severe limitation of the development of telemetry, antenna, different sensors and the altitude control unit at that time. At the beginning of 1965, it was decided to install a second 16-inch firewall from Yuma Proving Ground (YPG) in Arizona, with the ability to request permission to change the arms and eliminate the US's horizontal capacity.

Army Testing and Evaluation (TEC). The approval was received in March 1965, with an assigned project number. The vertical drawing was approved on November 24, 1965 and in August 1966 it was allowed to place a 5-inch vertical tunnel near the 16-inch cannon.

The excellent visibility from YPG, a very valuable issue for optical measurements of the upper atmosphere, has then become a side-but important benefit, which is why a scientific research program has been planned.

It is necessary to point out that the 16-inch HARP weapon was a joint effort between the McGill Institute for Space Research (SRI) and the American Blood Research Laboratories (BRL), with the SRI's principal and operational engineering.

All of these efforts were initiated with funding from the Armed Forces Research Office in 1962 and were fully funded until June 1964. At that time, a three-year joint US association was established and the Canadian Department of Defense Production. However, it should be noted that the establishment of a second 16-inch weapon in an armed test is no longer of interest to the Canadian government, although the specific tests of this armed unit have proved to be appropriate for the jointly funded program. For this reason, at the third meeting of the United States Joint Steering Committee for the HARP = McGill project, which took place on 8 July 1965, the Space Research Institute was authorized to make the necessary changes for Yuma, the military.

In September 1965, the Yuma armament began with the arrival of an SRI resident engineer, Mr. Roy Kelly. The cylinder has been extended and the pillar has been modified for vertical fire.

A second Mark 7 barrel was obtained from the recreational harbor in Pocatello, Idaho and arranged there. A barrel of 150 barrel and a smooth sheet for a shoe extension were obtained. The 140-tonne barrel and the 30-tonne extension were then moved to Yuma on the landing route where the YPG cannula was located, where they were assembled into the canal support and welded together.

Another 15 tons of stiffening elements and connecting rods were welded to the expanded tube, so there was no bending during repeated pulls due to the canon's long canon. Finally, an 11-inch diameter cylinder with a length of 20 meters was built and the plant became operational for vertical fires on June 7, 1966. This report also describes the two radar arms and chairs YAMA, ionosonde and k-46, CV, taking into account the burning results of these weapons.

It should be noted that the 16 centimeters in Barbados and Yuma are not at all competitive. The scientific studies that can be performed on both plants provide data for two different latitudes (13, 10 N for Barbados and 32, 90 N for Yuma).

The Yuma 40×10 mileage range limits exposure to unauthorized flights to fully develop the projectiles but offers the possibility of recovery. Barbados's ability to shoot over water in the South Atlantic allows for long-range flights as well as missile and projectile flights.

Yuma Proving Ground is located in the Sonoran desert in the southwest corner of Arizona and is bordered to the west by the Colorado River. It is 40 miles from the Mexican border, 185 miles inside the country of San Diego, California, at the same distance west of Phoenix, Arizona. HARP guns are located at Gun 10 of the KOFA range, which extends east of Arizona State Highway 95 for approximately 40 miles.

The locations of the 16-inch gun and the special HARP instrumentation are given in Table 1 from the Fig. 3. In addition to these, both a fixed and mobile 250 MHz TM receiving station operated by YPG have supported HARP firings (Murphy and Bull, 1967; Petrescu and Petrescu, 2013a; 2013b; 2013c, 2012a; 2012b, 2011; Petrescu, 2009).

Always materials used to build aircraft have been a priority (Aversa *et al*., 2017a-; 2017b; 2017c; 2017d; 2017e; 2016a; 2016b; 2016c; 2016d; 2016e; 2016f; 2016g; 2016h; 2016i; 2016j; 2016k; 2016l; 2016m; 2016n; 2016o; Mirsayar *et al*., 2017). But at that time, there were no possibilities of today in creating of materials.

Table I. Location of HARP Equipment

	Latitude	Longitude	Elevation (meters)
16-inch gun	32° 52' 33.2"	114° 19' 31.7"	141.9
MPS-19 radar	32° 52' 26.7"	114° 20' 8.3"	
Ionosonde	32° 56' 3.8"	114° 10' 34.4"	
K-46 Cameras			
AWC, Yuma	32° 41' 15.6"	114° 29' 29.9"	67.6
Blythe, Cal.	33° 36' 27.1"	114° 35' 29.7"	81.7
Gila Bend, Ariz.	32° 56' 42.6"	114° 43' 50.5"	221.0

Fig. 3: The locations of the 16-inch gun and the special HARP instrumentation. Source: Murphy and Bull, 1967

Results

The 16-inch gun has a length of 119 feet and a fire on a nominal azimuth of 78.20. Its rammer charger system was designed by Rock Island Arsenal and is made up of two-wheeled vehicles.

The projectile is first placed in the charging tray of the first vehicle and the tray is then fed into the link. Once this vehicle is left behind, the second vehicle carrying a hydraulic cylinder is rolled forward, attached to the coupling and the projectile with its shoe is pushed forward with a maximum force of 50 tonnes in its position.

The gun tube was milled at a diameter of 16.40 cm and a length of 18.35 cm and a length of 70.1 cm and a longer length of 10.4 cm length of 83.8 cm and a section with a diameter of 16.9 cm.

Six ¼ inch holes were punched at a distance of three, five feet of shoes on the southern side and two, four and six meters from the northern bot.

The electrical contacts placed in these holes are used to record the passing time of the projectile and therefore form a velocity measurement system.

The bottle is sealed before burning through a Mylar sheet and the hole is discharged into a tenth of atmosphere to achieve an estimated 150 feet per second increase.

The 5-inch extended drum is placed on a steel ramp 20 meters south of the 16-inch gun. It is 33 meters long, made of two 120-mm T-123 barrels and placed in a 155mm mobile holder.

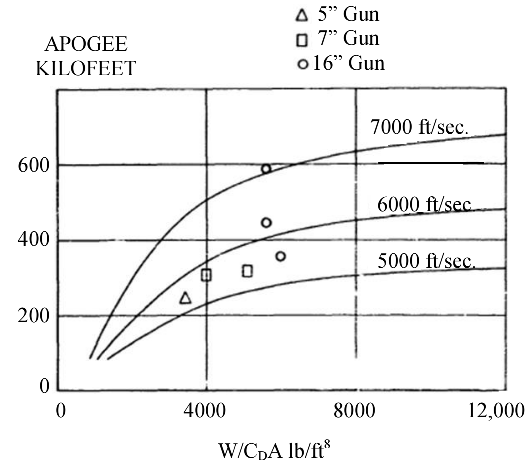
This gun is loaded by a small hydraulic cylinder with a maximum force of 10 tons.

The 16-inch base projection is 185 kg Marlet 2C and is held in a gun with a 230-pound basic button.

The 5-inch HARP projectile weighs 20-23 pounds and is supported in its gun by a more sophisticated sabotage center weighing 5 pounds.

Both sabots separate from their projectiles shortly after launch and fall into a ½ mile circle about their weapons. The performance of these missiles is shown in Fig. 4.

Three thousand two hundred meters behind the pistol's position are mounted MPS-19 mobile radar trucks in a T-band and connected through a small framing control desk.



5"GUN	5400 ft/sec.	250 kft	23 lb.
7"GUN	5400 ft/sec.	300 kft	59 lb.
7"GUN	5900 ft/sec.	330 kft	27 lb.
16"GUN	5600 ft/sec.	350 kft	185 lb.
16"GUN	6300 ft/sec.	465 kft	185 lb.
16"GUN	7100 ft/sec.	590 kft	185 lb

Fig. 4: Apogee for HARP glide vehicles. Source: Murphy and Bull, 1967

From this point of view, radio communication, telephone or intercom is available for the YPG control tower and other YPG reduction points, ionospheric points, k-46 locations, TM receiving stations and combustion circuit located in a trailer next to. This radar is identical to the one in the Barbados HARP series and Marlet 2C rocket projections up to 350,000 feet. Six times, this radar managed to regain Marlet 2C on the legs and provide the location and impact time. 5-inch projectiles can be purchased immediately after ejection and then tracked for the wind or soil recovery profiles.

The main scientific experiment conducted at YPG in 1966 involved the creation of light paths through trimetaluminium emission (TMA) and the measurement of photographic recordings of these trails to obtain wind profiles in the 90-180 km altitude range.

The core tools of the three K-24 locations at Yuma, Gila Bend and Blythe were designed, built and operated by BRL by Space Instruments Research, Inc. in Atlanta, Georgia.

Each station is made up of two K-46s mounted on a socket and a battery control unit. During each 30 sec operating cycle, the cameras have 3, 6 and 9 sec exposures and each movie frame is marked with exposure time, a number of photos and the location of the site in binary code. All sites are in a constant phone call with Launch control via a conference call.

In the northwest of the 25th century, near Tower 18.1, about 8.7 miles east and 6.2 miles north of the 16-inch gun, there is a towed ionosphere and a 60-meter antenna tower.

This tool is administered by the ESSA Telecommunications and Aeronautical Sciences Institute in Boulder, Colorado during the firing series and provides measurements of the Sporadic E layer for the theoretical correlation with the measured ionospheric winds. In the south of the road, four antennas are located for remote measurements of the receptors of certain groups of electrons.

These measurements were taken for the first time in November 1966 and an analysis of the electron cloud velocity and a comparison with the neutral wind is ongoing.

In 1966, three 16-inch combustion series were executed.

In June, an initial series of three wood sculptures and six TMAs were launched that carried out Martlet 2C to check the state of the pistol and the operational capability of the supporting tools.

The sixth model TMA-Martlet 2C and 1 Lahive 150 with TM were mainly dedicated to the engineering tests of the new multiple ignition systems for dust cone and telemetry performance, while TMS-Martlet 2C on the 17th ionosphere November 1962 was intense.

The data on the performance and dispersion of weapons are shown in Table II of Fig. 5.

Prior to the Yuma explosions, a major improvement in pistol performance occurred when the 51-meter gun was extended to the Barbados weapon, thus increasing the speed of the Martlet 2C shoe from 5600 feet per second to 6300 feet per second from 350,000 to 465,000 of legs. Barbados performance for web WM/M .225 and web M8M 0.220 is summarized in Table 3 of Fig. 6. Ignition was performed through a single pin in the lock block.

Table II. Sixteen-Inch Firings at YPG-1966

a) Gun performance

Date	Local time MST	Rd[1] No.	Powder	wt Lb	Pressure kilo-1b/in^2 M11	Gage[3]	Muzzle Vel Ft/Sec	Apogee Kilofeet
Jun 7	1818	001(w)	NAVY	700	13.0	----	3360[4]	No track
8	1927	002(w)	NAVY	800	14.4	14.1S	3190[4]	No track
13	1228	003(w)	WMM	660	21.3	20.6S	4810[4]	No track
13	2025	004	WMM	760	40.0	----	5930	415
13	2215	005	WMM	780	33.2	31.9S	5810	398
14	2146	006	WMM	780	44.0	42.7S	6060	400
14	2317	007	WMM	800	51.4	50.0S	6270	Damaged
15	0127	008	WMM	760	29.8	30.0T	5630	375
15	0305	009	WMM	780	34.6	33.0T	5850	410
Oct 25	2159	010	NAVY (M*)	1095	34.9	----	5250	310
26	2055	011	NAVY (M*)	1225	50.3	43.5K	5950	410
26	2356	012	WMM (M)	920	54.4	47.0K	6800	540
27	1547	013(L)	WMM (M)	900	45.6	----	7100	No track
27	1952	014	NAVY (M*)	1275	51.7	44.0K	5900	415
27	2146	015	WMM (M)	920	53.5	46.0K	6780	535
27	2320	016	WMM (M)	950	60.0	54.0K	7040	Damaged
Nov 16	1814	017	NAVY (M*)	1290	47.7	----	5900[4]	396[6]
16	2041	018	NAVY (M*)	1292	56.4	49.4K	5900[4]	395

Table II. Sixteen-Inch Firings at YPG-1966 (Continued)

a) Gun performance

Date	Local time MST	Rd[1] No.	Powder[2]	wt Lb	Pressure kilo-1b/in^2 M11	Gage[3]	Muzzle Vel Ft/Sec	Apogee Kilofeet
Nov 16	2231	019	NAVY (M*)	1296	48.5	49.5K	5850[4]	375
17	0015	020	NAVY (M*)	1296	47.5	45.0K	5950[5]	415
17	0316	021	NAVY (M*)	1290	60.8	----	----	Damaged
18	1820	022	NAVY (M*)	1263	49.3	----	5900[4]	400
18	2012	023	NAVY (M*)	1263	53.9	48.8K	5850	410
18	2149	024	WMM (M)	922	51.0	46.3K	6650	510
18	2342	025	W8M (M)	880	44.0	38.7K	6650	490
19	0100	026	W8M (M)	910	46.7	40.6K	6400[5]	530
19	0234	027	NAVY (M*)	1270	45.9	42.5K	6650[5]	400
19	0451	028	W8M (M)	960	57.5	51.3K	5850[5]	590
19	0608	029	NAVY (M*)	1270	50.3	45.0K	7000[5]	Damaged
19	1944	030	W8M (M)	960	42.7	38.8K	----	480
19	2120	031	NAVY (M*)	1270	39.8	41.3K	6350[5]	367[6]
19	2237	032	NAVY (M*)	1270	43.8	43.1K	5650[5]	370
19	2358	033	W8M (M*)	880	50.2	----	5650[5]	550

[1]All projectiles are Martlet 2C's (1n-gun wt 4151b; flight wt 185 1b) except for (w) wooden alugs (nominal in-gun wt 415 1b) and (L) Lahive 15° come (in-gun wt 274 1b).
[2]M-multi-point ignition; M*-multi-point ignition with shear lip on base plate.
[3]S-strain gage (HAT); T-Tourmaline gage; K-Kistler gage.
[4]No vacuum. All other shots had gun barrel evacuated to 0.1 atm.
[5]Velocity estimated form apogee.
[6]Apogee estimated from top of TMA trail.

Table II. Sixteen-Inch Firings at YPG-1966 (Continued)

b) Martlet 2C Dispersion*

Rd No.	Apgoee Kilofeet	Elevation Degrees	Azimuth degrees	Impact range Kilofeet
004	415	83.9	77(79.6)	161E (158)
005	398	----	----	----
006	400	83.6	83 (84.2)	164E (159)
007	Damaged	----	----	----
008	375	84.0	72	144E
009	410	84.2	72(75.0)	149E(146)
010	310	85.0	74	100E
011	410	85.0	78	129
012	540	85.0	72	167E
014	415	84.2	80	153
015	535	84.5	76	167
016	Damaged	----	----	----
017	369	----	----	----
018	395	84.5	78	137E
019	375	83.5	79	153E
020	415	83.9	76	161E
021	Damaged	----	----	----
022	400	83.9	74	156E
023	410	83.6	76	167E
024	510	84.3	70	182E
025	490	83.6	81	196E
026	530	83.8	77	207E
027	400	83.7	76	162E
028	590	84.8	75	188E
029	Damaged	----	----	----
030	480	83.5	78	198E
031	367	----	78	149
032	370	83.4	79	155
033	550	84.2	74	201E

E-Estimated from first thirty second of trajectory

Fig. 5: Gun performance and dispersion data are summarized. Source: Source: Murphy and Bull, 1967

Table III. Barbados Gun performance

a) Single point ignition, 220 M8M

p>38,000 psi

Date	Rd[3] No.	Charge wt.	Pressure kilo-1b/in.^{2} Mil	Strain gage	MV	Apgoee Kilofeet
24 Mar 65	098	750	45.8[1]	45.3	6100R	k27
28 Mar 65	104	725	38.8[1]	38.9	5820	389
28 Mar 65	105	730	38.6[1]	37.8	5750	384
11 July 65	125	780	44.8	41.8	6160R	436[2]
12 July 65	126	790	49.3	45.2	6160R	444
12 July 65	127	780	44.1	40.8	6140R	438
17 Nov 65	7	750	40.8	41.0	6000[4\]	390
17 Nov 65	8	750	37.9	37.5	5940R	404
17 Nov 65	10	770	41.1	41.4	6120[4]	400
18 Nov 65	11	770	35.0	40.2	5970[4]	408
18 Nov 65	13	750	42.2	42.4	6050R[4]	421
18 Nov 65	14	750	38.0	40.7	5800R	380
21 Nov 65	19	780	39.8	39.0	6130[4]	414

[1]MK 6 gages.

[2]Gun elevation was 82.5° for all other shots, it was 85°.

[3]If round number has not been assigned, number in series is given.

[4]Bore was evacuated to 0.1 atm.

R-Velocity estimated from radar.

Table III. Barbados Gun performance (Continued)

b) Single point, spaced charge, 225 WM/M

Date	Rd* No.	Charge wt.	Pressure kilo-1b/in.^{2} Mil	Strain gage	MV	Apgoee Kilofeet
24 Feb 66	15	850	54.0	46.0	5900R†	395
24 Feb 66	16	850	51.0	----	6080R†	426
24 Feb 66	17	850	48.6	----	5760R	377
28 Sept 66	1	825	53.5	52.3	†	300
28 Sept 66	2	825	53.6	52.4	†	414
28 Sept 66	3	825	49.8	49.4	6200R†	442
29 Sept 66	4	780	45.2	----	†	386
29 Sept 66	5	825	47.6	47.0	†	356
29 Sept 66	6	825	48.1	48.5	----	373
29 Sept 66	7	825	55.1	54.3	†	392
29 Sept 66	8	825	55.7	53.4	†	415
	9	825	46.3	44.6	†	402

*Round number is number in given series.
†Bore was evacuated to 0.1 atm.
R-Velocity was estimated from radar.
¶This round struck 4 inches short of seating position with 100 tons of ram force applied. Charge was, therefore, reduced 45 pounds.

Fig. 6: The Barbados performance for WM/M 0.225 web and M8M 0.220 web is summarized in Table 3a-b.
Source: Murphy and Bull (1967)

Discussion

In 1965, a step in increasing the pressure for compression pressure records was observed on a regular basis. Since the length of the load was used up to 130 cm to 190 cm in the room, it is believed that this step was caused by the shock waves formed between the tip of the dust bag and the thrust plate. Three wooden spacers were inserted to ensure that the final powder bag is in contact with the thrust plate and that the free volume was divided into three thirds, evenly spaced. This change eliminated the step in the pressure curve but reduced the peak pressure for the fixed load weight by 6-8000 psi. Thus, with a remote load, it is necessary to increase the weight of the load. Since November 1965, all 16-inch HARPs have used remote charges.

Table 3 (Fig. 6) and in particular Table 3b, shows considerable pressure and drainage pressure for the same load. Some of these variations are due to the pressure required by the ram, but it is believed that most damage caused by the small shield or a single projectile point can create perforated bags. In August 1966, it was decided to develop multiple ignition systems to simultaneously ignite dust bags.

The usual load of the powder consists of seventy kilograms of black diapers filled at the bottom. Pairs of centimeters were sewn into the dust bags of the other dust bags and connected in parallel with the combustion circuit. The bags were loaded so that each sponge bag had black patch patches in contact with a protective bag. Each bag was in direct contact with two aggressors.

This ignition system was first tested at the SRI's Highwater Laboratory, a 20-inch power gun. This change also had the effect of reducing the pressure for a fixed load, but, more importantly, it seemed to be a significant improvement in the speed of the shoe. The October Yuma series confirmed this improvement with a record high of 540000 feet and a record speed of 7,100 feet per second. In November, a record peak of 590000 feet (180 km) was established.

In spite of the scattering of data, it is possible, to sum up, the improvement of multiple ignition performances. For a pressure leak, the 44,000 psi M8M cylinder has a single point and the displaced cylinder will give 6250 feet per second and a peak of 460,000 feet, while the addition of multiple combustions raises that value to 6720 feet per second and 530,000 feet. Similarly, WM/M at a drain pressure of 50000 psi produces 6,200 feet per second and 44,000 feet for the ignition with a point and an improvement of 6,800 feet per second and 54,000 feet for multiple ignitions.

At the beginning of the HARP program, it is hoped that large 16-inch stocks could be used, but this powder, designed to launch 2,700 pounds at 2,500 feet per second, burns too slowly for HARP's high-performance projectiles. The first gun marches in June used marine fuel and the leakage pressure of over 14000 psi could not be produced. As a final effort to use this cheap available fuel, it has decided to ignite more points on high-powered marine propulsion. To accelerate its combustion characteristics, the shear lips were placed on the pusher plates to keep them in position until reaching about 3000 psi. High-end tests were promising and Yuma's burning showed that this could be successfully used to reach 400,000 feet. Because the cost of dust is equal to the cost of metal parts for cars, for missions that require moderate altitude, the use of marine fuel costs half the cost of the shot. It is interesting to note that the maximum weight of 1296 pounds is almost twice as high as the 660 pounds load service and is the largest load ever used by a 16-inch gun.

Even though these cannons are now abandoned, they have fulfilled their mission, demonstrating and obtaining important data at that time. Some scientists still think to use such devices to determine atmospheric movement or to pick up objects without rockets in the atmosphere. Personally, we believe that balloons, guided ships and other modern ships can successfully accomplish these missions without great effort or damage. However, high altitude weapons and high-speed combustion systems can be used successfully in our planet's military defense techniques, in addition to missiles, LASERS and MASTERS of high power, explosives and explosives with different intensities shipped quickly and with very long distances.

Of course, this does not necessarily mean resuming tests on similar devices, but rather replacing them with stronger sounds.

Conclusion

Yuma Proving Ground 5 and 16-inch weapons and associated instruments and flight results for 1966 are described in detail.

The introduction of multi-point ignition for the 16-inch pistol produced a new record of 111 miles using special propulsion and a moderate propulsion of 77 km. Twenty-four ionospheric wind profiles were obtained from 16-inch firearms and 15 stratospheric firing profiles. Telemetric performance and soil recovery capacity have been demonstrated.

Even though these cannons are now abandoned, they have fulfilled their mission, demonstrating and obtaining important data at that time.

Some scientists still think to use such devices to determine atmospheric movement or to pick up objects without rockets in the atmosphere.

Personally, we believe that balloons, guided ships and other modern ships can successfully accomplish these missions without great effort or damage.

However, high altitude weapons and high-speed combustion systems can be used successfully in our planet's military defense techniques, besides high-power missiles, LASERS and MASTER, explosions and explosives with varying and very long changes.

Acknowledgement

We acknowledge and thank Mr Taher M. Abu-Lebdeh, Associate Prof at North Carolina A and T State Univesity, United States and Mr Muftah H. El-Naas PhD MCIC FICCE QAFCO Chair Professor in Chemical Process Engineering Gas Processing Center College of Engineering Qatar University and Ms Shweta Agarwala, Senior Research Scientist at Singapore Center for 3D Printing Nanyang Technological University Singapore for their suggestions and comments.

Author's Contributions

All the authors contributed equally to prepare, develop and carry out this manuscript.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

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