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TECHNICAL MEMORANDUM REPORT ORDBB-TE3-9

A PROPOSED ARMAMENT SYSTEM FOR MEDIUM TANKS (U)

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FC

AUGUST 1959

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Technical Memorandum Report No. ORDBB-TE3-[illegible]

A PROPOSED ARMAMENT SYSTEM FOR MEDIUM TANKS (U)

by

Sidney Jacobson

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July 1959

Feltman Research and Engineering Laboratories

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OBJECTIVE

(C) The object ? this study is to evaluate and propose a tank gun weapon system whi exhibits significant improvement over the capabilities of the ently adopted 105mm, T254 Gun.

SUMMARY

(C) An armamen system is described ~~in this report~~ which is designed to provide i reased firepower for existing medium tanks and to provide a weapor system for future generation tanks. The system consists of a 105m smoothbore gun designed to minimize turret intrusion and gun le gth. It fires a discarding sabot kinetic energy projectile capable f penetrating in excess of five ~~(5)~~ inches of armor plate at 60° bliquity at a range of 2000 yards or six ~~(6)~~ inches at 60° at ra ges up to 500 yards. The ammunition complement of this system wil include HEAT, HE and WP Cartridges.

CONCLUSIONS AND RECOMMENDATIONS

(C) 1 A tank gun-ammunition system is proposed which is superior in armor penetration capability to any existing tank gun system.

(C) 2. The design of the gun provides for the smallest turret intrusion of any gun in the medium tank class and consequently permits a saving in turret size and weight.

(C) 3. The proposed gun system is adaptable to the recently standardized M60 Tank offering increased weapon effectiveness.

(C) 4. All ammunition types proposed are presently being test fired or were recently suspended while in an advanced state of development.

(C) 5. It is recommended that a prototype gun be designed, fabricated and tested.

(C) 6. It is recommended that further studies be undertaken by the responsible agencies to adapt the proposed system to existent or future generation tanks.

INTRODUCTION

(C) 1. During October and November 1958, a series of exhaustive comparative tests were conducted at Aberdeen Proving Ground, Maryland for the purpose of determining the most suitable gun system for the XM-60 Tank. The result of these tests was a recommendation that "the 105mm, X15E8 Gun be considered the most suitable of the candidate types considered for the XM-60 Tank" (Ref. 1, Pg 37).

(C) The following gun-ammunition systems were evaluated in these comparative tests:

TABLE I

Armament Systems Evaluated at APG During Oct - Nov 1958

Gun		Ammunition	
Caliber	Designation	Type	Designation
120mm	M58	HEAT	T153E13
120mm	T123	HEAT	T153E13
120mm	M58	AP-T	M358E1
120mm	T123	AP-T	M358E1
105mm	X15E8	APDS-T	-
105mm	T254	APDS-T	-
90mm	T208E9	APFSDS-T	T320E82
90mm	M41	HEAT	T300E53

(C) 2. The smoothbore 90mm T208 Gun - T320 APFSDS "Arrow" system exhibited terminal ballistic characteristics superior to the recommended X15E8 Gun System, however other considerations such as the accuracy penalty incurred by the high gun wear rate weighed heavily against the choice of this system. It is the purpose of this report to present a gun system which fully exploits the armor defeating potential of the arrow-type smoothbore gun-projectile system, while eliminating its objectionable aspects.

DISCUSSION

(C) 1. In light of the results of the comparative testing performed at Aberdeen Proving Ground, the need for an armament system which retains the good features of the 105mm, X15E8 Gun and yet is capable of defeating more armor is clearly evident. The system proposed in this report is designed to incorporate discarding sabot and HEAT ammunition of minimum size and weight for ease of handling and rapid loading to minimize time to hit. The gun for this system is designed to have a penetration capability greater than the recently adopted 105mm T254 Gun while the turret intrusion and consequent necessary size of turret is reduced. A comparison of the proposed system to various existing tank gun systems is shown in Table II.

TABLE II

Physical Characteristics of Various Medium Tank Gun Systems

Designation	Caliber (mm)	Weight (lbs)	Length (ins)	C.G. from rear face of Breech (ins)
XM- (proposed)	105	3012	233.2	49.0
T254E2 (U.S. version of X15E8)	105	2492	218.50	62.9
T210	105	4315	312.30	75.1
T208	90	3265	276.38	68.6
M41, M36	90	2650	193.4	55.5

(C) 2. The initial parameters to be fixed in the design of the gun were muzzle velocity and as-fired weight for the discarding sabot projectile. Various gun configurations yielding the aforementioned muzzle conditions were evaluated, using a Berkeley "Ease" analog computer to calculate Pressure vs. Travel and Velocity vs. Travel curves. The results of these calculations showed that in order to obtain a small chamber volume and thereby a small complete round, an increase in pressure above common values was indicated. A pressure of 61,000 psi (copper) was chosen as being the upper limit which can be withstood by the ammunition. This pressure yielded a chamber volume requirement of 625 cu. in. based on a loading density of .85 g/cc of M17 Propellant. The ballistic drawing of the final gun design is shown in Fig. 1. The overall length of the complete round (APFSDS Shot, Fig. 2) is approximately 41 inches for this chamber configuration.

The gun design for this proposed system utilizes the autofrettage manufacturing technique and a gun steel with a 150,000 psi elastic limit to achieve a tube of minimum weight and size. A representative breech mechanism weight of 1200 lbs was chosen from various existing breech mechanisms of similar size.

(C) 3. The gun configuration which resulted from these calculations offers a number of advantages. Of primary importance is a penetration capability considerably better than any existing gun firing an APDS round. Second is the small turret intrusion made possible by a center of gravity location closer to the breech than any of the guns compared in Table II. Third, the detrimental effect of high erosion rates common to high velocity guns is reduced by autofrettage, which hardens the bore surface thereby reducing erosion, and by the elimination of the steep forcing cone which experienced the highest erosion rate in the smoothbore T208 and T210 Guns. Also, the delta-finned APFSDS Shot, described later in the report, is not sensitive to erosion, resulting in a considerably longer gun life than the smoothbore guns in which erosion was a serious problem.

(C) 4. The APFSDS round for this system (Fig. 3) is based on a projectile concept presently being tested in a supporting research project. This projectile has exhibited excellent potential in firing tests performed to date. The penetrator is essentially the same as that of the 90/40mm, T320 and the 105/40mm, T346 Arrow projectiles. But since the velocity regime of the proposed system is 100 fps higher than that of the 90mm Arrow round, penetration potential of the new round is estimated to be somewhat superior to that demonstrated by the latter.

(C) 5. This delta-finned round eliminates development problems of Arrow type ammunition in three major areas. The most important of these is the detrimental effect on accuracy incurred by the high wear rate of the T208 and T210 Guns. It has been established in firing tests of the Delta finned shot that excellent obturation is obtained with this round even in tubes worn to a point where considerable loss in obturation is noted in an Arrow type round (Fig. 4). Therefore, even if a relatively high wear rate were still present in the proposed design, the effect of this wear would be reduced and the useful life of a gun tube increased considerably. No definite figure is available as to what gun life can be expected with this round; results of firings to date indicate that the life should be at least double that experienced with Arrow type projectiles.

(C) 6. The second of these areas is the problem of burning of the fins and consequent loss in accuracy experienced during the Arrow development program. The delta-fin design does not expose the fins to the high temperature propellant gases at any time as does the Arrow. Since obturation is at the pusher plate, the fin is protected from these hot gases. Also, a fin of the delta type is specifically designed for the hypersonic flight regime, and will not be materially affected by aerodynamic heating while in flight.

(C) 7. The third superior aspect of this new design is its low aerodynamic drag. The aerodynamic configuration of the projectile was designed to yield as low a drag coefficient as possible without sacrificing flight stability. The result of this low drag is a markedly reduced velocity fall-off rate and the ability to deliver to the target a higher percentage of the available muzzle energy than any other discarding sabot shot.

(C) 8. Using the existing penetration capabilities of the protection ballistic limits of the Arrow projectile as a basis for estimating the performance of the delta-fin shot, penetration of 5 inches of armor plate at 60° obliquity is predicted at a range of 2000 yards and 6 inches at 60° obliquity at a range of 500 yards. Defeat of the triple spaced Tripartite armor configuration is estimated to be marginal with the present penetrator configuration. However, a program has been initiated to develop a penetrator configuration capable of defeating triple spaced armor. This program is described in Paragraph 14.

(C) 9. Another of the major problem areas common to all hypervelocity ammunition is that of determining the flight path of the round in the event of a target miss. This is accomplished in lower velocity ammunition by means of a pyrotechnic tracer installed in the base of the projectile. However, the use of a tracer for sensing a projectile having flight velocities in the neighborhood of 5000 ft./sec. becomes quite difficult due to the short time of flight. Adding to this problem is the obscuration of vision caused by the dust and smoke of the muzzle blast. This obscuration is of such a degree and duration that if a hit is not made on the target, there is little chance of sensing the round regardless of whether a tracer is employed or not. To eliminate this disadvantageous condition, it is proposed to incorporate a sensing system in the 105/40mm Delta-finned round which will leave a persistent trail capable of being observed from the tank after the obscurating smoke and dust has cleared.

(C) 10. A system of this nature is presently under study at Picatinny Arsenal. Sensing is provided by a smoke trail of sufficient density and persistence to make observance along the trail possible, while it will not be readily observable from some point to the side of the trail. A delay provision is to be incorporated in the round so that the trail will commence at a point some 400 or 500 yards from the gun muzzle, thereby reducing the ability of an observer to locate a tank firing from concealment.

(C) 11. The smoke generator will be installed in the hollow steel windshield of the projectile. (Fig. 5). It consists of a liquid which will provide smoke of the proper density when brought into contact with air at the high temperatures produced in flight due to the Mach number temperature rise. This liquid is metered through bleed holes at the base of the windshield, and is forced out of the windshield cavity by the pressure generated by allowing ram air into the front of the cavity through a hole in the nose. Provision will be made to prevent contact of the pressurizing air and the smoke producing liquid. Generation of gas inside the windshield cavity could result in splitting or bursting the windshield in flight. The delay provision could be accomplished by plugging the exit holes with a thermoplastic compound which will melt after being exposed to aerodynamic heating for a period of approximately a 1/4 second.

(C) 12. The HEAT round for this system is the cartridge presently under development for the 105MM Gun, T254, namely, Cartridge, HEAT, 105MM, T384 (Fig. 6). Although the T254 Gun is a rifled tube, firing of the T384 from a smoothbore tube would present no design problems because it is a fin stabilized configuration. This round is presently in the ED phase of development.

(C) 13. The HE and WP projectiles for this system are the Cartridges, 105MM, HEFS, T344 and 105MM, WPFS, T343 respectively. These were initially under development for the 105MM Smoothbore Gun T210, and although suspended, are in an advanced state of development.

(C) 14. To further develop the potential of the proposed system, the results of two programs now in progress can be integrated into the overall system. First of these is the combustible cartridge case, which would offer the advantages of a smaller and lighter complete round, no cartridge cases to dispose of and faster loading and handling. The second program is an investigation of armor penetrators being initiated on a scale-model basis in a light gas gun at Picatinny Arsenal. The aim of this investigation is to evolve superior armor penetrators for both single and spaced armor targets. A specific goal of this scale-model program is to develop a composite penetrator of high length-to-diameter ratio capable of penetrating a triple spaced-armor target such as specified in the Tripartite Agreements.

REFERENCES

1. "Report on XM60 Weapon System Evaluation". First Report on Ordnance Project No. TW-418, Aberdeen Proving Ground, Maryland (Secret).

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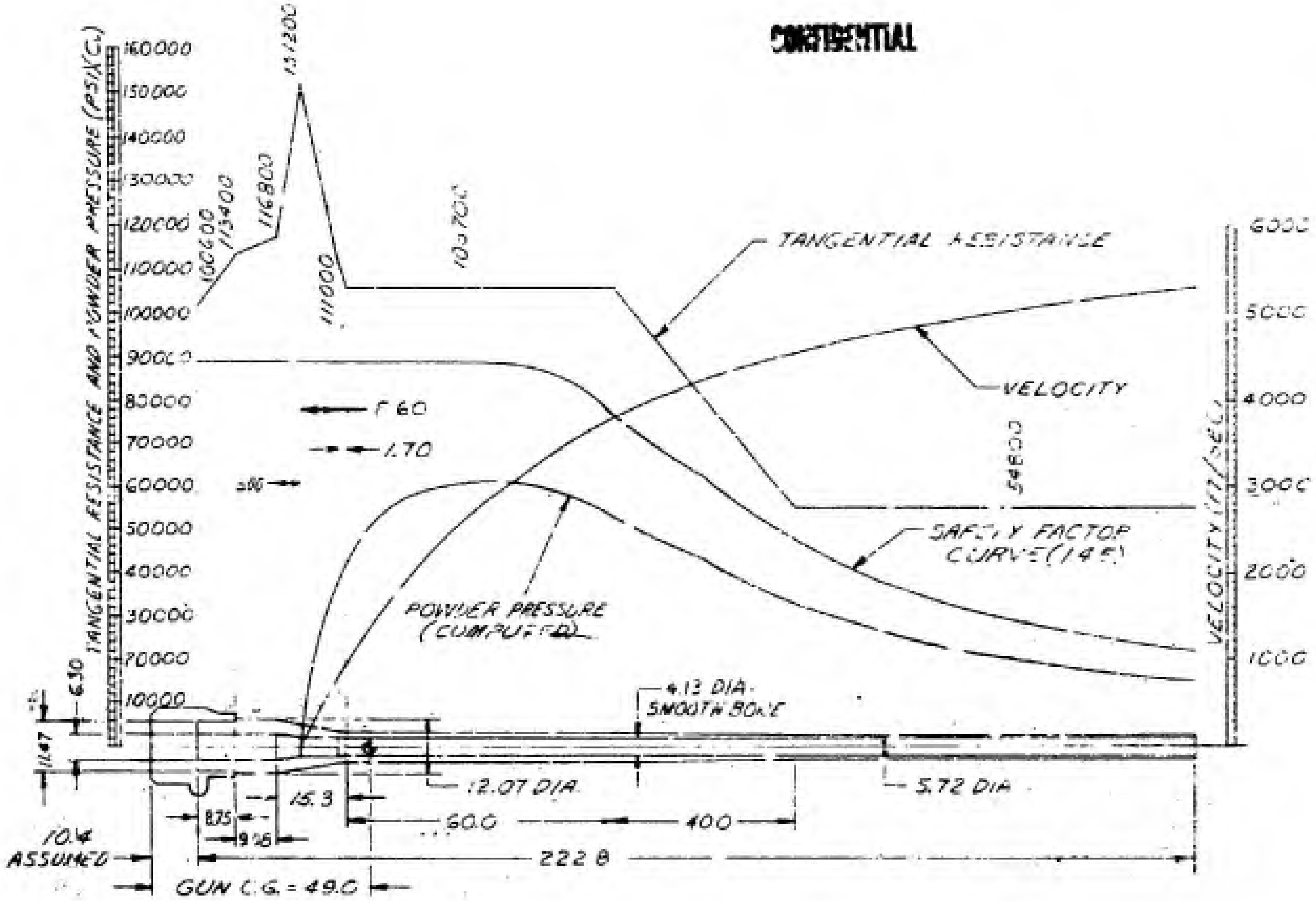

TANGENTIAL RESISTANCE
T.R. = 1.05 [E.L. + 10^4] ...
E.L. = 150000 PSI
MONOBLOC AUTOFRETTAGE CONSTRUCTION

CHARACTERISTICS OF GUN
LENGTH OF TRAVEL — — — — — — 200 IN.
MUZZLE VELOCITY — — — 5300 FT/SEC
PROJECTILE WEIGHT — — — 12.0 LBS
CHAMBER VOLUME — — — 625 CU IN
WEIGHT OF PROPELLANT — — — 19 LBS
LOADING DENSITY — — — — 0.85 G/CC
MAX POWDER PRESSURE — — 61100 PSI (CU)
TUBE WEIGHT — — — — 1812 LBS
ASSUMED BREECH WEIGHT — — 1200 LBS
GUN WEIGHT — — — — — 3012 LBS
GUN CENTER OF GRAVITY — — 49.0 IN

FIGURE 1
GUN, 105MM, XM- BALLISTIC DRAWING

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SCALE 1:20

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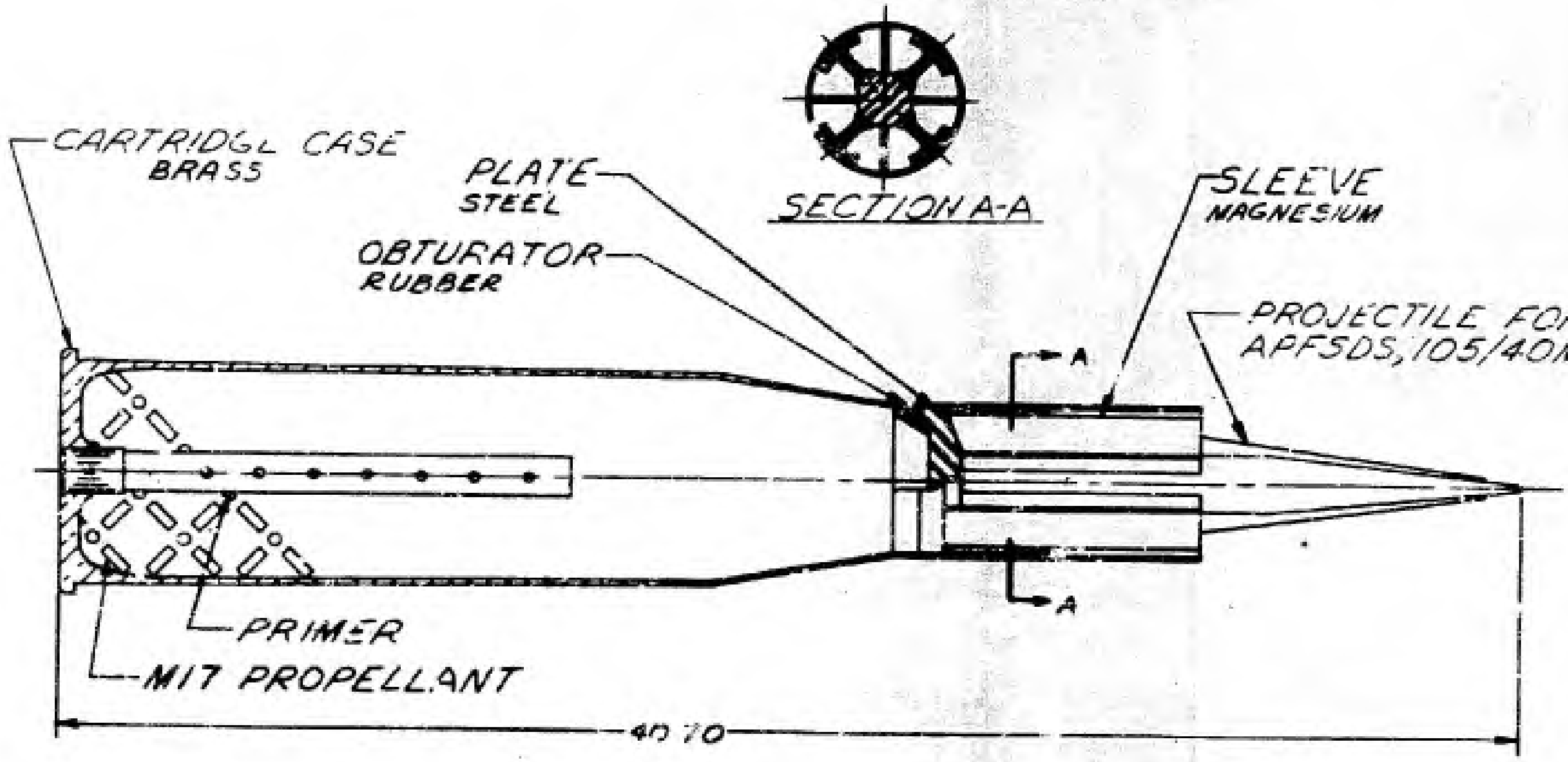

CARTRIDGE, APFSDS, 105/40MM, XM-

FIGURE 2

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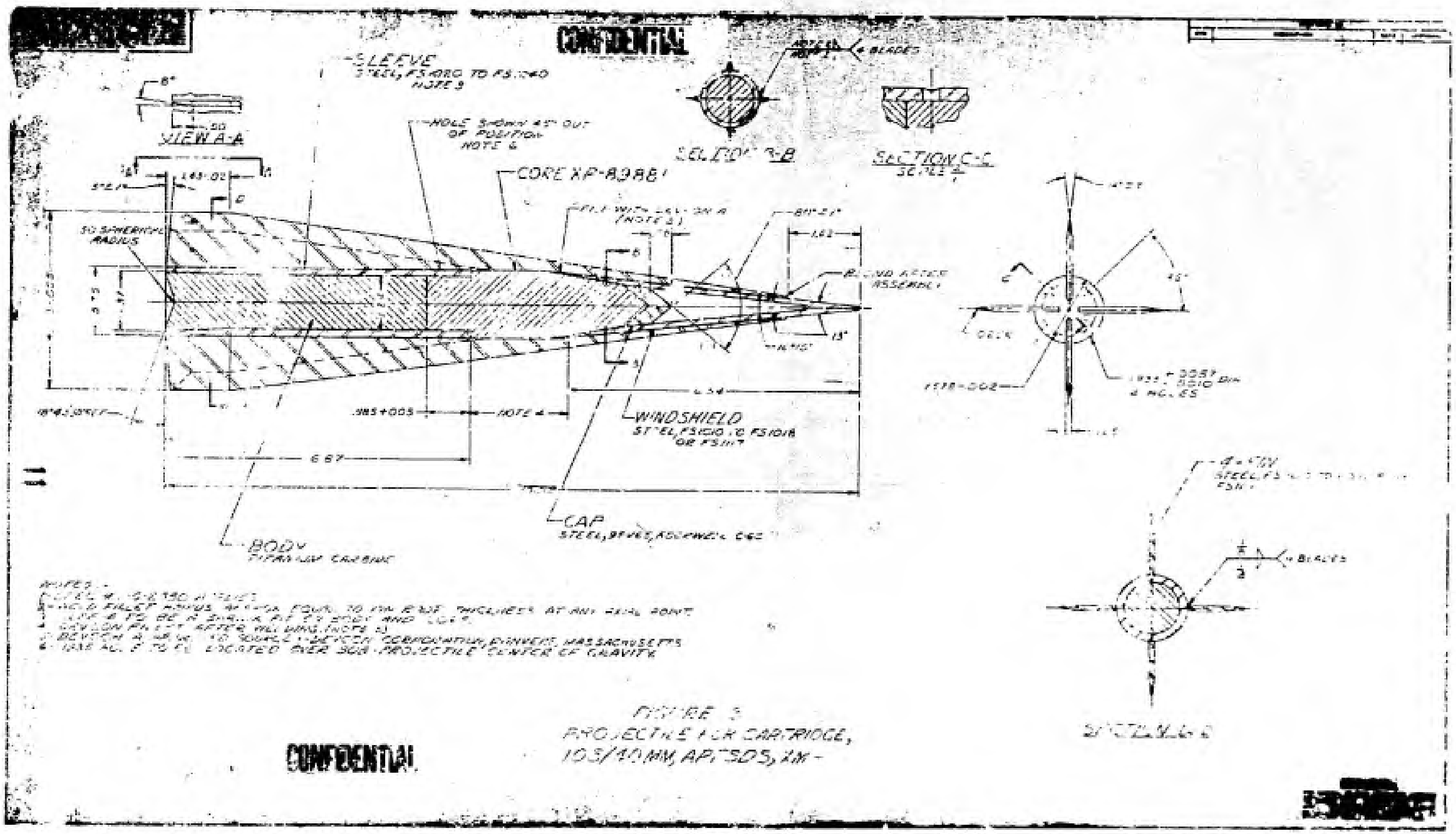

FIGURE 5
PROJECTILE FOR CARTRIDGE,
105/40 MM, APDS, XM-

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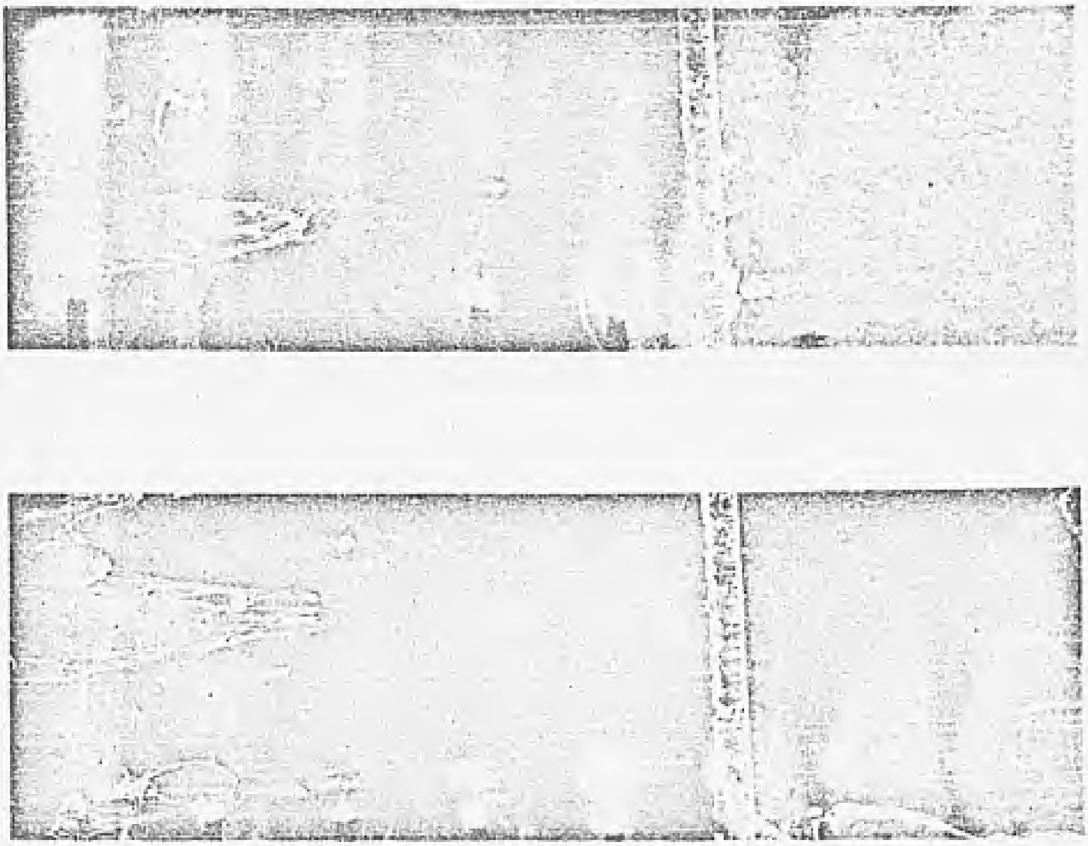

Figure 4

A comparison of Typical Obturation Characteristics between the 90MM Delta-Finned Round and the 90MM T320 Arrow Round.

TOP: Delta-Fin (Shot, FS, Model 2) T208E4 Tube, tube round #57. Note emergence of round before blast.

BOTTOM: Arrow (T320E76) tube round 56.

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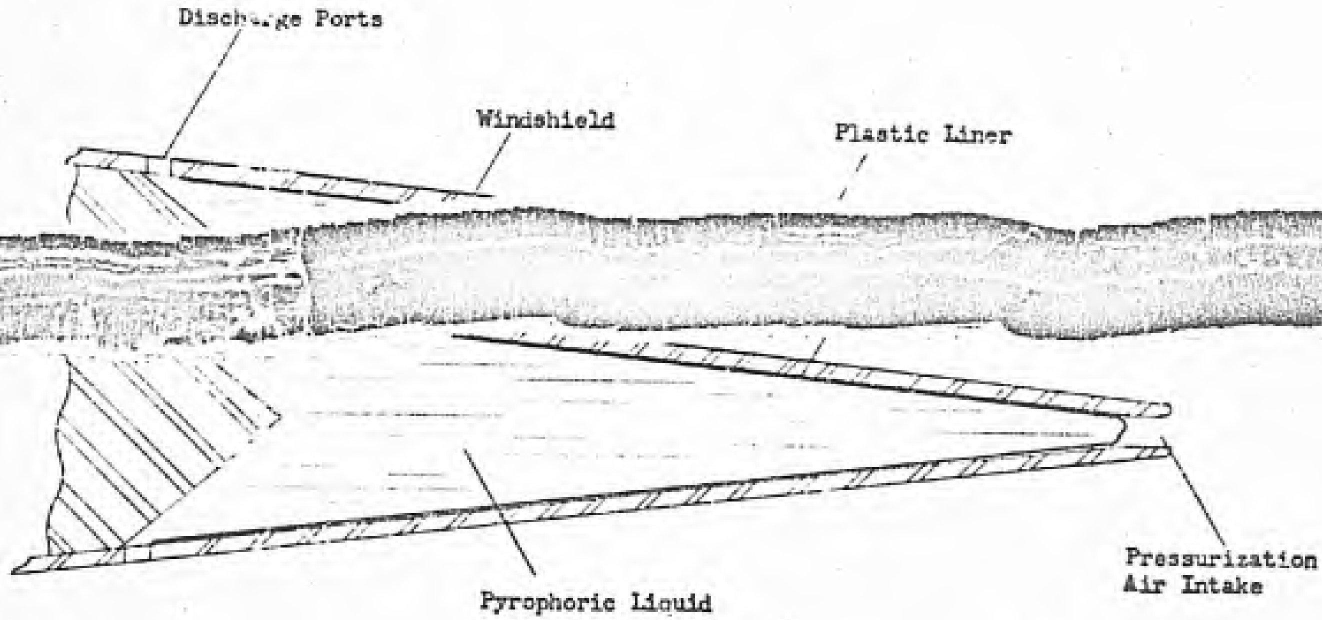

Scale 1.5: 1

Discharge and inlet ports are sealed with a thermoplastic material designed to melt under aerodynamic heating while in flight.

Figure 5
Installation of a Smoke Generator in the Windshield of Projectile for Cartridge, 105/40mm, APFSDS, XM-

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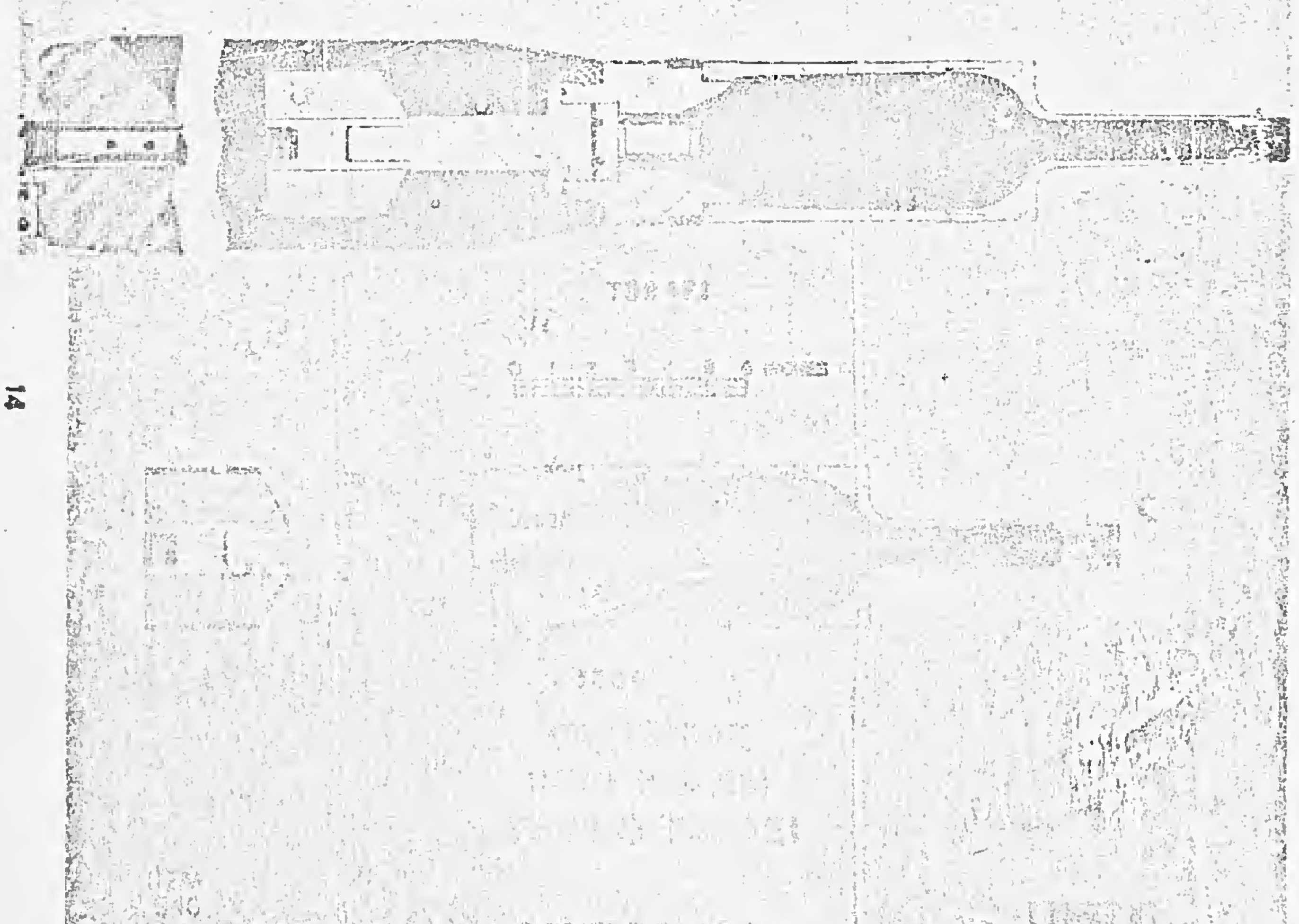

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