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M5 - 4 (E12 - 7R1) MECHANIZED FLAME THROWER INSTALLED IN M4A1 OR M4A3 MEDIUM TANKS

CONFIDENTIAL
OSRD NO. 6350

DIVISION 11
NATIONAL DEFENSE RESEARCH COMMITTEE
of the
OFFICE OF SCIENTIFIC RESEARCH AND DEVELOPMENT

M5-4 (E12-7R1) MECHANIZED FLAME THROWER

INSTALLED IN M4A1 OR M4A3 MEDIUM TANKS

Service Directive: CWS-10

Endorsement (1) from Dr. H.C. Hottel, Chief, Section 11.3 to Dr. H.M. Chadwell, Chief, Division 11.

Forwarding report and noting:

> "This report describes a mechanized flame thrower installed in the M4A1 or M4A3 medium tanks. This development was begun in August, 1944, due to the obsolescence of the M5A1 light tank in which an earlier mechanized flame thrower had been installed. This mechanized flame thrower was placed in production, and 620 units were on order at the end of the war. Following V-J day, this order was reduced to 150 units. Seventeen of these units, accompanied by one of the engineers from the Standard Oil Development Co., were sent to the Pacific in June, 1945, but they arrived too late for action."

Endorsement (2) from Dr. H.M. Chadwell, Chief, Division 11 to Dr. Irvin Stewart, Executive Secretary of the National Defense Research Committee.

Forwarding report and concurring.

This is a progress report under Contract OEMsr-390 (11-270) with the Standard Oil Development Co.

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Division 11
NATIONAL DEFENSE RESEARCH COMMITTEE
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OFFICE OF SCIENTIFIC RESEARCH AND DEVELOPMENT

M5-4(E12-7R1) MECHANIZED FLAME THROWER INSTALLED IN M4A1 OR M4A3 MEDIUM TANKS

by

Standard Oil Development Co.

Report OSRD No. 6350
Copy No. 22
Date: October 31, 1945

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STANDARD OIL DEVELOPMENT COMPANY
Elizabeth, N. J.

M5-4 (E12-7R1) MECHANIZED FLAME THROWER

INSTALLED IN M4A1 OR M4A3

MEDIUM TANKS

S.O.D. Projects 31472 and 31720
O.S.R.D. Contract OEMsr-390
Final Report PDN 4025
October 31, 1945

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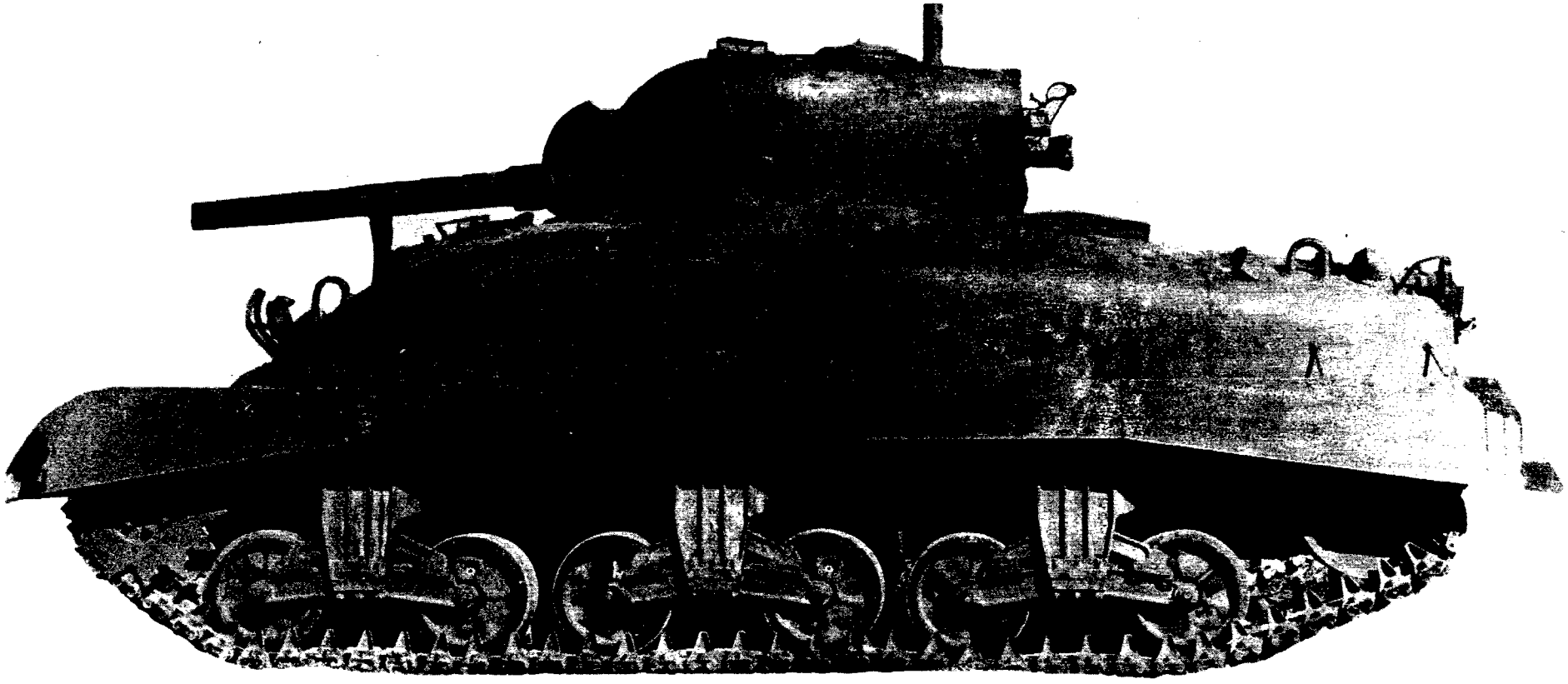

FIG. 1 M5-4 (E12-7R1) FLAME THROWER IN M4A1 MEDIUM TANK

I. SUMMARY

Under contract OEMsr-390 and at the request of Chemical Warfare Service, the Standard Oil Development Company undertook the development and design of the Mechanized Flame Thrower E12-7R1 which was later standardized as the M5-4. Much of the development work had been completed in the design of the earlier Model Q prototype, the Navy Mark 1, the E7-7 (M5A1 light tank), and the E7-LVT-A1 (amphibious tank) units, but additional improvements were developed and tested under the M5-4 assignment. Acting as engineering consultants for Chemical Warfare Service, and with the guidance and cooperation of Chemical Warfare Service-Technical Division, Headquarters A.S.F., and the New Developments Division, the assignment was carried out in close cooperation with the C.W.S. prime contractor, the M. W. Kellogg Company, and their subcontractor, the Lecourtenay Company. Initiated in August, 1944, this assignment also included the inspection and testing of the first twenty units, which were completed in May, 1945, establishing inspection procedures for large scale production, training of two U. S. Army instructor teams, issuing operating and maintenance manuals, and providing a field consultant under O.F.S. in the theater of operations.

The M5-4 design included the E7R1 flame gun (improved "Model Q" with interchangeable 1/2" and 3/4" bore nozzles) replacing the 75 mm. cannon in M4A1 or M4A3 medium tanks, with pressure containers in turret and hull providing for 270 gallons effective capacity of thickened fuel and storage of 2000 p.s.i.g. propellant air or inert gas. In silhouette the M5-4 appears as a standard medium tank equipped with a 75 mm. gun and normal auxiliary armament.

Cessation of hostilities reduced production to a total of approximately 150 units and precluded combat testing of M5-4 flame thrower tanks, although several units had been shipped to the Pacific Theater for training and combat operations.

Characteristics of the M5-4 are summarized as follows:

Vehicle	M4A1 or M4A3 Medium Tank*
Silhouette	Unchanged
Flame Gun (E7R1)	Replaces 75 mm. cannon in turret
Nozzles	1/2" or 3/4" bore - interchangeable

---

* Restricted to those models providing dry 75 mm. ammunition stowage.

Rate of Fire	2.2 gals./sec. (1/2" nozzle) 4.4 gals./sec. (3/4" nozzle)
Elevation	-12° to +25° (double original 75 mm. elevation speed)
Traverse	360°+ (Power or Manual)
Effective Fuel Capacity	270 gals.
Operating Pressure	375-400 p.s.i.g.
Total Firing Time	125 secs. (1/2" nozzle) 63 secs. (3/4" nozzle)
Fuel Propellant	Compressed air or nitrogen (11.5 cu.ft. at 2000 p.s.i.g.)
Ignition	Gasoline-Electric
Crew	2 - Turret 2 - Hull

Typical Range Data* (8% Napalm Thickened Gasoline)

Nil Wind	10° Elevation	20° Elevation
1/2" nozzle	95 yards	105 yards
3/4" nozzle	105 yards	125 yards
10 MPH Tail Wind		
1/2" nozzle	110 yards	125 yards
3/4" nozzle	125 yards	150 yards

* Measured from flame gun to center of ground deposit.

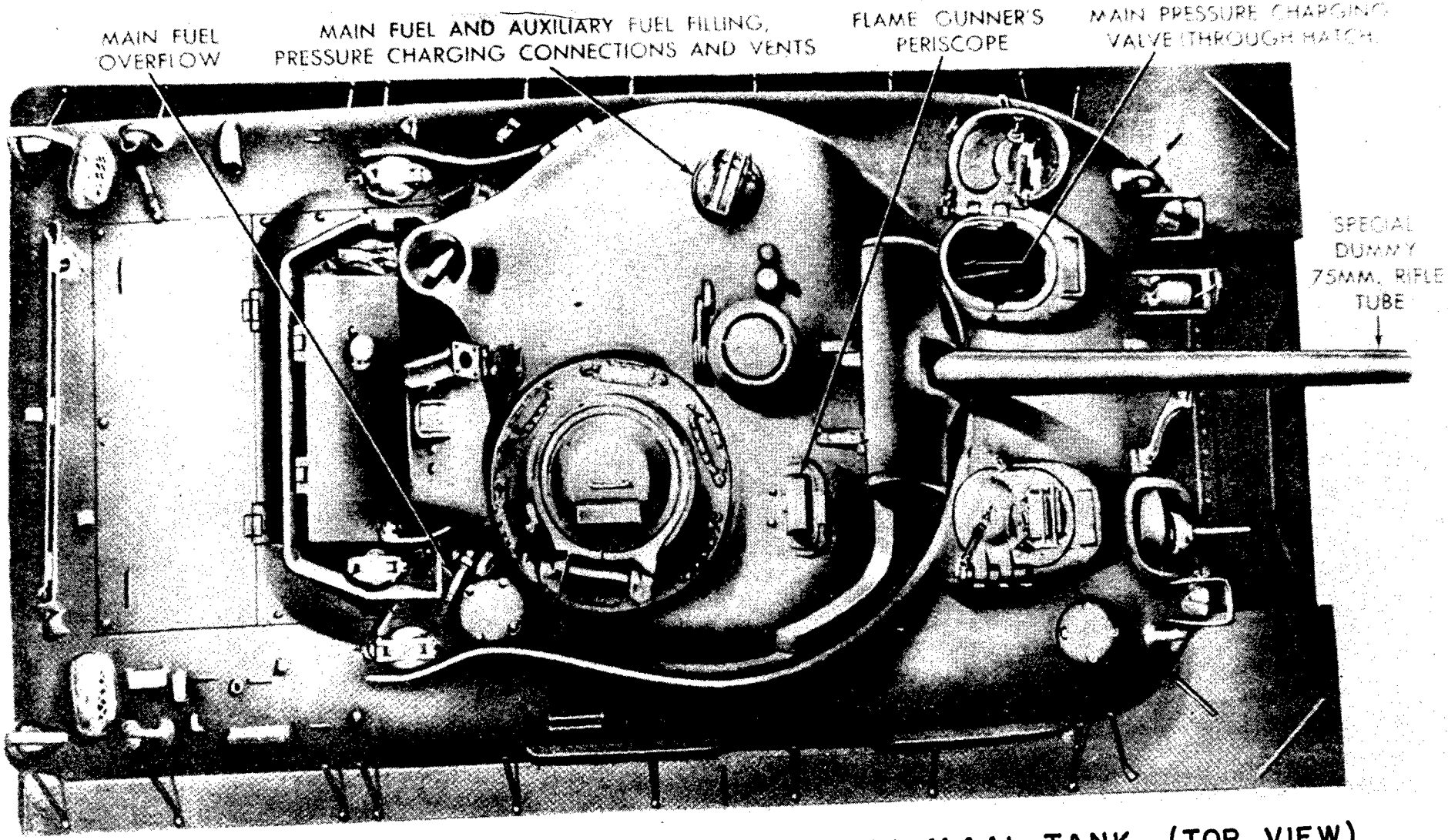

FIG. 2 M5-4 (E12-7R1) FLAME THROWER IN M4A1 TANK (TOP VIEW)

II. INTRODUCTION

Prior to 1944, application of flame throwers in combat by the U. S. Armed Forces was generally confined to the use of short-range, low-capacity portable units employed directly by ground troops or by improvised installation in available armored vehicles.

Following experimental and development work on large capacity, long-range flame throwers carried out under Contract OEMsr-390 in 1942, the Standard Oil Development Company by early 1943 had completed and demonstrated* to the military the "Model Q" (E7) flame gun designed for use with thickened fuels in mechanized vehicular installations. The first production model of this gun was completed in July, installed in an M5A1 light tank, and demonstrated in November, 1943. Three additional M5A1 installations were completed by late 1944 and successfully combat tested in Luzon, Philippine Islands in April, 1945**. Further work on this installation was abandoned because of obsolescence of the vehicle.

In early 1944, thirty-one large flame thrower units, designated U.S.N. Mark 1, were built for the U. S. Navy using this basic design***. These flame throwers were equipped with the "Model Q" guns and designed for use in small landing boats. The units were successfully employed in amphibious tanks in land combat on Peleliu Island (September-October, 1944).

Experience gained with the above units and combat operations with improvised flame throwers built and operated in the Pacific emphasized the important need for long-range, large capacity, heavily armored vehicular flame throwers in both mop-up and offensive operations. Use of the British "Crocodile" in the European Theater also proved the value of the large mechanized flame thrower in combat.

---

* PDN 1158, "Mobile Flame Thrower Model Q," April 6, 1943
** PDN 3925, "Development and Field Use of E7-7 Mechanized Flame Thrower Installed in M5A1 Light Tank," September 12, 1945
*** PDN 2290, "Demonstration of U. S. Navy Mark 1 Flame Thrower," March 24, 1944.

Hence, in August, 1944, the Army Ground Forces and C.W.S. requested construction of twenty medium tank flame throwers to be used for service and combat testing as a basis for extended production. This limited procurement comprised the M5-4 (E12-7R1) mechanized flame thrower installed in M4A1 medium tanks*. Successful service testing (March, 1945) of the first completed unit by the military in this country led to an extended order** for 600 M5-4 installations in M4A1 or M4A3 medium tanks, curtailed to approximately 150 units for training purposes following V-J Day. Cessation of hostilities precluded combat testing in either the European or Pacific Theaters.

Under Contract OEMsr-390, the Standard Oil Development Company acted as engineering consultants for the Chemical Warfare Service in the design and development of the M5-4 mechanized flame thrower through limited and extended procurement. The assignment was carried out over the period August, 1944 - October, 1945, with the guidance and cooperation of Chemical Warfare Service-Technical Division, Headquarters A.S.F., and the New Developments Division. Extended in close cooperation with the C.W.S. prime contractor, the M. W. Kellogg Company, and their subcontractor, the Lecourtenay Company, the assignment included design and development, the inspection and testing of the first twenty units, establishing inspection and test procedures for large scale production, training of two U. S. Army instructor teams, issuing operating and maintenance manuals***, and providing a field consultant under O.F.S. in the theater of operations.

The M5-4 medium tank flame thrower system included an E7R1 (improved Model Q) flame gun replacing the 75 mm. turret cannon, with pressure vessels in hull and turret basket sufficient to fire 270 gallons of fuel with the necessary 2000 p.s.i.g. compressed air, nitrogen, or inert gas propellant. Externally, the M5-4 flame thrower is identical in appearance with a standard M4A1 or M4A3 medium tank equipped with a 75 mm. gun.

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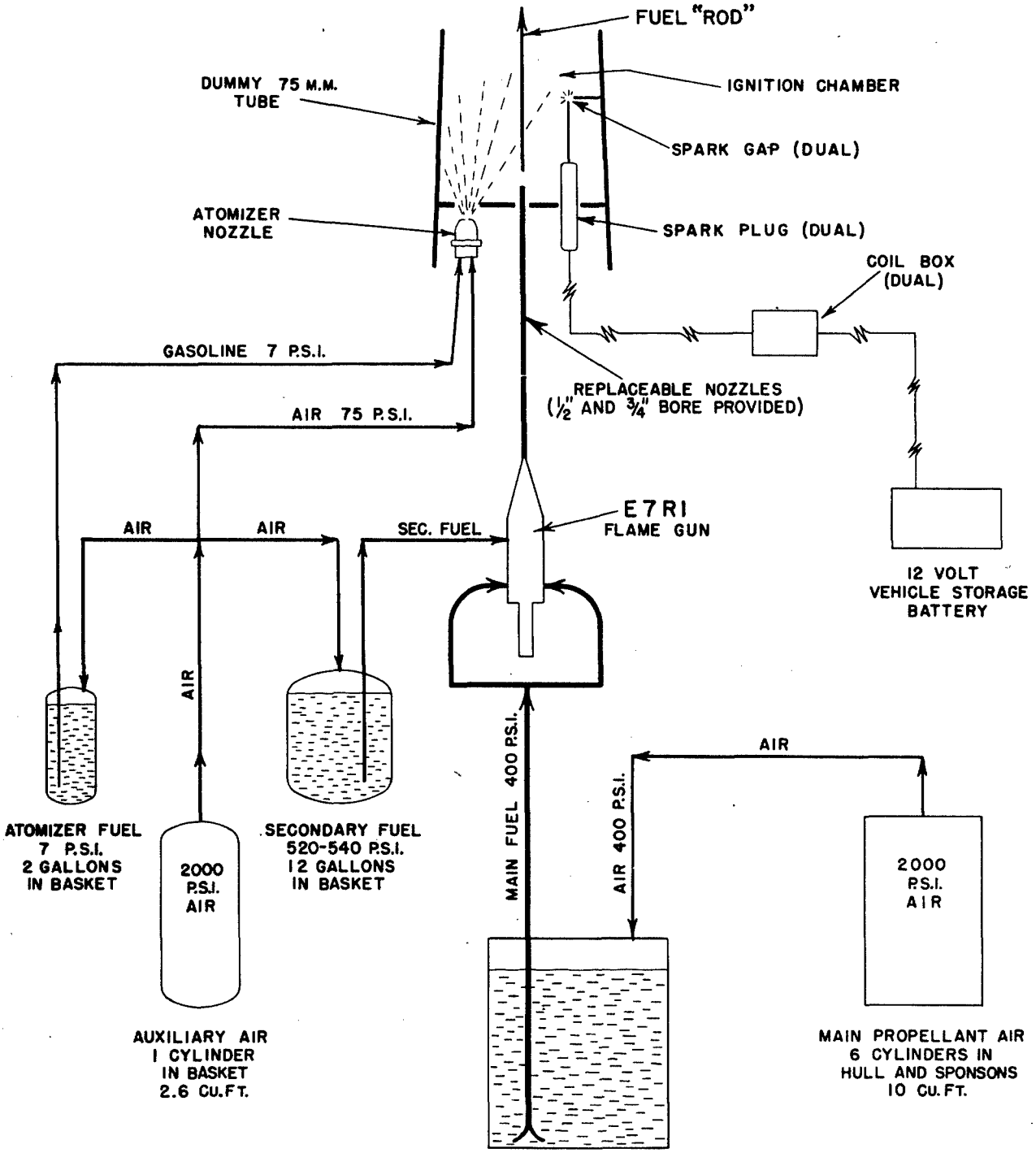
* PDN 2936, "Flame Thrower, Mechanized, E12-7R1," September 28, 1944.

** PDN 3265, "Mechanized Flame Throwers-E12-7R1, Servicing Units-E8, Suggested Responsibilities for Extended Orders," January 11, 1945.

*** PDN 3450, "Flame Thrower, Mechanized, E12-7R1, April 16, 1945. Assistance rendered C.W.S. in preparation of War Department TM 3-360, "Flame Thrower, Mechanized, E12-7R1," July 20, 1945.



NOTES:-

(1) PRESSURE TO FUEL VESSELS AND ATOMIZER NOZZLE CONTROLLED AUTOMATICALLY BY AIR REGULATORS.

(2) IGNITION CONTROLLED BY FLAME GUNNER'S LEFT FOOT PEDAL.

(3) FUEL FIRING INCLUDING SECONDARY FUEL CONTROLLED BY FLAME GUNNER'S RIGHT FOOT BUTTON (ELEC.).

(4) FLAME GUN ACTUATED BY AIR FROM AUXILIARY AIR CYLINDER IN BASKET.

FIG. 3 SIMPLIFIED FLOW PLAN M5-4 FLAME THROWER SYSTEM

III. DESCRIPTIVE DATA

A. E7R1 Flame Gun

1. Nozzle Diameters (interchangeable extensions)	1/2 in. or 3/4 in. bore
2. Nozzle Pressure (operating)	325 to 350 p.s.i.g. (approximate)
3. Nozzle Velocities (fuel flow rate)	a) 1/2" nozzle- 215 ft./sec. b) 3/4" nozzle- 190 ft./sec.
4. Elevation (twice normal elevating speed in medium tank)	-12° to +25° (gyro stabilizer removed)
5. Traverse (standard power or manual)	360°+
6. External Silhouette (in dummy gun tube)	Same as displaced 75 mm. gun

B. Main Fuel System

1. No. of Main Fuel Containers	3 (piped in series - 2 in hull, 1 in turret)
2. Gross Capacity (including expansion space or void)	290 gallons
3. Maximum Fuel Capacity (allowing 5% expansion space or void)	275 gallons
4. Effective Discharge Capacity	270 gallons (1,700 lbs. of thickened fuel)
5. Main Pressure Regulator Setting	375-400 p.s.i.g.
6. Operating Pressure (main regulator discharge)	360-390 p.s.i.g.
7. Rate of Fuel Discharge	a) 1/2" nozzle - 2.2 gals./sec. b) 3/4" nozzle - 4.4 gals./sec.

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8. Total Firing Time	1/2" nozzle-125 secs. 3/4" nozzle-63 secs.
9. Firing Controls (on basket floor in front of flame gunner)	a) Main fuel firing button (right foot electrical switch) b) Emergency fuel firing pedal (right foot manual control)

C. Secondary Fuel System

1. No. of Fuel Containers	1
2. Gross Capacity (Gasoline)	12 gallons
3. Operating Pressure	520-540 p.s.i.g.
4. Discharge Rate	Approx. 300 cc./sec.
5. Firing Controls	Identical with main fuel firing controls-simultaneous operation

D. Main Air System* (Hull)

1. No. of Pressure Containers	6 (interconnected in series-parallel)
2. Total Capacity	10 cu.ft.
3. Starting Pressure	2000 p.s.i.g.
4. Final Pressure (after firing complete main fuel load)	400-500 p.s.i.g.

E. Auxiliary Air System* (Turret)

1. No. of Pressure Containers	1
2. Capacity	a) 2.6 cu.ft.(earlier models) b) 1.5 cu.ft.(later models)
3. Starting Pressure	2000 p.s.i.g.
4. Final Pressure (after firing complete main fuel load)	1000-1400 p.s.i.g.

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* Compressed air, nitrogen or inert gas can be employed.

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F. Flame Thrower Ignition System

1. Type	Air-atomized gasoline ignited by dual high tension spark.
2. Fuel Ejection	Atomizer Nozzle
3. No. of Fuel Containers	1 (in turret)
4. Capacity (gasoline)	2 gallons
5. Power Supply	12 volts D.C. (one of the vehicle storage batteries)
6. Electrical Discharge delivered to Spark Gaps	12,000 volts A.C.
7. No. of Spark Coils	2
8. No. of Spark Plugs	2
9. Gasoline Operating Pressure	Approx. 7 p.s.i.g.
10. Air* Operating Pressure	70-80 p.s.i.g.
11. Gasoline Operating Rate	1.5 to 3 cc./sec.
12. Operating Control (on basket floor in front of flame gunner)	Left foot pedal

G. Vehicle

1. Armament	a) 1 E7R1 flame gun replacing 75 mm. cannon b) 1 coaxial .30 cal. turret machine gun** c) 1 bow .30 cal. machine gun d) 1 .50 cal. A.A. machine gun
2. Total Crew	4
a) Turret (right side only)	Tank Commander, Gunner
b) Hull	Driver, Assistant Driver

---

* Air, nitrogen or inert gas may be employed.
** Fired electrically by foot button adjacent to flame gun ignition pedal.

H. Sighting Equipment

1. For E7R1 Flame Gun	a) Wide-angle periscope with special scaling and adjustable peep sight b) Special sliding periscope link for use with (a). c) Vision cupola (to facilitate coaching flame gunner on target by tank commander)
2. For Coaxial .30 cal. Turret Machine Gun	Standard coaxial telescope, or gunner's periscope as above.

I. Communication Equipment

1. Standard Communication	SCR-528 Radio (4 interphone positions)
2. Communication with Adjacent Ground Troops	a) AN/VRC-3 radio b) External interphone RC-298

J. Firing Extinguishing Equipment

1. For Flame Thrower Installation	
a) In left sponson (internal and external pulls)	Three 10-lb. CO_2 cylinders discharging into fighting compartment.
b) In turret	One 4-lb. CO_2 cylinder for flame gun muzzle fires. One 2-lb. CO_2 portable cylinder.
2. For Vehicle in General	
a) In left sponson (internal and external pulls)	One 10-lb. CO_2 cylinder discharging into engine compartment
b) In assistant driver's compartment	One 4-lb. CO_2 portable cylinder

K. Miscellaneous

1. Turret Traverse Controls	Standard electrical or hydraulic; standard emergency manual. (360° unlimited turret traverse)

2. Flame Thrower Main, Atomizer (igniter), and Secondary Fuel Filling and Auxiliary Air Charging Connections	External, left turret roof (camouflaged under dummy periscope plate and cover).
3. Main Air Charging Inlet	Inside hull to left rear of driver.
4. Special Dummy 75 mm. Rifle Tube (external housing for E7R1 flame gun)	1/2" armor plate
5. Turret Front Shield	Standard for M34-A1 75 mm. gun mount.

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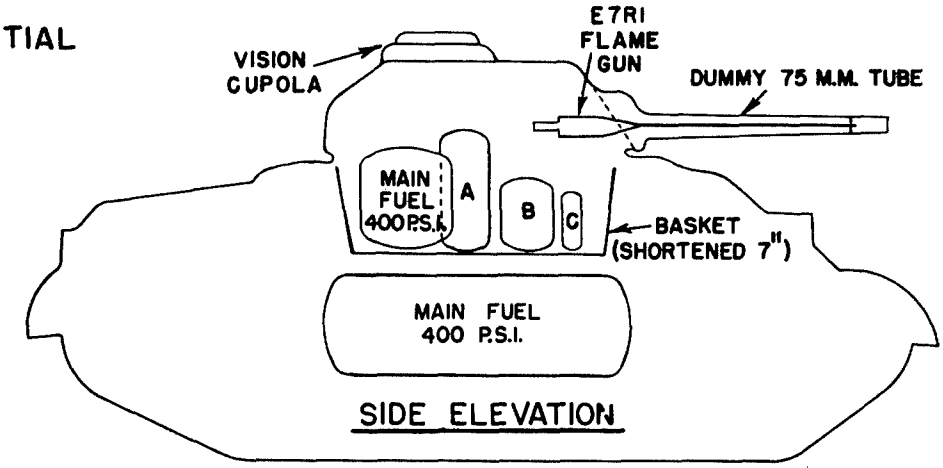
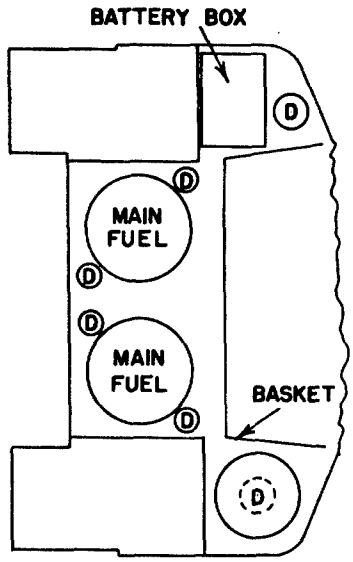
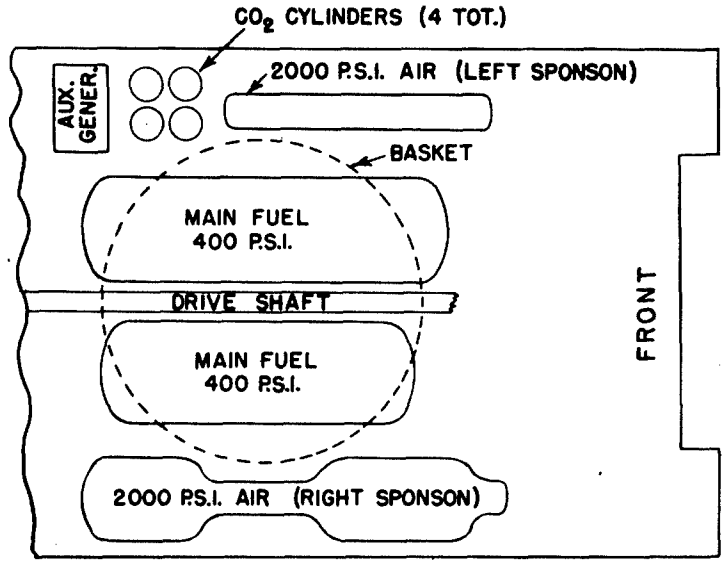


SIDE ELEVATION

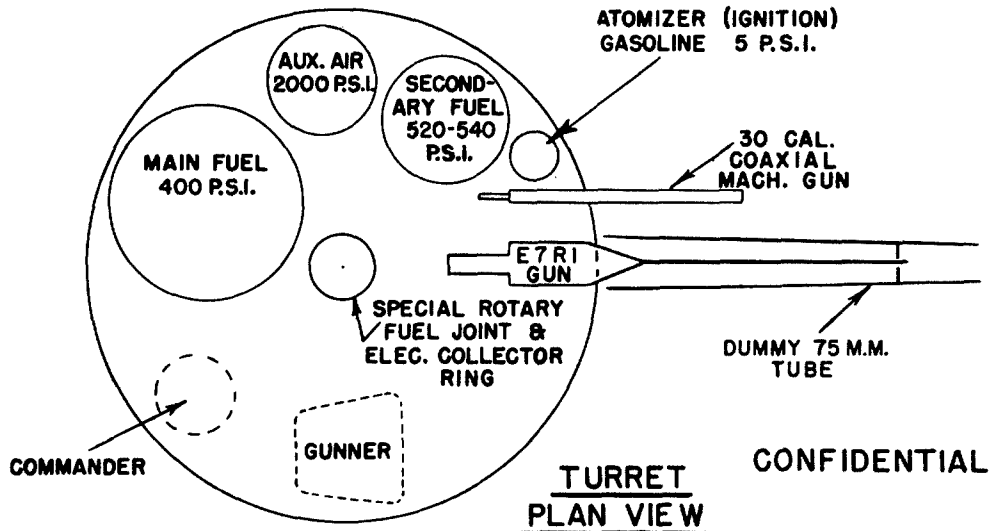
NOTE
(A = 2000 P.S.I. AIR FOR FLAME GUN AUXILIARIES IN BASKET
(B = SECONDARY FUEL FOR FLAME GUN
(C = ATOMIZER GASOLINE FOR IGNITER
(D = 2000 P.S.I. AIR CYLINDERS IN HULL OR SPONSONS



REAR ELEVATION



PLAN VIEW



TURRET PLAN VIEW

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FIG. 4. SCHEMATIC LAYOUT
M5-4 FLAME THROWER IN M4A1 OR M4A3 TANK

IV. DESCRIPTION

The M5-4 flame thrower unit consists of an E7R1 flame gun (improved Model Q) installed in an armored dummy tube replacing the 75 mm. gun in the turret, and the E12 fuel and pressure unit mounted in the hull and turret basket of an M4A1 or M4A3 medium tank as shown in Figure 4. Flame thrower fuel is ejected by compressed air, inert gas, or nitrogen. A simplified flow plan of the flame thrower system, Figure 3, is detailed in Appendix Figure B.

A. Modifications to M4A1 or M4A3 Medium Tank

1. Gun

The 75 mm. cannon, gun mount, and counterweight were replaced by the E7R1 flame gun, dummy gun tube, and special rotor mount and counterweight. The gyro stabilizer was eliminated. The standard turret shield (for M34A1 gun mount) and accommodations for mounting the coaxial .30 cal. machine gun and telescope were retained.

2. Turret

A special basket, shortened 7 inches to accommodate the flame thrower system in the hull, was installed to support four pressure vessels and other essential flame thrower equipment and personnel in the turret. The turret gun loader was eliminated, but original space for turret gunner and tank commander in the right basket area was retained. Turret stowage and wiring were altered to accommodate the flame thrower system. The gun elevation handwheel was provided with a special gear adapter to double elevating speed. A special periscope link, spring, and peepsight were installed on the gunner's periscope to facilitate sighting and aiming the flame gun. External charging connections for main fuel and auxiliary fuel and air were installed under the left turret roof periscope plate and cover.

Each turret was equipped with a standard vision cupola for improved vision and an AN-VRC-3 radio for communication with ground troops.

3. Hull

Stowage and wiring were rearranged in the hull to accommodate the flame thrower system. Only vehicles originally equipped for dry stowage of 75 mm. ammunition were employed. Batteries were moved from the hull floor to a special box in the left sponson. Remaining hull stowage under the basket was removed. Floor mounted main generators were relocated over the forward drive shaft, and voltage regulators shifted to the left

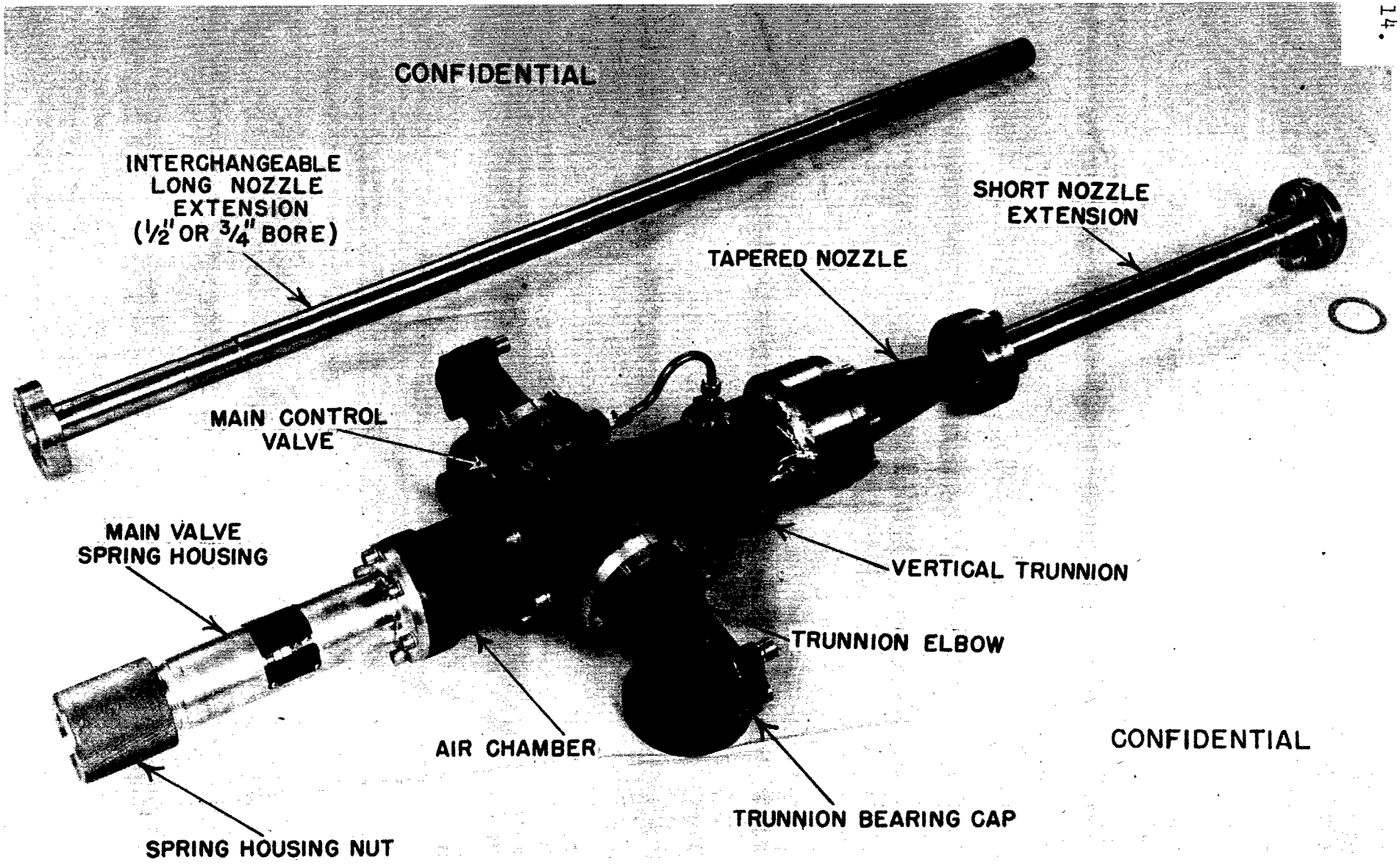

FIG. 5 E7R1 FLAME GUN

sponson as necessary. The CO_2 fire extinguisher cylinders were moved to the left sponson and extra cylinders and discharge horns provided for either engine or fighting compartment fires. Right sponson stowage was reduced and rearranged to accommodate a large propellant air cylinder. An external overflow and vent pipe from the main flame thrower fuel system was installed through the right hull roof adjacent to the rear ventilator. Pressure relief valve discharge tubes and main fuel safety relief vent were piped respectively through the right sponson and hull floors. The external rear hull blanket rack was relocated in a higher position. A ground stake and cable for static electric discharge during servicing operations was installed on the left rear of the vehicle. An external interphone (RC-298) was installed on the right rear hull for direct infantry communication.

B. Flame Gun and Controls*

The E7R1 flame gun is remote-controlled, equipped with a fast-acting internal valve which is opened by air pressure and closed by spring action (Figure 5 and Appendix Figure B). The gun is designed primarily for use with thickened fuels, although liquid fuels can be employed. An internal perforated cylinder feeds a coating of secondary fuel (unthickened, motor gasoline) around the main fuel prior to ejection of the fuel rod from the gun nozzle, improving ignition and range of thickened fuels fired under adverse wind and cold weather conditions. Both 1/2" and 3/4" bore extended, interchangeable gun nozzles are provided to permit variation in flame thrower range, firing time, and firepower.

The flame gun is fired by depression of a right foot button switch in front of the turret gunner, which actuates a solenoid-operated air valve opening the internal fuel valve in the weapon. Secondary fuel is simultaneously released around the main fuel flowing through the gun. An emergency foot pedal can also be used to actuate the gun in case of solenoid or local electrical failure. The standard elevation handwheel with special gear adapter permits elevation or depression of the flame gun at twice the normal elevation speed of the medium tank main armament. Traverse of the flame gun is accomplished through the normal power or emergency manual hand traverse control in front of the gunner, the flame gun traversing 360° with the turret.

C. Main Fuel System

Main fuel for the flame gun is carried in three pressure vessels connected in series as shown in Figure 6. Two

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* For operation, see War Department Technical Manual TM3-360, July 20, 1945, "Flame Thrower, Mechanized, E12-7R1."

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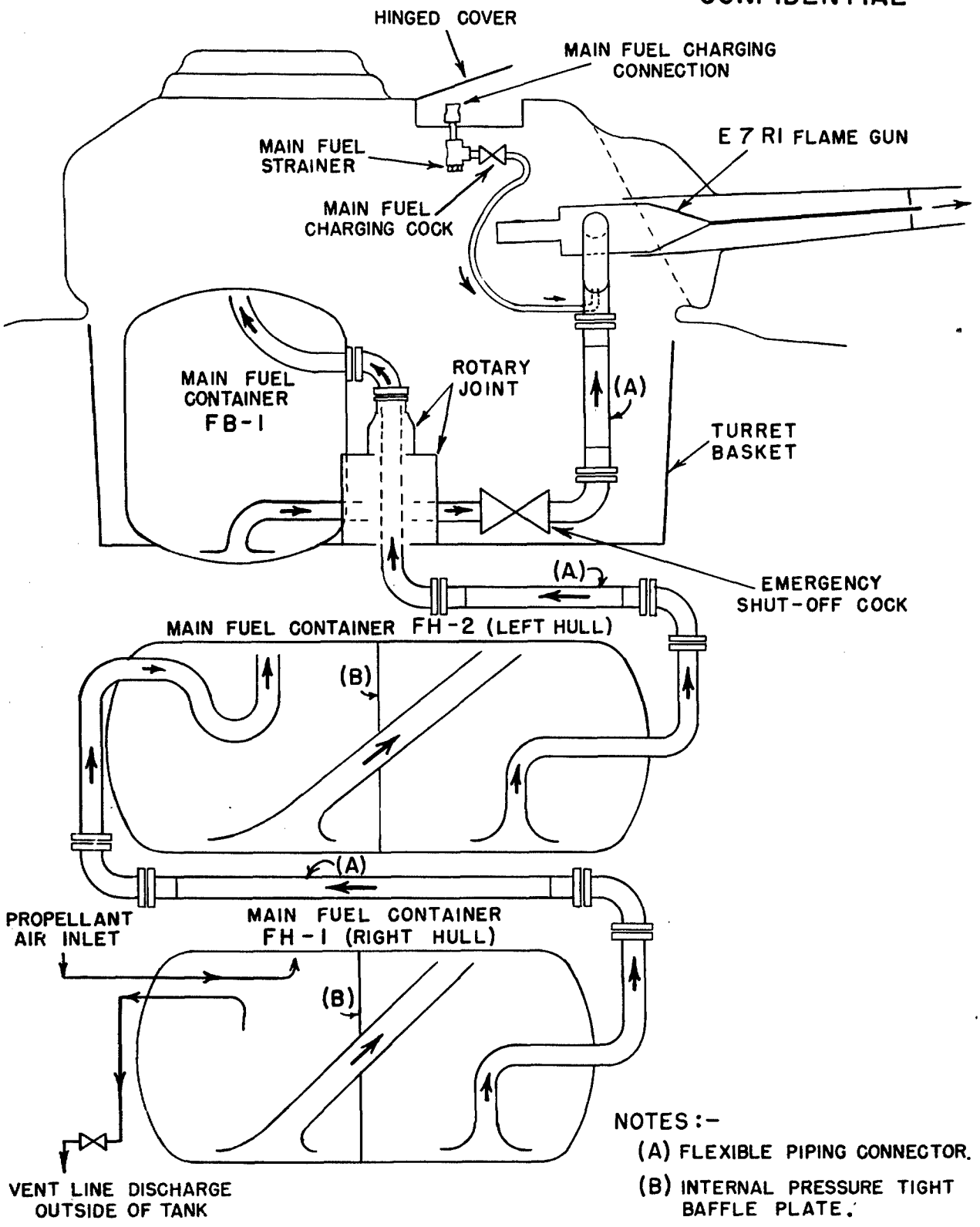

FIG. 6 SCHEMATIC FLOW DIAGRAM MAIN FUEL SYSTEM

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horizontal cylindrical containers in the hull act as essentially four series-connected vertical vessels because of internal baffles installed to assure maximum fuel outage regardless of vehicle position. Through a special rotary joint in the turret basket floor, the hull fuel containers are connected to a vertical cylindrical vessel in the basket, discharge from which is piped to the flame gun. Fuel enters the gun at diametrically opposite points through two rotary joint elbows supported at the turret trunnion axis.

Fuel (275 gals.) is charged to this system through a filling inlet in the left turret roof, until the last fuel container in series in the hull overflows through piping and a temporary hose over the right side of the hull. This overflow line extends into the right hull fuel container sufficiently to create a void space for possible subsequent fuel expansion.

D. Main Air System

Propellant air, inert gas, or nitrogen for the main fuel is stored in the hull at 2000 p.s.i.g. pressure in six interconnected horizontal cylinders, one in each sponson, and four adjacent to the two hull fuel containers (see Figure 4). This pressure storage is directed through an adjustable automatic pressure regulator to the top of the right hull fuel container, forcing fuel through the main system and flame gun when the weapon is actuated. Sufficient air storage (10 cu.ft.) is provided in the hull to maintain fuel operating pressure of 375 to 400 p.s.i.g. on main fuel when initially charged to 1800-2000 p.s.i.g.

Propellant gas is charged to the main air system through a valved connecting line inside the driver's hatch.

E. Secondary and Atomizer Fuel Systems

Secondary and atomizer (ignition) fuel, ordinary unthickened motor gasoline, are carried in separate vertical cylindrical pressure vessels located forward in the left half of the basket (Figure 4).

Secondary fuel flows by air or nitrogen pressure through the E7R1 main control valve into the flame gun when the main fuel valve in the weapon is actuated. Secondary fuel (12 gals.) is charged to the container through a protected external connection adjacent to the main fuel filling inlet in the left turret roof. An overflow vent adjacent to the filler connection and extending into the secondary fuel container assures a void for possible fuel expansion when the container is charged.

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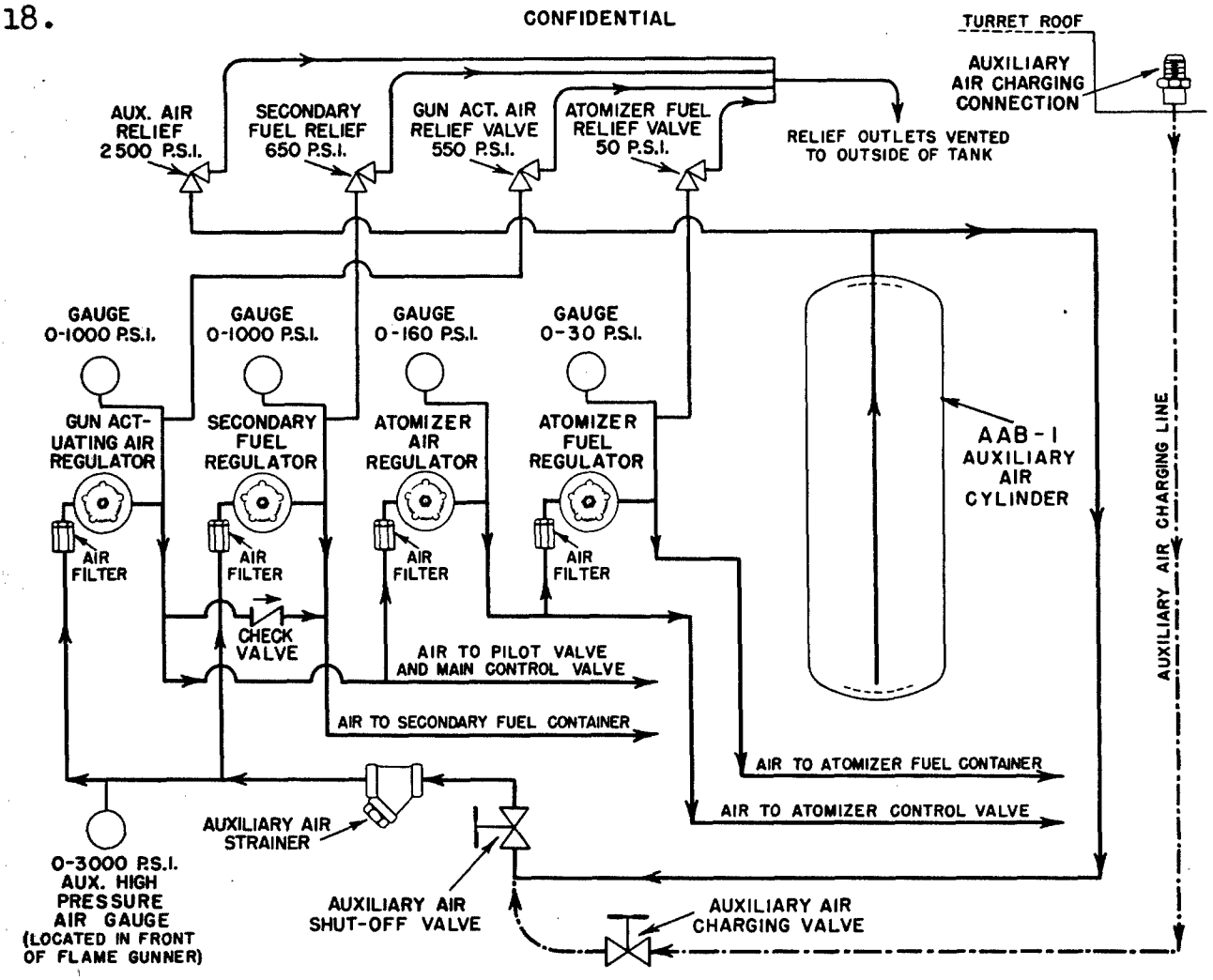

FIG. 7 AUXILIARY AIR PRESSURE REGULATING SYSTEM

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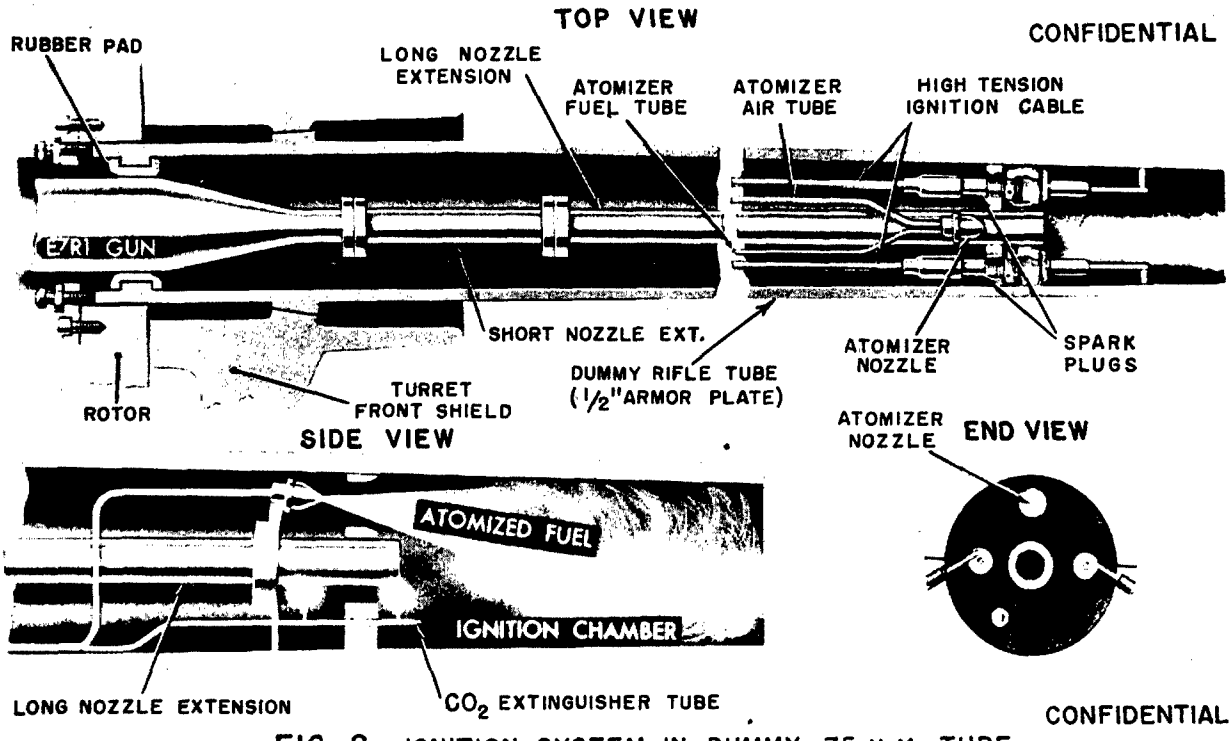

FIG. 8 IGNITION SYSTEM IN DUMMY 75 M.M. TUBE

Propelled by compressed air, inert gas, or nitrogen, atomizer fuel flows through the atomizer gasoline valve into the atomizer nozzle in the forward end of the dummy gun tube when the ignition pedal is depressed by the flame gunner. In the atomizer nozzle, the fuel is mixed with pressured air and expelled as an atomized spray into the ignition chamber forward of the flame gun nozzle exit. Separate external filling and vent connections for the atomizer fuel container (2 gals.) are similar and adjacent to those for secondary fuel in the turret roof.

F. Auxiliary Air System

Auxiliary air or nitrogen (1.5 cu.ft. for later units, 2.5 cu.ft. for earlier units) is stored at 2000 p.s.i.g. in a vertical cylindrical container adjacent to the main fuel vessel in the left turret basket (Figure 4). This vessel is segregated from the hull main air system to avoid complication of a high pressure slip ring between hull and turret for unlimited turret traverse. Pressure from this container is supplied through separate adjustable, automatic, pressure regulators to flow secondary and atomizer fuels, to actuate the flame gun, and to atomize igniter fuel (Figure 7). Auxiliary air to the atomizer nozzle is released simultaneously with atomizer fuel upon actuation of the atomizer valve, a dual valve operated by the ignition foot pedal. The auxiliary pressure container is charged or vented through an external fitting in the turret roof adjacent to the main fuel filling inlet.

G. Ignition System

Ignition of the main fuel rod ejected from the flame gun nozzle is initiated by actuation of the gunner's left foot pedal prior to depression of the fuel firing button. The ignition pedal operates the atomizer valve and simultaneously closes an electrical switch which sends 12 volt D.C., obtained from one of the vehicle storage batteries, to two special coil boxes located under the forward turret roof. Each coil box independently feeds 12,000 volts A.C. to one of two special spark plugs positioned in the ignition chamber at the muzzle end of the dummy gun tube (Figure 8). The air-atomized gasoline spray released into the ignition chamber by actuation of the atomizer valve surrounds and is ignited by the dual spark plugs with grounded electrodes on the dummy tube walls. As long as the ignition pedal is fully depressed, the resulting flame persists as a blow torch through which must pass the main fuel rod (coated with secondary fuel) ejected by the flame gun.

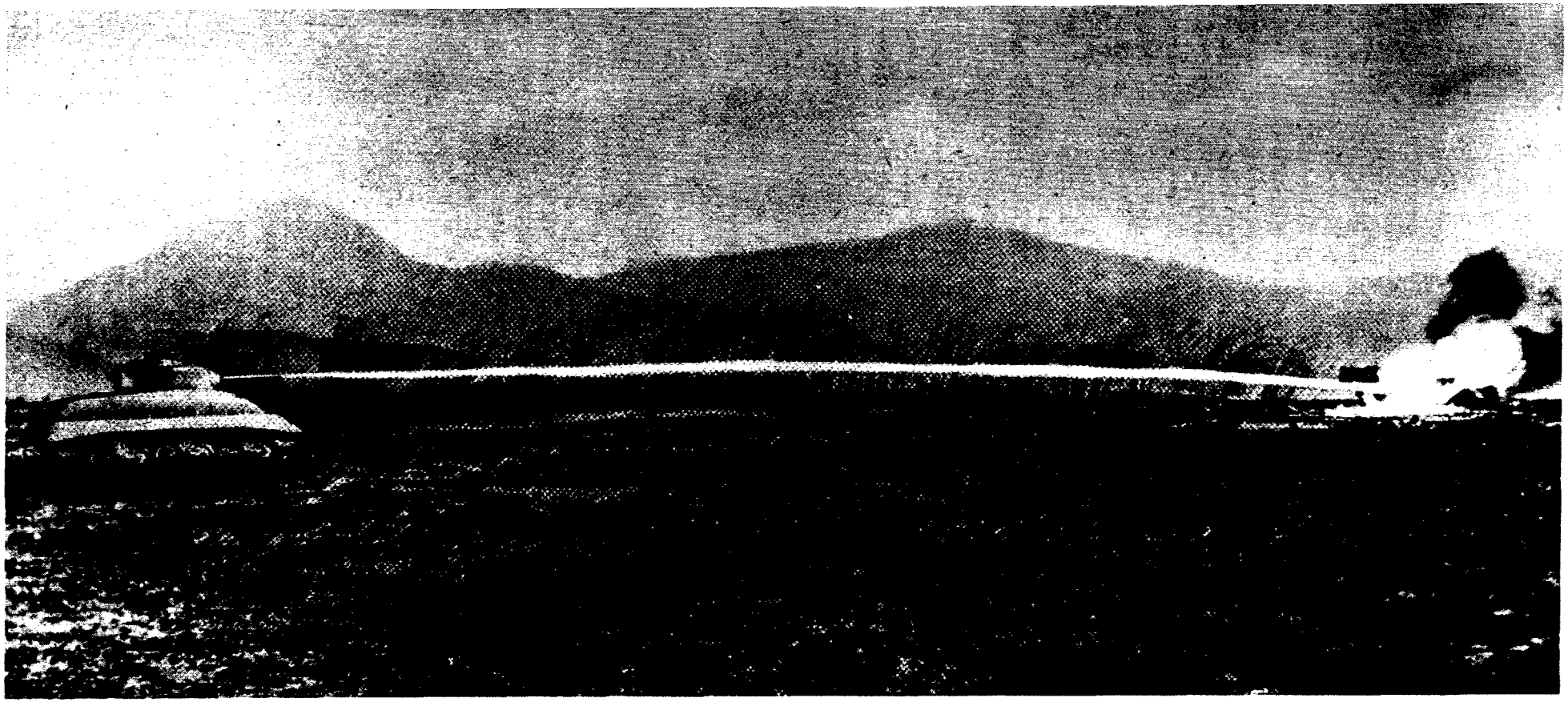

FIG. 9 M5-4 FIRING 8% NAPALM-THICKENED FUEL
(65 YARDS TO TARGET)

V. PERFORMANCE

As a large capacity, long-range, main-armament mechanized flame thrower, the M5-4 unit is designed principally to fire gasoline fuels thickened with up to 10% by weight of Napalm. Fuel thickened with 6 to 8% Napalm is generally employed for optimum combined performance and serviceability (Figure 9). Liquid, unthickened fuels can also be used, although at very appreciable sacrifice in range, aimability, and burning time on the target. Use of unthickened fuel leaves from approximately 1 pint to 1 quart of residual fuel in the extended nozzle downstream of the E7R1 internal fuel valve. The main fuel rod is ejected by the E7R1 flame gun with a coating of secondary fuel (gasoline) to improve thickened fuel ignition and range under adverse wind and weather conditions.

The unit is capable of ejecting a total of 270-275 gallons of thickened fuel at approximately 2.2 gals./sec. for 125 seconds with 1/2" bore nozzle, or 4.4 gals./sec. for a total of about 63 seconds with a 3/4" nozzle. These nozzles are interchangeable between missions.

The flame gun is operated by the turret gunner using foot controls, freeing his hands for (1) handwheel elevation of the weapon and coaxial .30 caliber machine gun through -10° to +25° at double normal elevating speed, and (2) unlimited standard power or manual traverse of these guns and turret through 360°. Either rapid (1/2 to 1 second bursts) or prolonged fire is permitted with the E7R1 gun. Ignited or unignited bursts can be fired. Typical average ranges measured from gun to center of ignited ground pattern on level terrain are as follows:

M5-4 MECHANIZED FLAME THROWER
FIRING 8% NAPALM-THICKENED GASOLINE, 400 P.S.I.G.
OPERATING PRESSURE, 300 CC./SEC. SECONDARY FUEL

Average Range in Yards to Center of Ground Deposit*

Nil Wind	1/2" Bore Nozzle		3/4" Bore Nozzle	
10° Elevation	-------95-------		------105-------	
20° Elevation	------105-------		------125-------	
5 MPH Wind	**Tail**	**Cross**	**Tail**	**Cross**
10° Elevation	105	75	115	85
20° Elevation	115	80	140	95
10 MPH Wind	**Tail**	**Cross**	**Tail**	**Cross**
10° Elevation	110	60	125	65
20° Elevation	125	60	150	75

* Insignificant difference between average ranges of extended nozzle E7R1 and short nozzle E7 flame guns under comparable operating conditions.

FIG. 10 SERVICING M5-4 FLAME THROWER WITH MAIN FUEL & AIR USING E8R1 MOBILE SERVICE UNIT

VI. SERVICING

Prior to operation, the M5-4 flame thrower system is charged with the following:

1. Main Fuel - 275 gallons
2. Secondary Fuel - 12 gallons
3. Atomizer (Igniter) Fuel - 2 gallons
4. Main Propellant Air, Nitrogen, or Inert Gas at 2000 p.s.i.g. pressure - 10 cu.ft. (Initial charge as low as 1800 p.s.i.g. to main and auxiliary air systems is sufficient to expel full fuel load satisfactorily. Typical production units charged to 2000 p.s.i.g. retained pressure to 1800-1950 p.s.i.g. under 16 to 24 hr. test. Maximum of 2200 p.s.i.g. can be charged for extended turnaround between missions)
5. Auxiliary Propellant Air or Nitrogen at 2000 p.s.i.g. Pressure - 2.6 cu.ft. (1.5 cu.ft. on later models)

With the exception of main propellant air, external filling connections for the above are provided in a sealed well suspended beneath the M5-4 left turret roof periscope plate, which is retained as a hinged cover for camouflage and protection. The main air charging connection is located inside the hull roof, available through the driver's hatch to the left rear of the driver. Main fuel and main and auxiliary air are charged under pressure through flexible hoses provided with servicing equipment. Secondary and atomizer fuels (ordinary motor gasoline) are separately charged by hand through funnels set into the corresponding charging connections. Separate vent outlets from each fuel system act as liquid overflows which indicate full condition of corresponding containers.

Although air, inert gas, or nitrogen can be charged from pressure cylinders or from suitable compressors, and thickened main fuel from pressured barrels, such procedure for large mechanized flame throwers is generally inefficient, laborious, and time-consuming in the field. At the request of the Chemical Warfare Service, a special mechanized flame thrower service unit, E8R1*, permanently mounted on an Army

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* War Department Tech. Manual TM 3-361, "Service Unit, Mechanized Flame Thrower, E8R1," June 26, 1945; or PDN 3975, "Development of Mobile Servicing Equipment for Mechanized Flame Throwers, E8R1 Service Unit - Truck Mounted, E6 Mixer and E8 Compressor - Skid Mounted," October 18, 1945.

2-1/2 ton L.W.B. 6x6 Cargo truck was designed and developed under N.D.R.C. contract by the Standard Oil Development Company (Figure 10). This unit provides 2000 p.s.i.g. compressed air and facilities for mixing and charging thickened fuel at a rate of two M5-4 units per hour. Secondary and atomizer fuel are charged manually while the service truck is providing main fuel and compressed air.

Comparable transportable servicing equipment, separately skid-mounted Mixer E6 and Compressor E8*, were subsequently designed and developed by the Standard Oil Development Company at C.W.S.' request. These units can be loaded independently on various Army tracked or wheeled vehicles, providing field servicing equipment which frees the carriers for other use.

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* PDN 3975, "Development of Mobile Servicing Equipment for Mechanized Flame Throwers, E8R1 Service Unit - Truck Mounted, E6 Mixer and E8 Compressor - Skid Mounted," October 18, 1945.

VII. COMPARISON OF M4A1 AND M4A3 INSTALLATIONS

Under limited procurement, the first twenty M5-4 units were installed only in M4A1 medium tanks. Prior to extended production, however, the basic design was altered slightly to accommodate either M4A1 or M4A3 vehicles equipped originally for dry stowage of 75 mm. ammunition. These changes were as follows*:

1. Reduction in length of left hull fuel container to avoid interference with propeller shaft rear housing in M4A3 hull. This reduced gross main fuel capacity from 297 to 291 gallons.

2. Provision of cut-out section in turret basket floor and rim to permit removal of M4A3 engine air strainer oil baths for routine servicing. This also facilitated access to the engine oil filler pipe in the M4A1 installations.

A few minor changes in flame thrower system piping were also necessary to accommodate the M4A3 vehicles. In addition, hull electrical wiring details differed between the two units.

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* PDN 3898, "Use of M4A3 Medium Tanks for E12-7R1 Flame Thrower Installation," August 31, 1945.

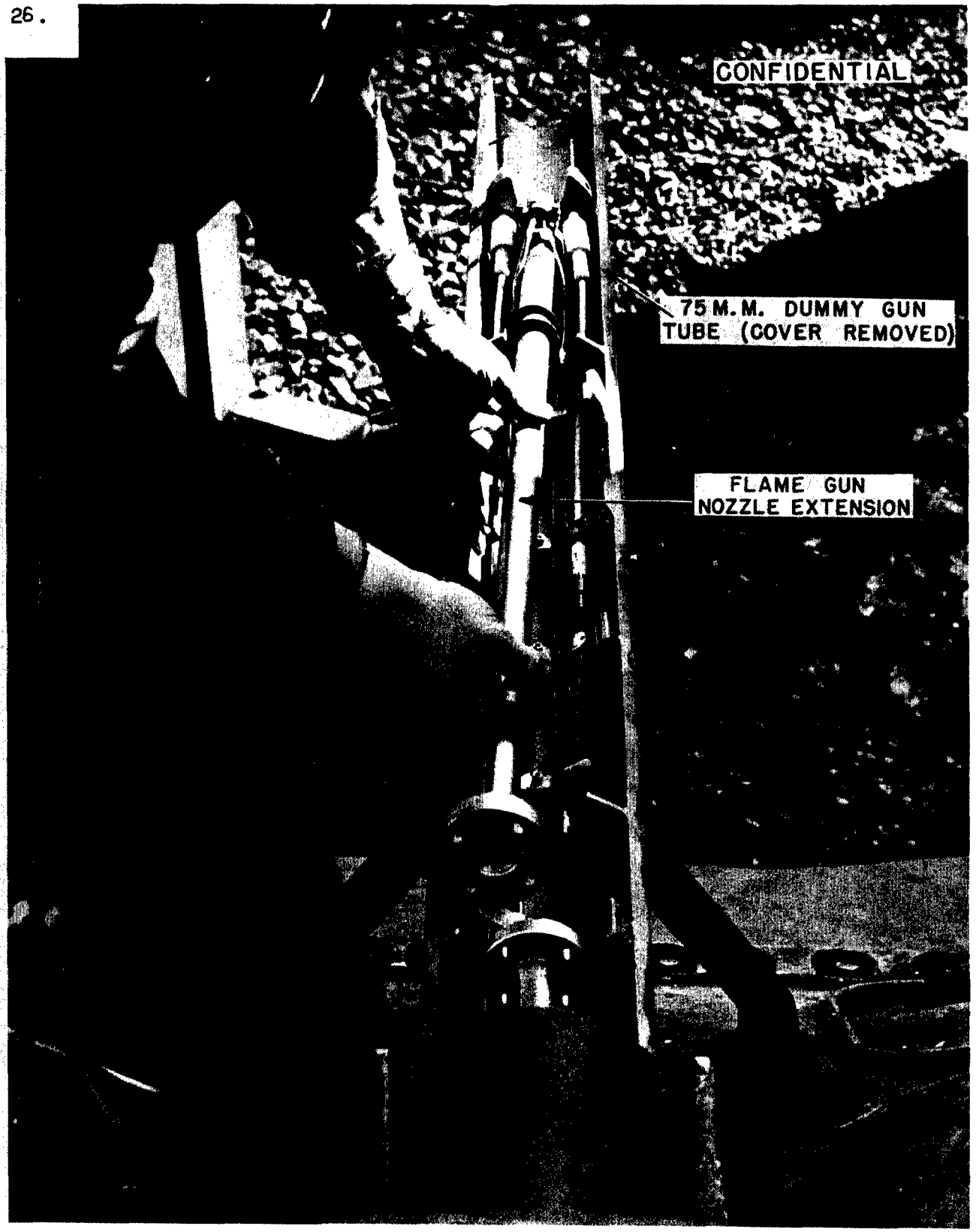

FIG. 11 E7R1 INTERCHANGEABLE NOZZLE EXTENSION

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VIII. SPECIAL DEVELOPMENTS

A. E7R1 Extended Nozzle

Inasmuch as the E7 flame gun was designed with a relatively short nozzle unsuited for use in an extended dummy gun tube simulating the 75 mm. rifle installed in medium tanks, it was necessary to carry out development work to modify the nozzle for use in the M5-4 units.

The final E7R1 nozzle design was developed by test firing through various extensions, comparing range, cutoff, and general gun performance with previous established results on the original short nozzle. Operations firing thickened fuel through a 3/4" bore extension reduced to 1/2" or 3/8" bore over only the last five inches at the nozzle outlet gave unsatisfactory cutoff with the E7 gun. (The short E7 nozzle includes a uniform bore discharge section 5" long). It was therefore necessary to make the interchangeable 3/8", 1/2", and 3/4" bore nozzles requested by the military* considerably longer (Figure 11) (approximately 43" overall) than was originally hoped. Final E7R1 nozzle design facilitates interchangeability in the dummy gun tube and assures satisfactory operation using various nozzle bores with thickened or unthickened fuel. Average results with the extended nozzles did not differ significantly from range and performance established with the original short nozzle under similar conditions**.

B. Rotary Joint

The special rotary joint used in the M5-4 units to carry main fuel and multiple electrical circuits from the vehicle hull to the basket through 360° unlimited turret rotation was designed by the M. W. Kellogg Company in collaboration with the Standard Oil Development Company (Figure 12). This joint provides for a central fuel passage surrounded by a slightly modified standard medium tank electrical collector ring and a lubricated ball bearing guide. The liquid pressure seal between moving members is maintained by a single synthetic rubber "O" ring. A special oil bath was constructed around the electrical collector ring assembly to minimize possible sparking inside the vehicle should gasoline vapors be present.

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* The 3/8" bore nozzle was eliminated for extended M5-4 production.

** PDN 3116, "E7R1 Flame Thrower Gun, Preliminary Range Data," November 16, 1944.

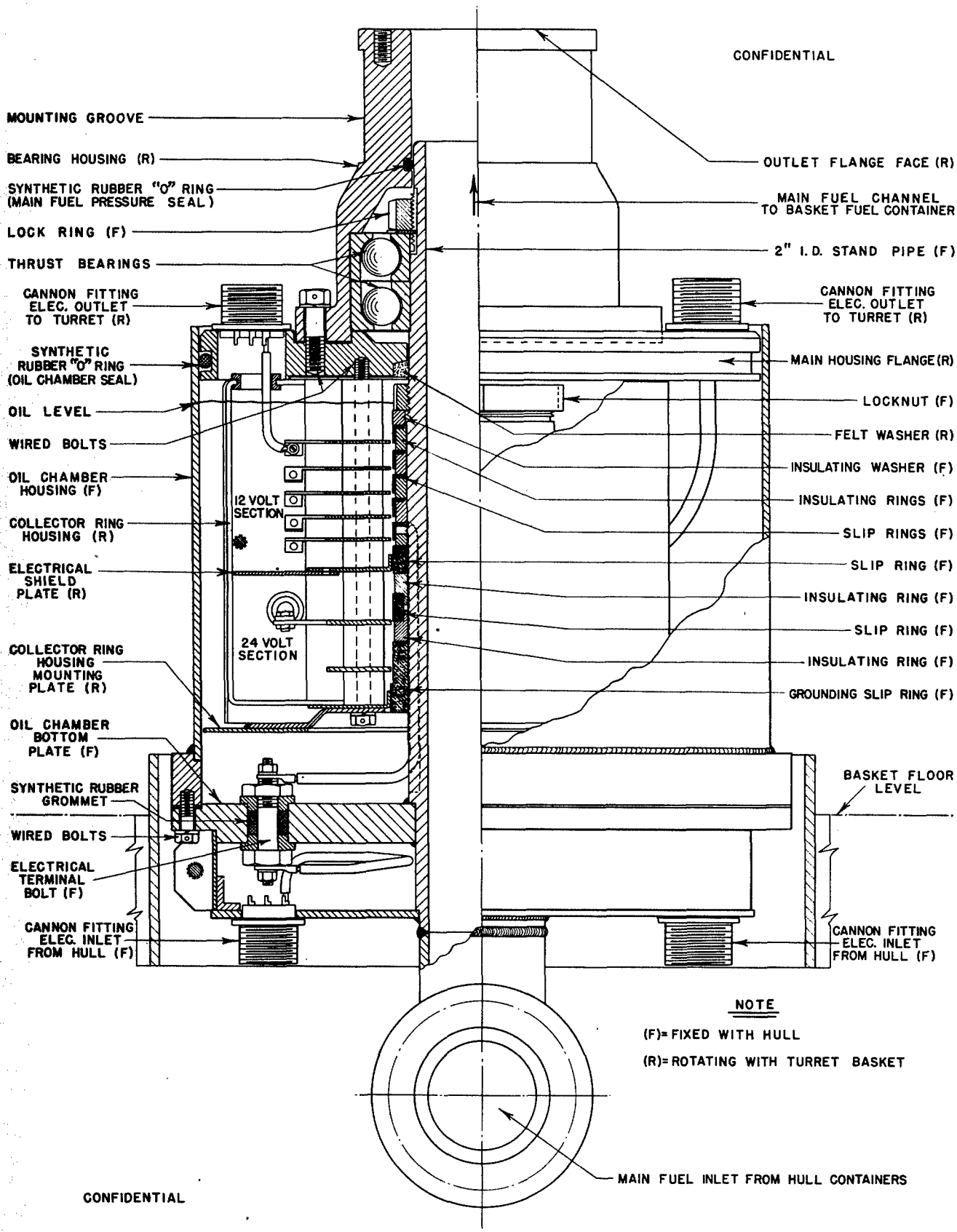

FIG. 12 ROTARY JOINT

Shop tests carried out on a representative rotary joint were as follows:

1. 600 p.s.i.g. hydrostatic pressure using light lubricating oil sealed in joint.

2. Rings and brushes connected in series carrying 5 amps. current at 64 volts D.C. in oil bath.

3. 4 RPM rotational speed of joint, bottom (inlet pipe) held stationary.

4. 12,169 revolutions made clockwise.

5. 9,070 total revolutions made alternately clockwise and counterclockwise.

No sign of failure was noted in the above tests, and subsequent inspection following dismantling revealed no appreciable wear of either the "O" ring rotary pressure seal or the brushes. To date no rotary joint failures have been noted in operational or service tests of completed M5-4 units.

C. Dummy Gun Tube

The special armor plate 75 mm. dummy gun tube housing the flame gun extended nozzle was designed by the Standard Oil Development Company, with ballistics assistance from the Breeze Corporations and breech mounting details developed by the M. W. Kellogg Company. This tube was constructed of 1/2" armor, using homogeneous plate on the first twenty units and face-hardened plate on subsequent production. The tube is split horizontally, the top half providing a removable bolted cover to facilitate interchanging flame gun nozzles and servicing the flame thrower ignition system (Figure 13). The forward 11-inch section of the tube comprises the ignition chamber, containing dual igniter spark plugs mounted on a vertical "ballistic plate at the rear of the ignition zone (Figure 8). The atomizer nozzle is mounted in the tube to the rear of the ballistic plate. It ejects a cone of atomizer gasoline through a hole in the plate, into the ignition chamber around the dual spark gaps. Passage of the atomizer jet through the ballistic plate aspirates additional necessary igniter air from outside through 20 secondary air holes drilled in the bottom of the dummy tube. Further to the rear of the ballistic plate, the dummy tube is provided with internal brackets which support the extended flame gun nozzle and auxiliary lines in cushioned neoprene mountings. The dummy tube is held rigidly in position by rearward pull exerted by bolts attached to the rotor gun mount inside the turret, an integral tapered ring around the tube seating in a matching cone recess machined in the 75 mm. gun opening in the turret front shield (Figure 8). The tube extends through the shield into a retaining and alignment hole in the rotor gun mount.

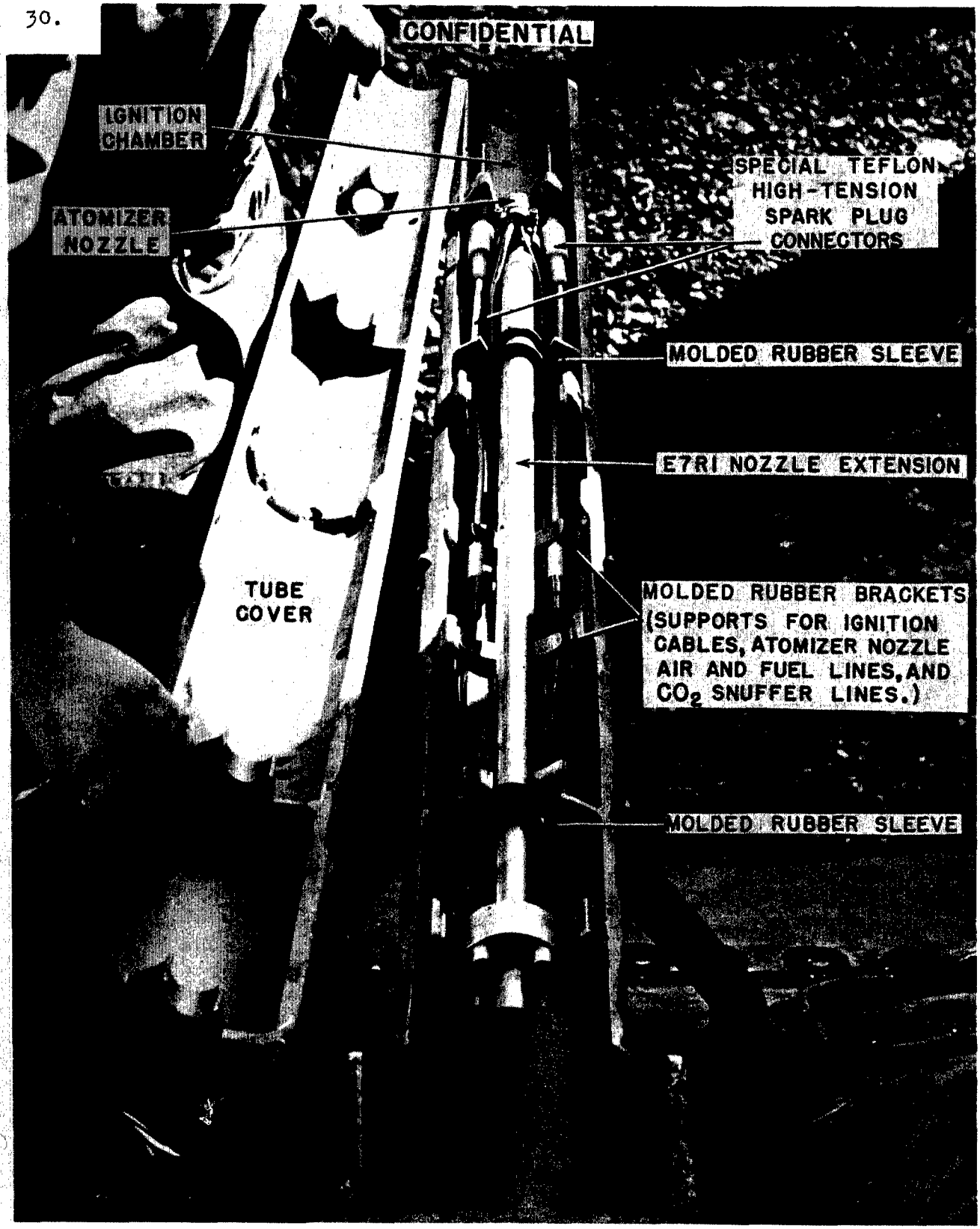

FIG. 13 75 M.M. DUMMY GUN TUBE INSTALLATION

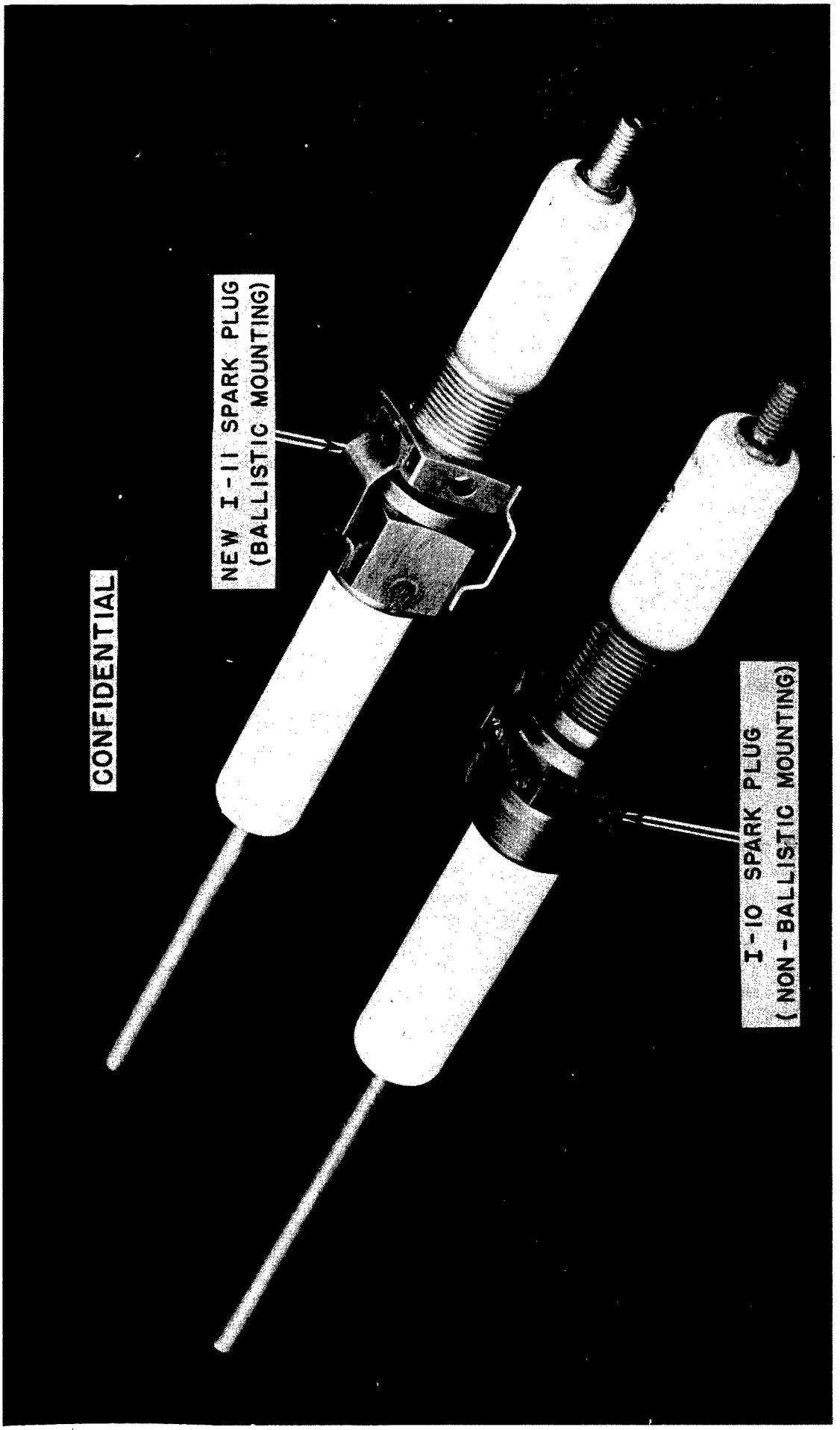

FIG. 14 I-10 & I-11 IGNITER SPARK PLUGS

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Firing tests* carried out with standard service ammunition on representative dummy gun tubes gave the following results:

1/2" Thick Armor Plate	Homogeneous	Face-Hardened
Range - yards	100	
Angle of Hits on Tube	0° to 20°	
.30 Cal. Armor Piercing Ammunition	Penetrated	-
.50 Cal. Ball Ammunition	Penetrated	Deflected
Bolted Cover	Secure	Secure
Estimated Range for Deflection of		
.50 Cal. Ball or .30 Cal. A.P.	200-300 yds.	0 yds.
.50 Cal. Armor Piercing	1200-1300 yds.	300-400 yds.

Resistance to penetration by small caliber ammunition was considerably greater for the face-hardened dummy gun tubes.

D. Igniter Spark Plugs

An improved igniter spark plug (Model I-11) was designed by the Standard Oil Development Company when firing tests carried out on representative dummy gun tubes revealed that the porcelain insulators of the special I-10 spark plugs originally employed shattered under the ballistic shock imposed by .50 cal. hits on the tube exterior. The new I-11 igniter is constructed with a flexible metallic mounting for the insulator, and is interchangeable with the earlier I-10 design (see Figure 14).

Tests made on the improved I-11 igniters were as follows:

1. I-11 Installed in Face-Hardened Dummy Gun Tube	Spark Plug Failures
.50 cal. hits on tube using ball and armor piercing ammunition fired at 100 yds. range, with both deflection by and penetration of tube.	None
2. I-11 Subjected to Drop Test	
Spark plugs screwed horizontally into steel plate subjected to 4" drop at 700 cycles/hr.	After 12,000 to 20,000 drops flexible mounting straps for insulator ruptured.
3. I-11 Bench Tests	
Spark plug insulator support twisted minimum of 20° relative to body bushing mounting to deform flexible mounting straps	None

* PDN 4002, "Ballistic Tests, 75 mm. Dummy Gun Tube, M5-4 (E12-7R1) Mechanized Flame Thrower," October 31, 1945

E. Fire-Resistant Ignition Cable*

As the result of infrequent and short duration fires in the muzzle resulting from slight drip of atomizer nozzle gasoline around the base terminal of the igniter spark plugs in the dummy gun tube, ordinary high-tension cable and insulators connecting the spark plugs were damaged by excess heat. Occasional resulting electrical short circuits weakened or prevented sparking at the dual spark plug electrode gaps in the ignition chamber. For the M5-4 installations, the Standard Oil Development Company therefore designed and developed a special fire-resistant cable and connector assembly for conducting high voltage current to the igniter spark plugs (see Figure 13). These special connectors were constructed of "Teflon," a rugged, flexible, inert insulating material obtained as an extruded polymer (polytetrafluoroethylene), susceptible to easy machining and applicable as a sealed cover for small wire conductors.

Exhaustive tests indicated that for the installation space available, Teflon-insulated high-tension connector assemblies were superior from the standpoint of combined qualities of fire-resistance, electrical insulation, ruggedness, flexibility and simplicity.

Shop tests conducted on special connectors for the igniter spark plugs were as follows:

1. Breakdown Voltage (60 cycle A.C.)

a) Teflon connector	61,000 volts
b) Unprotected standard insulated ignition cable (Spec. AN-JC-56, 7 mm.)	53,000 volts
c) AN-JC-56 cable protected by glass or asbestos sleeving, combinations of sleeving and/or porcelain beads	44,000 to 49,000 volts (electrical leakage excessive at ends of sleeving - corona effect increased with rough sleeving)
d) AN-JC-56 cable protected by asbestos and aluminum foil sleeving	12,000 volts

* PDN 4001, "Fire Protection of Igniter Leads - M5-4 (E12-7R1) Mechanized Flame Thrower," October 31, 1945.

2. Flame Endurance

High-tension connectors were tested using flame thrower electrical hookup and voltage (12,000 volts A.C.), applying continuous gasoline fire simulating severe conditions encountered in dummy tube.

	Time Flame Exposure Before Insulation Failure
a. Teflon Connector	4 mins. - 30 secs. (Teflon unignited)
b. Unprotected standard insulated ignition cable (Spec. AN-JC-56, 7 mm.)	1 min. - 20 secs. (Insulation ignited)
c. AN-JC-56 cable protected by asbestos or asbestos and glass sleeving	3-1/2 minutes (Insulation ignited)
d. AN-JC-56 cable protected by glass sleeving and procelain beads	5 min. - 10 secs.
e. AN-JC-56 cable protected by glass sleeving, asbestos wrapping, and porcelain beads	7 min. - 20 secs.

3. Flame Cycle

High-tension connectors were tested in dummy tube under operating conditions, applying alternately 1-1/2 minutes gasoline flame and 1-1/2 minutes cooling for complete cycle.

	Cycles Prior to Insulation Ignition or Severe Current Leakage
a. Teflon Connector	No damage or electrical leakage after 60 cycles
b. Unprotected standard insulated ignition cable (Spec. AN-JC-56, 7 mm.)	1
c. AN-JC-56 cable protected by asbestos and glass sleeving	1
d. AN-JC-56 cable protected by glass sleeving and porcelain beads	7
e. AN-JC-56 cable protected by glass and asbestos sleeving and porcelain beads	7

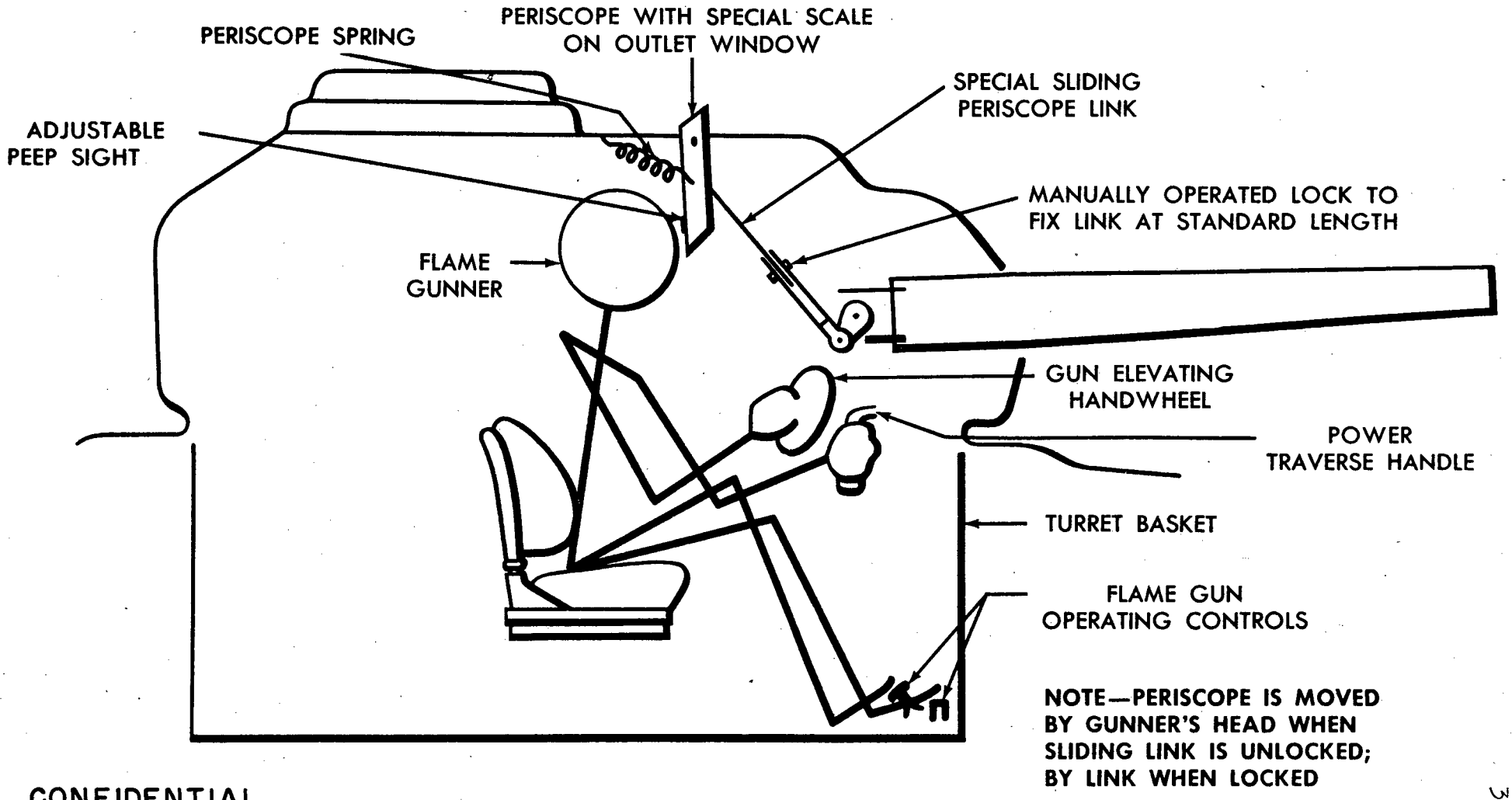

FIG. 15 FLAME GUN SIGHTING

4. Humidity Effect

Teflon connector assembly in dummy tube subjected to humidity bath exposure (in saturated atmosphere of 125°F. for 8 hours, alternated with 65°F. for 8 hours) followed by flame cycle test as under (3) above:

a. 36 hours in humidity bath followed by 10 flame cycles	Ignition at spark gap O.K.
b. 24 hours in humidity bath followed by 10 flame cycles (repeated twice)	Ignition at spark gap O.K.

F. Flame Gun Sighting Equipment

Based on preliminary sighting devices suggested and given trials by Armored Force personnel during M5-4 instructional training, special equipment was designed to facilitate use of the turret gunner's periscope for aiming the flame gun and for observing target fire when outside the normal field of view of the standard linked periscope (Figure 15).

This equipment comprises:

(1) A special adjustable peep sight for the periscope inside window. Suitable for field installation.

(2) Special horizontal and vertical sight reference lines permanently scribed on the periscope outside window. (M-12 wide-angle plastic periscopes were furnished with the M5-4 units, together with a template and scribe for marking equivalent scales on replacement periscopes in the field.)

(3) A special sliding periscope link with a simple quick locking device, such that in the sliding operation the link permits free operation of the periscope by head pressure of the flame gunner, and in the locked condition moves the periscope in elevation with the flame gun. A spring installed on the periscope holder permits the gunner to align the periscope as desired using head pressure when the link is freed. The special link is interchangeable with the standard periscope link on the vehicles employed.

G. Elevating Gear Adapter

A simple gear adapter was installed under the main armament elevating handwheel to double the speed of elevation of the flame gun. This special housed adapter is bolted directly to the standard elevating gear housing and relocates the standard elevation handwheel slightly closer to the gunner.

H. Commander's Seat

A special tank commander's seat was devised to replace the standard installation. The new seat provides variable vertical adjustment as well as folding retractability, whereas the original commander's seats were not adjustable vertically.

IX. SAFETY FEATURES

In order to provide maximum safety to personnel and equipment, the following items were included in the M5-4 flame thrower installations:

A. Gun Controls

The E7R1 gun is provided with "dead man" controls. The main fuel valve in the gun closes and the ignition control returns to "off" position automatically when released by the operator. This is independent of pressure loss from the system.

(1) An ignition safety switch was installed in the electrical circuit leading to the igniter floor pedal control feeding the dual coil boxes and igniter spark plugs. This safety is a toggle switch located with red signal light and identifying label in front of the gunner.

(2) A fuel firing safety switch was installed in the electrical circuit leading to the main fuel firing button. This safety is a toggle switch with red signal light and identifying label located adjacent to the ignition safety switch.

(3) A mechanical fuel firing safety lock was installed on the solenoid bracket carrying the air pilot valve which actuates the flame gun. Manual operation of this lock to the "on" position prevents inadvertent firing of the flame gun, either by depression of the main fuel firing button or the emergency fuel firing pedal.

B. Pressure Reliefs

(1) Automatic spring-loaded safety relief valves venting outside the vehicle were installed to release excess pressure in the main fuel, main air pressure, auxiliary air pressure, gun operating air, secondary fuel, and atomizer fuel systems.

(2) A rupture disc was installed in the main fuel system to discharge outside beneath the tank in case the main fuel pressure inadvertently increased to 600 p.s.i.g. (375 - 400 p.s.i.g. normal operating pressure). This is in addition to a relief valve previously mentioned.

C. Emergency Shut-Off Cocks

(1) Quick-acting, manually operated cocks were installed in the main fuel feed to the flame gun and in the secondary and atomizer fuel container discharge lines, to be used for emergency cut-off in case of damage to downstream lines or flame gun and gun controls.

D. Fire Extinguishers

(1) Three 10 lb. CO_2 fire extinguishers were installed in the left sponson with discharge horns manifolded along both sides and rear wall of the fighting compartment. This system was equipped with both internal and external operating pulls in standard locations. The original CO_2 system provided for the vehicle engine compartment was reduced from two to one 10 lb. container, relocated adjacent to the special containers for the hull, with separate fire pulls similarly placed.

(2) A 4 lb. CO_2 cylinder was installed adjacent to the flame gunner to supply a snuffer system discharging into the ignition chamber and under the atomizer nozzle in the dummy gun tube muzzle. This is available when needed to extinguish occasional muzzle fires, with CO_2 trigger valve operation.

E. Flexible Hoses

(1) High pressure, reinforced, synthetic rubber hoses were installed in all piping lines connected to each pressure vessel in the flame thrower system, except where sufficient flexibility was obtained in steel outlet lines from the secondary and atomizer fuel containers in the turret basket. Installation of these flexible connectors minimizes possible damage to the pressure piping or recurrent leaks resulting from vibration or deformation of the vehicle structure during operation over rough terrain or as a result of minor battle damage. In later production, each hose was protected by a spiral wire wrapping to minimize possible mechanical injury.

X. PRODUCTION IMPROVEMENTS

As feasible without appreciable production delay, improvements resulting from operational and service testing were incorporated in the twenty limited procurement M5-4 installations following testing of the first completed unit (March, 1945)*. These improvements were of a minor nature having no effect on flame thrower operation nor any basic effect on design. Further improvements were similarly included in extended production, such as simplification of the rotary joint, use of improved ballistically protected dummy gun tube, improvement in location of minor items of equipment, inclusion of improved flame gun sighting equipment, installation of luminescent dial pressure gages, etc.** Minor improvements in mechanical installation as revealed by assembly line production experience were incorporated when practicable during production.

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* Letter on E12-7R1 Improvements, Major E. W. Hollingsworth, CWS-Tech. to Chief, Technical Division, C.W.S. dated April 25, 1945.

** PDN 3908,"Production Improvements - M5-4 (E12-7R1) Mechanized Flame Throwers," September 7, 1945.

XI. INSPECTION AND TESTING DURING MANUFACTURE

Special inspection and testing of the M5-4 flame thrower installations during construction and final acceptance were established during manufacture of the first twenty flame throwers*. Recommended procedure included:

(1) Inspection and testing E7R1 flame guns.

(2) Inspection and testing M5-4 component parts and sub-assemblies.

(3) Field operational tests of completed M5-4 units.

(4) Final inspection of M5-4 units prior to shipment by prime contractor.

Inspection during manufacture of E7R1 guns and the dummy gun tubes, and final field operational testing and inspection of completed flame throwers prior to shipment were carried out on the first twenty M5-4 units**. This work was continued by C.W.S. under extended procurement.

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* PDN 3673, "Inspection and Testing E12-7R1 Units," July 9, 1945.

** PDN 3672, "Inspection and Field Operational Tests of Twenty E12-7R1 Flame Throwers," June 6, 1945.

XII. SERVICE TESTS

A. Shakedown and Operation

The first two M5-4 units completed under limited procurement (March, 1945) were shipped respectively to the Armored Board at Fort Knox, Kentucky and the Chemical Warfare Service at Edgewood Arsenal, Maryland for service testing*. Armored Board tests primarily involved a 45-hour shakedown to test ruggedness and operability of the unit over rough terrain. C.W.S. tests primarily concerned flame thrower operability and performance. No basic deficiencies were found, and from these tests it was concluded that the M5-4 units performed satisfactorily and were sufficiently rugged for combat use. Minor changes were recommended, such as improved facilities for reaching the oil filler pipe (M4A1 vehicles) in the fighting compartment, installation of auxiliary pressure regulator identification and instructional panel, installation of fuel outage chart, improvement in flame gun sighting facilities, etc. The recommended changes were incorporated in production in so far as practicable without production delay.

B. Radio Interference

Radio interference tests were conducted on a representative M5-4 unit by U. S. Army Signal Corps engineers. These tests indicated excessive radio interference at short range in line with the dummy gun tube during operation of the flame thrower ignition system. Interference to either side of the gun tube was considerably less severe under the circumstances. Most of the radio interference originated at the dual high-tension spark gaps in the ignition chamber. No changes were made to eliminate this interference, since no effective method of electrical shielding was apparent without major changes in design and further extensive development work. However, the relatively short intervals over which the flame thrower ignition system is normally operated minimize the seriousness of consequent radio interference during tactical employment in combat.

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* "Field Test of E12-7R1 Mechanized Flame Thrower Mounted in M4A1 Medium Tank, and E8 Service Unit Mounted in 2-1/2 Ton Truck," Chemical Warfare Board Report, Project 627, May 9, 1945; "Letter Report on Mechanized Flame Thrower E12-7R1 Mounted in Medium Tank M4A1," Armored Board Report, Project 667, March 28, 1945.

XIII. MISCELLANEOUS TESTS

As a basis for selection of high pressure hose used as flexible piping connections in the M5-4 fuel and air systems, special static pressure tests were carried out on hose and end coupling assemblies. Results are outlined below:

A. 2" I.D. 3-Wire Braid Reinforced Synthetic Rubber Hose, Goodrich Co. Spec. 55-37-800, with Eastman Mfg. Co. Factory-Installed, Flange Type End Couplings - 14-1/2" Overall Length
(375-400 p.s.i.g. normal operating pressure in M5-4 unit)

(1) Hydrostatic tests in jig, both ends of assembly fixed.

a) Ends misaligned and assembly stretched 1/4 to 1/2" - no failure after 15 mins. at 2000 p.s.i.g.

b) Ends misaligned and assembly compressed 1/4 to 1/2" - no failure after 15 minutes at 2000 p.s.i.g.

c) Ends misaligned and assembly stretched 1/4 to 1/2" - very slight end leak between hose and end fitting at 4000 p.s.i.g.; no mechanical failure.

Note: Each of the similar hose assemblies in the M5-4 main fuel system is hydrostatically tested at 1000 p.s.i.g. prior to installation.

B. 1" I.D. 2-Wire Braid Reinforced Synthetic Rubber Hose, Spec. AN-ZZ-H-623a, with Factory-Installed End Couplings - 36" Overall Length
(375-400 p.s.i.g. normal max. operating pressure in M5-4 unit)

(1) Hydrostatic test, one end of hose free.

a) No failures nor leaks up to 5,200 p.s.i.g. pressure.

b) Hose burst 12-1/2" from one end at 5,200 p.s.i.g. pressure. End-fittings held hose O.K.

Note: Each of the similar hose assemblies in the M5-4 main fuel and air system is hydrostatically tested at 1000 p.s.i.g., prior to installation.

C. 13/32" I.D. Single Wire Braid Synthetic Rubber Hose, Spec. AN-H-24, with Field-Installed AN-787-8 End Fittings (2000 p.s.i.g. normal max. operating pressure in M5-4 unit)

(1) Hydrostatic Tests

a) Straight assembly - hose burst at 11,000 p.s.i.g., coupling held O.K. (operation repeated twice).

b) Hose bent in "U" to 1-1/2" radius - hose burst at 10,500 p.s.i.g., coupling held O.K.

c) Same as (b), except hose burst at 10,000 p.s.i.g.

Note: Each of the similar hose assemblies in the M5-4 air systems is hydrostatically tested at 3000 p.s.i.g. prior to installation.

XIV. PERSONNEL TRAINING

In April, 1945, two groups of Armored Force and Chemical Warfare Service personnel were trained for two-week periods in the operation and maintenance of the M5-4 mechanized flame thrower. Operational training was carried out on limited procurement M5-4 units undergoing final operational tests at Elizabeth, New Jersey. The Army personnel were selected by the military to serve as instructors on M5-4 mechanized flame throwers and accompanying E8R1 servicing equipment. A list of the personnel attending and the instruction schedule are appended.

A scientific consultant representing the Office of Field Service, O.S.R.D., was supplied to the Pacific Theater during July and August, 1945, to assist Army instructors in M5-4 training in combat areas.

A manual, "Flame Thrower, Mechanized, E12-7R1," PDN 3450, April 16, 1945, was prepared on training, operation, and maintenance for the first twenty E12-7R1 units. This served as a guide during subsequent assistance rendered C.W.S. in preparation of a formal War Department Technical Manual (TM 3-360, "Flame Thrower, Mechanized, E12-7R1," July 20, 1945) to cover extended production and field use.

Brief informational movies were made of the first unit completed.

XV. ACKNOWLEDGMENTS

During development and production of the M5-4 (E12-7R1) mechanized flame throwers, valuable guidance and assistance in military requirements, military installations, design, production adaptations, inspection and testing were obtained from the following:

A. U. S. Army

1. Chemical Warfare Service
   a) Technical Division
   b) Spare Parts and Catalog Branch
   c) Tactical Doctrine Branch
2. New Developments Division
3. General Planning Branch, Research & Development Division, Headquarters, A.S.F.
4. Ordnance
   a) Office, Chief of Ordnance-Detroit
   b) Aberdeen Proving Ground
5. Armored Forces
   a) Armored Board
   b) Training Personnel

B. N.D.R.C. Contractors

1. Morgan Construction Company
2. Massachusetts Institute of Technology

C. Manufacturer and Subcontractors

1. M. W. Kellogg Company (prime contractor)
2. Lecourtenay Company
3. Breeze Corporations, Inc.
4. Eastman Manufacturing Company
5. B. F. Goodrich Company
6. Edison-Splitdorf Company
7. Electronics Labs., Inc.
8. DeVilbiss Company

XVI. APPENDIX

A. Bibliography

B. Military Training Classes

C. List of Drawings

1) E7R1 Flame Gun

2) M5-4 (E12-7R1) Unit

D. Drawings

1) E7R1 Flame Gun

2) M5-4 (E12-7R1) Flow Plan

A. Bibliography

M5-4 (E12-7R1) Mechanized Flame Thrower in M4A1 or M4A3 Medium Tanks

Title	Author	Date	Number
M4 Medium Tank Flame Thrower Installations	S.O.D. Co.	8/31/44	PDN 2852
Visit to MIT and Morgan Construction Co. - Medium Tank Flame Thrower Prototypes	S.O.D. Co.	9/27/44	PDN 2931
Flame Thrower, Mechanized, E12-7R1	S.O.D. Co.	9/28/44	PDN 2936
Kellogg Job 4800 - CWS Order 5-3578 - E12-7R1	S.O.D. Co.	9/29/44	PDN 2947
Life Test on Solenoid Operated Pilot Valve Spring - E12-7R1 in M4A1	S.O.D. Co.	11/8/44	PDN 3085
E7R1 Flame Thrower Gun - Preliminary Range Data	S.O.D. Co.	11/16/44	PDN 3116
Kellogg Job 4800 - CWS Order 5-3578 - E12-7R1 in M4A1	S.O.D. Co.	12/19/44	PDN 3213
E12-7R1 in M4A1 - Muzzle and Trunnion Block Details	S.O.D. Co.	1/6/45	PDN 3251
Test Procedure on E12-7R1 in M4A1 Medium Tank	S.O.D. Co.	1/10/45	PDN 3261
E12-7R1 in M4A1 - Inspection and Testing	S.O.D. Co.	1/10/45	PDN 3262
Mechanized Flame Throwers E12-7R1, Servicing Units E8 -- Suggested Responsibility for Extended Orders	S.O.D. Co.	1/11/45	PDN 3265

Title	Author	Date	Number
E12-7R1 in M4A1 Medium Tank	S.O.D. Co.	1/16/45	PDN 3284
Washington Conference, January 12, 1945	S.O.D. Co.	1/19/45	PDN 3288
Spare Parts for 300 E12R1-7R1 and 75 E8 Units	S.O.D. Co.	2/14/45	PDN 3340
E12-7R1 Tests at Fort Knox, Kentucky	S.O.D. Co.	2/22/45	PDN 3369
Demonstration of Mechanized Flame Thrower E12-7R1	S.O.D. Co.	2/22/45	PDN 3370
Training Program	S.O.D. Co.	2/26/45	PDN 3379
E12-7R1 in M4A1 - Shop Tests	S.O.D. Co.	3/8/45	PDN 3419
Training Program - Flame Thrower E12-7R1 and Service Unit E8	S.O.D. Co.	3/9/45	PDN 3427
Report of Conferences Held at the Armored Board, Fort Knox, Kentucky, 21st, 22nd, and 23rd of March, 1945	H.C. Hottel (N.D.R.C.)	3/24/45	674160
Letter Report on Mechanized Flame Thrower, E12-7R1 Mounted in Medium Tank M4A1	Armored Board	3/28/45	Project 667
Flame Thrower, Mechanized, E12-7R1 and Service Unit, Flame Thrower, E8	S.O.D. Co.	4/2/45	PDN 3499
Manual - Flame Thrower, Mechanized, E12-7R1	S.O.D. Co.	4/16/45	PDN 3450
Letter to Office of Chief, CWS-TD, referring to Armored Board Letter Report Project 667, above	CWS-TD (Major E. W. Hollingsworth)	4/25/45	--

Title	Author	Date	Number
Field Test of E12-7R1 Mechanized Flame Thrower Mounted in M4A1, Medium Tank, and E8 Service Unit Mounted in 2-1/2 Ton Truck	Chemical Warfare Board	5/9/45	Project 627
Production Drawings E7R1 Flame Gun for Twenty E12-7R1 Units - Limited Procurement	S.O.D. Co.	5/31/45	PDN 3659
Production Drawings E7R1 Flame Gun for E12-7R1 Units on Extended Production	S.O.D. Co.	6/5/45	PDN 3668
Inspection and Field Operational Tests of 20 E12-7R1 Flame Throwers	S.O.D. Co.	6/6/45	PDN 3672
Inspection and Testing - E12-7R1 Units	S.O.D. Co.	7/9/45	PDN 3673
New Igniter Spark Plugs, E12-7R1 Mechanized Flame Throwers	S.O.D. Co.	7/11/45	PDN 3769
Basket Height - E12-7R1 and P.O.A.	S.O.D. Co.	7/11/45	PDN 3771
Technical Manual - Flame Thrower, Mechanized, E12-7R1 (Installed in Medium Tanks M4A1 and M4A3)	War Department	7/20/45	TM3-360
Report of Mission of J.O. Collins, Scientific Consultant, O.F.S. - E12-7R1 Mechanized Flame Thrower	S.O.D. Co.	8/20/45	--
M. W. Kellogg Job No. 4800 - Drawings E12-7R1 - Limited Procurement of 20 Units	S.O.D. Co.	8/24/45	PDN 3879
Flame Gun Sighting Equipment for E12-7R1 Units	S.O.D. Co.	8/28/45	PDN 3886

Title	Author	Date	Number
E12-7R1 Flame Thrower in M4A1 Medium Tank - Armored Board Shakedown Test at Fort Knox, Ky.	S.O.D. Co.	8/31/45	PDN 3892
Use of M4A3 Medium Tanks for E12-7R1 Flame Thrower Installation	S.O.D. Co.	8/31/45	PDN 3898
Ignition System M5-4 (E12-7R1) Flame Throwers	S.O.D. Co.	9/5/45	PDN 3903
Production Improvements M5-4 (E12-7R1) Flame Throwers	S.O.D. Co.	9/7/45	PDN 3908
Fire Protection of Igniter Leads - M5-4 (E12-7R1) Mechanized Flame Thrower	S.O.D. Co.	10/31/45	PDN 4001
Ballistic Tests 75 mm. Dummy Gun Tube, M5-4 (E12-7R1) Mechanized Flame Thrower	S.O.D. Co.	10/31/45	PDN 4002
Summary Report - Contract OEMsr-390 Development of Flame Throwers, Service Units, and Thickened Fuels	S.O.D. Co.	10/31/45	PDN 4027

PDN 4025

B. Military Training Classes

M5-4 (E12-7R1) Mechanized Flame Thrower

1. Date

   a) First Course - April 2-14, 1945.

   b) Second Course - April 16-28, 1945.

2. Location

   a) Standard Oil Development Company, Linden, New Jersey.

   b) Linden Test Field, Standard Oil Co. of New Jersey, Linden, New Jersey.

   c) M. W. Kellogg Company, Jersey City, New Jersey

3. Schedule (each course)

   a) 1st Day - Introduction and Outline of Program

   b) 2nd Day - Movies: E8*Unit and Thickened Fuels
   - Design, E8 Unit - Class

   c) 3rd Day - E8 Operation - Field

   d) 4th Day - E8 Maintenance - Field and Class

   e) 5th Day - Movies: M5-4
   Design, M5-4 - Class

   f) 6th Day - M5-4 Operation - Field

   g) 7th Day - M5-4 Operation and Maintenance - Field

   h) 8th Day - M5-4 Operation and Maintenance - Class

   i) 9th Day - M5-4 Gun Assembly & Maintenance - Class

   j) 10th Day - M5-4 and E8 Operation - Field

   k) 11th Day - M5-4 and E8 Operation - Field

   l) 12th Day - Inspection M5-4 in Production - M. W. Kellogg Co. Plant

* PDN 3975, "Development of Mobile Servicing Equipment for Mechanized Flame Throwers, E8R1 Service Unit-Truck Mounted, E6 Mixer and E8 Compressor-Skid Mounted," October 18, 1945.

4. Attendance

a) First Course

Chemical Warfare Service

Capt. J. F. Olds
Capt. W. Sidun
Capt. J. L. Pfeifer
1st Lt. C. H. Hainfeld
1st Sgt. G. B. DuBose
Sgt. J. K. Hoyer
T/5 A. J. Carmella
Pvt. M. Hoitko
Pvt. S. E. Shackelford

Armored Forces

Maj. L. F. Roberts
Capt. T. C. Tillotson
1st Lt. A. W. Dunn
S/Sgt. B. K. Easley
Sgt. J. K. Gale
T/3 G. E. Smith
Pfc. H. E. Medford
Pvt. G. B. Cathey
Pvt. A. M. Cox
Pvt. D. C. Fugate
Pvt. C. L. Redler
Pvt. E. A. Thomas
Pvt. P. C. Tucker

N. D. R. C.

J. J. Clancy

b) Second Course

Chemical Warfare Service

Capt. D. G. Drawbaugh
Capt. J. F. Fraser
Capt. R. H. Hageman
1st. Lt. W. A. Helwig
Sgt. C. W. Hall
T/5 T. C. Elder
Pfc. L. Bloomingdale, Jr.
Pfc. C. E. Falk
Pfc. L. I. Osipow

Armored Forces

Capt. E. E. Hill, Jr.
Capt. J. Rockis, Jr.
1st Lt. G. C. Dalglish
1st Lt. L. S. DeLozier
T/4 J. J. Conway
T/4 A. Giardina
Cpl. P. B. Revvill
Pvt. S. Kessler
Pvt. C. W. McBride
Pvt. L. L. Patterson
Pvt. M. Trouberman

U. S. Marine Corps

Sgt. C. A. Gordon
Sgt. E. H. Quertermous

C. List of Drawings

1. E7R1 Flame Gun (Lecourtenay Co. Drawings)

Drawing No. (Lecourt. Co.)	Subject	Revision	Date
A149-163	Sectional Assembly	-	3/1/45
-67F	Vertical Trunnion	II	2/16/45
-164	Outline Dimensions	-	3/1/45
-168	Long Ext. Nozzle (3/4 Bore)	-	2/5/45
-169	Long Nozzle Ext. (1/2 Bore)	-	2/5/45
-170	Long Nozzle Ext. (3/8 Bore)	-	2/5/45
B149-68	Trunnion Elbow R.H.	I	3/14/45
-68-1	Trunnion Elbow L.H.	I	3/14/45
-71	Air Chamber	I	2/8/45
-81	Control Valve Body	-	2/28/44
-87	Pilot & Atomizer Air Body	-	2/25/44
-146	Main Valve Spring Housing	I	2/27/45
-148	Tapered Nozzle	I	2/14/45
-165	Solenoid & Pilot Valve Bracket	-	3/19/45
-167	Short Nozzle Extension	-	2/5/45
C149-70	Trunnion Elbow Collar	-	3/1/44
-75	Main Piston Spring	I	10/11/44
-76	Main Valve Piston	II	4/23/45
-83	Control Valve Piston Bonnet	I	4/23/45
-85	Control Valve Piston	-	2/27/44
-153	Secondary Fuel Cylinder	-	11/6/44
D149-77	Main Valve Piston Collar	-	2/16/44
-78	Main Valve Piston Disc	-	2/16/44
-80A	Main Valve Seat	-	2/29/44
-82	Control Valve Spring Housing	-	2/26/44
-86	Control Valve Spring	-	2/27/44
-88	Pilot Valve Body Cover	-	2/24/44
-91	Pilot Valve Piston	-	2/24/44
-92	Pilot & Atomizer Valve Spring	-	2/25/44
-108	Atomizer Gasoline Body	I	5/8/45
-109	Atomizer Spring Housing	-	2/23/44
-110	Atomizer Piston	-	2/23/44
-111	Atomizer Valve Stem	-	2/23/44
-112	Main Valve Piston Disc Washer	-	2/16/44
-115	Main Spring Housing Nut	I	2/27/45
-116	Main Spring Guide	I	4/23/45
-127	Gaskets	-	3/7/44

Drawing No. (Lecourt. Co.)	Subject	Revision	Date
D149-156	Rocker Arm	-	10/16/44
-158	Push Rod Bracket	I	5/2/45
-159	Safety Lever	-	2/19/45
-160	Safety Lever Button	II	5/1/45
-161	Safety Lever Spring	-	2/22/45
-162	Atomizer Valve Flange	I	4/30/45
-166	Pilot Valve Flange	I	4/30/45
D58-45	Nameplate	-	3/19/45

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2. M5-4 (E12-7R1) Flame Thrower Installation (M.W. Kellogg Co.)

Drawing No. (M.W.K. Co.)	Subject	Revision	Date
15543-A	Bracket for Top Ring of Turret Basket	3	5/28/45
15544-A	Layout of Fuel Tanks & Air Bottles in Hull & Details of Support Plates	2	5/23/45
15545-A	Assembly & Details of Fuel Tank FH-1	-	3/20/45
15546-A	Pipe Details for Fuel Tank FH-1 in Hull	-	3/20/45
15547-A	Assembly & Details of Fuel Tank FH-2	1	5/24/45
15548-A	Pipe Details for Fuel Tank FH-2 in Hull	-	3/20/45
15549-A	Assembly & Details of Air Bottle AH-1 in R.H. Sponson	1	7/25/45
15550-A	Assembly & Details of Air Bottle AH-2 in L.H. Sponson	1	7/25/45
15551-A	Assembly & Details of Secondary Fuel Tank SFB-1	-	3/20/45
15552-A	Assembly & Details of Auxiliary Air Bottle AAB-1	1	6/2/45
15553-A	Assembly & Details of Atomizer Fuel Tank ATB-1	-	3/20/45
15554-A	Turret Basket Floor Plan & Details	3	7/30/45
15555-A	Turret Basket Floor Plates	1	6/21/45
15556-A	Turret Basket Top Ring	-	4/6/45
15557-A	Swivel Support Fuel Line to Basket	-	4/12/45
15558-A	Bill of Material for 50 Sets of Tanks & Bottles	-	3/30/45
15559-A	Bill of Material for 100 Sets of Tanks & Bottles	-	3/30/45
15560-A	Assembly & Details of Fuel Tank FB-1	5	8/1/45
15562-A	Speed Gear Box, Details for Pilot Unit	2	7/13/45
15566-A	Fabrication Details for Chimney	3	8/3/45
15567-A	General Arrangement of Speed Gear Box	2	7/13/45
15568-A	Assembly 2" I.D. Stand Pipe Ring Holder, Swing Joint & Oil Cylinder	3	6/30/45
15569-A	M4 Tank Battery Box Details	2	5/22/45
15570-A	M4 Tank Battery Box Assembly	1	4/29/45
15571-A	Details of Main Control Box Located in Turret Basket of M4 Tank	3	5/17/45

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Drawing No. (M.W.K. Co.)	Subject	Revision	Date
15572-A	Details of Floor Beams for Basket	-	4/6/45
15573-A	Blank for Steel Outlets Mkd. FH-1G & FH-2G	-	4/11/45
15581-A	Blank for Steel Outlet Mkd. FH-1F	1	4/14/45
15582-A	Blank for Steel Outlet Mkd. FH-2F	1	4/11/45
15587-A	Tapered Seat & Plug Details for Chimneys	-	4/18/45
15588-A	Details for Right & Left Side Plates for Rotor Replacement	-	4/26/45
15589-A	Details for Chimney Hold Down Bar Assemblies	-	5/4/45
15590-A	Welding & Machining Details for Rotor	-	5/17/45
15591-A	Rotor & Support Assembly	-	5/14/45
15592-A	Charging Connections & 10" Dia. Sump for F.T. Unit in Turret	1	8/8/45
15594-A	2" I.D. Stand Pipe & Ring Holder	4	7/6/45
15601-A	Miscellaneous Electrical Fittings M4-A1, M4-A3 & LVT (A)(1) Vehicles F.T. Installation	7	8/11/45
15602-A	Wiring Diagram for M4-A1 Tank - E12-7R1 F.T. Installation	3	6/11/45
15603-A	Wiring Diagram of Turret Basket for M4-A1 & M4-A3 Dry Stowage Tanks E12-7R1 F.T. Installation	2	7/11/45
15604-A	Wire Schedule for M4-A1 & M4-A3 Dry Stowage Tanks E12-7R1 F.T. Installation	2	7/7/45
15605-A	Layout & Wiring of Battery Terminal Box & Main Switch Box for M4-A1 Tank E12-7R1 F.T. Installation	1	6/11/45
15606-A	Alterations to Existing Main Switch Box for M4-A1 & M4-A3 Tanks E12-7R1 F.T. Installation	-	5/28/45
15607-A	Wiring Diagram for M4-A3 Dry Stowage Tank E12-7R1 F.T. Installation	2	10/2/45
15608-A	Layout & Wiring of Battery Terminal Box & Main Switch Box for M4-A3 Dry Stowage Tank E12-7R1 F.T. Installation	-	6/11/45
15609-A	Miscellaneous Electrical Fittings for M4-A1, M4-A3 & LVT (A)(1) Vehicles F.T. Installation	-	7/10/45

Drawing No. (M.W.K. Co.)	Subject	Revision	Date
15630-A	Component Parts Assembled to Right & Left Rotor Shafts	1	7/21/45
15631-A	Telescope Mounting Bracket	-	4/20/45
15636-A	Location of Test Field	2	6/16/45
15637-A	Commanders Seat General Arrangement (Middle Position) Sections AA & BB	-	6/28/45
15638-A	Commanders Seat - Details	-	6/29/45
15639-A	Commanders Seat (Seat shown in High Position) General Arrangement	-	7/21/45
15640-A	Commanders Seat Latch,Carriage & Bracket Details	-	7/8/45
15643-A	Shield - Rotor	-	6/5/45
15644-A	Stationary Gun Shield Details	-	6/5/45
15645-A	Stationary Gun Shield Detail Pc #E5721	-	6/2/45
15646-A	Stationary Gun Shield Detail Pc #5721	-	6/2/45
15650-A	Charging Connections & 8" Dia. Sump for F.T. Unit in Turret	1	8/8/45
15651-A	Details of Periscope Link	2	8/9/45
15660-A	General Arrangement of Piping for F.T. Unit in Hull	-	7/14/45
15661-A	Elevations of General Arrangement of Piping for F.T. Unit in Hull	-	7/14/45
15662-A	Bill of Material for Piping in Hull for F.T. Unit	-	7/14/45
15663-A	Commanders Seat (Adjustable) General Arrangement Showing Carriage in Lowest Position.	-	7/9/45
15666-A	General Arrangement of Piping for F.T. Unit in Turret and Basket	1	8/4/45
15667-A	General Arrangement of Piping for F.T. Unit in Turret and Basket	1	8/4/45
15668-A	General Arrangement of Piping for F.T. Unit in Turret and Basket	1	8/4/45
15669-A	Bill of Material for Piping in Turret & Basket for F.T. Unit	1	8/4/45
15671-A	Flow Diagram for E12-7R1 Flame Thrower in M4-A1	-	7/14/45
15672-A	Arrangement of Gages & Regulators in Turret	-	7/9/45
15673-A	Sectional Plan - General Arrangement of Ejector Unit, Chimney & Rotor	1	8/31/45

Drawing No. (M.W.K. Co.)	Subject	Revision	Date
15674-A	Sectional Side Elevation, General Arrangement of Ejector Unit, Chimney & Rotor	-	6/8/45
15675-A	Sectional Elevation Looking Forward General Arrangement of Ejector Unit, Chimney and Rotor	-	6/10/45
15676-A	Layout of CO_2 Lines in Hull for F.T. Unit	-	7/16/45
15678-A	Electrical Harness Layout-Plan-Hull for M4A1 Tanks and E12-7R1 F.T. Installation	-	7/30/45
15679-A	Electrical Harness Layout Section AA - Hull for M4A1 Tanks, E12-7R1 F.T. Installation	-	8/24/45
15680-A	Electrical Harness Layout Sections "BB" "CC" "DD" & "EE" - Hull for M4A1 Tanks, E12-7R1 F.T. Installation	-	8/23/45
15681-A	Electrical Harness Layout Plan-Turret for M4A1 and M4A3 Tanks, E12-7R1 F.T. Installation	-	9/10/45
15682-A	Electrical Harness Layout Sections "FF" "GG" "HH" and "JJ" Turret for M4A1 and M4A3 Tanks E12-7R1 F.T. Installation	-	9/18/45
15684-A	Harness-Batt.Term. Box to Instr. Panel(15684-A1 & A2) Batt.Term. Box to Aux. Gen. Volt Reg. (15684-A-3) for M4A1 Tank, E12-7R1 F.T. Installation	1	8/22/45
15685-A	Harness-Aux.Gen. Volt Reg. to Aux. Gen. Main Gen.Volt, Reg. to Main Gen. for M4A1 Tank - E12-7R1 F.T. Installation	1	8/22/45
15686-A	Harness Battery Term. Box to Rear Term. Box for M4A1 Tanks E12-7R1 F.T. Installation	1	8/22/45
15687-A	Harness Instrument Panel to Rear Terminal Box (Mag. Line) for M4A1 Tanks E12-7R1 F.T. Installation	1	8/22/45
15688-A	Harness-Batt. Term. Box to Radio Term. Box for M4A1 Tank E12-7R1 F.T. Installation	1	10/16/45
15689-A	Harness-Batt. Term. Box to Main Genr. Voltage Reglt'r. for M4A1 Tank, E12-7R1 F.T. Installation	1	8/22/45
15690-A	Harness-Main Gen.Regulator to Rear Term. Junction Box for M4A1 Tank, E12-7R1 F.T. Installation	1	8/22/45

Drawing No. (M.W.K. Co.)	Subject	Revision	Date
15691-A	Harness-Battery Term. Box to Slip Ring Box in Hull for M4A1 Tank, E12-7R1 F.T. Installation	1	8/22/45
15692-A	Harness-Radio Box to Slip Ring Box for M4A1 Tank, E12-7R1 F.T. Installation	1	10/16/45
15694-A	Harness Slip Ring Box to Turret Switch Box Via Fuel Switch for M4A1 and M4A3 Tanks, E12-7R1 F.T. Installation	1	8/22/45
15695-A	Harness Slip Ring Box to Turret Radio Box for M4A1 and M4A3 Tanks, E12-7R1 F.T. Installation	1	8/22/45
15696-A	Harness-Turret Switch Box to Turret Radio Box for M4A1 & M4A3 Tanks, E12-7R1 F.T. Installation	1	8/22/45
15697-A	Harness-Fuel Sol. J.B. to Mach. Gun Sol. & Ignition Coils Turret Sw. Box to Foot SW-Foot SW to Fuel Sol.Junc.Box for M4A1 & M4A3 Tanks-E12-7R1 F.T. Installation	1	8/22/45
15722-A	Electrical Harness Layout Plan-Hull for M4A3 Tanks, E12-7R1 F.T. Installation	-	10/16/45
15723-A	Electrical Harness Layout-Section "K-K" Hull for M4A3 Tanks, E12-7R1 F.T. Installation	-	10/16/45
15724-A	Elec. Harness Layout Sections "L-L" "M-M" "N-N" & "P-P" Hull for M4A3 Tanks, E12-7R1 F.T. Installation	-	10/16/45
15725-A	Harness-Batt. Term. Box to R.&L. Gen.Regulators for M4A3 Tank, E12-7R1 F.T. Installation	-	9/19/45
15726-A	Harness-Batt.Term.Box to Starter for M4A3 Tank, E12-7R1 F.T. Installation	-	9/21/45
15727-A	Harness-Batt.Term.Box to Slip Ring Box for M4A3 Tank, E12-7R1 F.T. Installation	-	9/25/45
15729-A	Harness-Sponson Terminal Box to Rear Term.Box for M4A3 Tanks, E12-7R1 F.T.Installation	-	9/26/45
15730-A	Harness-Batt.Term.Box to Spon. Term.Box.Batt.Term.Box to Aux. Gen.Volt Reg. & Aux. Gen. Volt Reg. to Aux.Gen. for M4A3 Tank, E12-7R1 F.T. Installation	-	9/27/45

Drawing No. (M.W.K. Co.)	Subject	Revision	Date
15731-A	Harness-Right & Left Gen.Volt Reg. to R.&L. Gen. Inst. Panel to R.&L. Mag. Section Near Sponson Term.Box for M4A3 Tank, E12-7R1 F.T. Installation	-	10/3/45
15732-A	Piping Arrangement in Hull for M4A3 Vehicles Only	-	10/20/45
11621-B	Atomizer Control Valve Foot Pedal Switch Assemoly E12-7R1 in M4A1	3	8/10/45
11622-B	Counter Weight Box	1	8/3/45
11624-B	Lower Elec. Recep. Flg. & Split Band for Collector Ring Assembly	3	9/7/45
11625-B	Bill of Material for 1-Fuel Tank Mkd. FH-1	-	3/30/45
11626-B	Bill of Material for 1-Fuel Tank Mkd. FH-2	-	3/30/45
11627-B	Bill of Material for 1-Air Bottle Mkd. AH-1	-	3/30/45
11628-B	Bill of Material for 1-Air Bottle Mkd. AH-2	-	3/30/45
11629-B	Bill of Material for 1-Secondary Fuel Tank Mkd. SFB-1	-	3/30/45
11630-B	Bill of Material for 1-Auxiliary Air Bottle Mkd. AAB-1	-	3/30/45
11631-B	Bill of Material for 1-Atomizer Tank Mkd. ATB-1	-	3/30/45
11632-B	Decalcomania Stencils	-	3/29/45
11633-B	Decalcomania Stencils	-	3/27/45
11634-B	Bill of Material for 1-Fuel Tank Mkd. FB-1	-	4/9/45
11635-B	Bill of Material for 50 Sets of Tanks FB-1	-	4/9/45
11636-B	Bill of Material for 100 Sets of Tanks FB-1	-	4/9/45
11637-B	Flame Resistant Ignitor Lead	-	4/14/45
11638-B	Bill of Material for 1-Turret Basket	-	4/16/45
11639-B	Bill of Material for 75 Sets of Turret Baskets	-	4/16/45
11640-B	Bill of Material for 228 Sets of Turret Baskets	-	4/16/45
11641-B	Hold Down Blocks for Chimneys	-	5/19/45
11642-B	Shaft for Rotor Support L. Side	1	6/14/45
11643-B	Shaft for Rotor Support	-	5/23/45
11644-B	Bearing Housing	1	6/14/45
11645-B	Main Flange for Swing Joint	3	6/30/45
11646-B	Electrical Assembly Detailed Sections BA-9-1 and BA-9-2	2	7/11/45
11647-B	Oil Cylinder-Oil Cylinder Flange & Shielding Flange	4	7/23/45

Drawing No. (M.W.K. Co.)	Subject	Revision	Date
11648-B	Bill of Material & Part Numbers	4	6/30/45
11658-B	Peep Sight Assembly & Etching for Periscope	2	5/3/45
11663-B	Gas Cutting Diagrams for Miscellaneous Rotor Parts	-	5/14/45
11669-B	Bill of Material for One (1) Set of Pressure Vessels in Hull & Their Supports	-	5/24/45
11670-B	Bill of Material for One (1) Set of Pressure Vessels in Hull & Their Supports	2	8/4/45
11671-B	Bill of Material for One (1) Basket & One (1) Set of Pressure Vessels in Basket & Their Support	1	6/5/45
11672-B	Bill of Material for (1) Set of Fire Extinguisher Equipment for M4A1 or M4A3 Vehicles	3	8/10/45
11673-B	Bill of Material for (1) Set of Fire Extinguisher Equipment for M4A1 or M4A3 Vehicles	3	7/27/45
11674-B	Bill of Material for (1) Set of Electrical Wiring in Hull	-	6/21/45
11675-B	Bill of Material for (1) Set of Electrical Wiring in Hull	4	8/11/45
11679-B	Bill of Material for (1) Set of Parts for Stowage	3	7/27/45
11680-B	Bill of Material for (1) Set Slip Joint Assembly & Misc. Material	4	8/11/45
11681-B	Bill of Material for (1) Set of Name Plates for M4A1 & M4A3 Vehicles	2	8/11/45
11682-B	Bill of Material for (1) Set of Name Plates for M4A1 & M4A3 Vehicles	2	7/26/45
11683-B	Bill of Material for Ordnance Spare Parts Required Per 100 Vehicles	2	8/10/45
11684-B	Bill of Material for Ordnance Spare Parts Required Per 100 Vehicles	2	8/10/45
11685-B	Bill of Material for Ordnance Spare Parts Required Per 100 Vehicles	1	7/12/45
11686-B	Bill of Material for Ordnance Spare Parts Required Per 100 Vehicles	2	8/11/45
11687-B	Bill of Material for (1) Set of Low Pressure Piping in Hull	4	8/9/45

Drawing No. (M.W.K. Co.)	Subject	Revision	Date
11688-B	Bill of Material for (1) Set of Low Pressure Piping in Hull	5	8/10/45
11692-B	Drain Valve Assembly		
11702-B	Bill of Material for (1) Set of Complete Ejector Equipment for M4A1 Vehicles	3	7/27/45
11703-B	Bill of Material for (1) Set of Complete Ejector Equipment for M4A1 Vehicles	4	8/13/45
11704-B	Bill of Material for (1) Set of Electrical Wiring in Hull	6	7/30/45
11705-B	Bill of Material for (1) Set of Piping in Turret & Basket	3	8/4/45
11706-B	Bill of Material for (1) Set of Piping in Turret & Basket	3	8/4/45
11707-B	Bill of Material for (1) Set of Piping in Turret & Basket	7	8/10/45
11708-B	Bill of Material for (1) Set of Electrical Wiring in Turret & Basket	-	7/5/45
11709-B	Bill of Material for (1) Set of Electrical Wiring in Turret & Basket	4	8/11/45
11710-B	Bill of Material for (1) Set of Electrical Wiring in Turret & Basket	2	8/4/45
11711-B	Bill of Material for (1) Set of Piping in Turret & Basket	6	8/11/45
11712-B	Drain Valve Assembly	-	6/2/45
11714-B	Bill of Material for 22 Sets of Turret Baskets	-	7/3/45
11717-B	Bill of Material for 10" Dia. Sump in Turret (Dwg. 15592A) & for 8" Dia. Sump in Tur. (Dwg.15650A)	1	8/8/45
11718-B	Bill of Material for (1) Set of Parts for Stowage	2	7/30/45
11722-B	Bill of Material for (1) Set of Electrical Equipment in Hull	-	8/11/45
11723-B	Bill of Material for Arrangement of Ejector Unit, Chimney & Rotor	-	8/5/45
11725-B	Cap, Trunnion, Right	-	6/12/45
11727-B	Bill of Material for (1) Set of Ejector Equipment	-	8/13/45
1G	A.P.I.-A.S.M.E. 2:1 Ellipsoidal Formed & Flanged Heads	3	6/2/45
2G	A.P.I.-A.S.M.E. 2:1 Ellipsoidal Formed & Flanged Heads	1	5/10/45
3G	A.P.I.-A.S.M.E. 2:1 Ellipsoidal Formed & Flanged Heads	1	5/10/45
4G	A.P.I.-A.S.M.E. 2:1 Ellipsoidal Formed & Flanged Heads	1	5/10/45

Drawing No. (M.W.K. Co.)	Subject	Revision	Date
5G	A.P.I.-A.S.M.E. 2:1 Ellipsoidal Formed & Flanged Heads	1	5/10/45
6G	Seamless Swaged Ends	1	5/11/45
7G	2-1/2" Forged Steel Flanges	2	7/11/45
8G	2-1/2" Forged Steel Flanges	1	7/11/45
9G	2-1/2" x 2" Reducing Flanges	1	7/11/45
10G	2-1/2" Flange Forging	2	7/11/45
11G	Special Couplings	-	3/15/45
12G	Rubber Covered Steel Plate Parts	-	4/4/45
13G	Rubber for Supports of Vessels in Basket & Hull	-	4/4/45
14G	Wire Guide Clips	-	3/30/45
15G	Rubber Supporting Rings	-	3/30/45
16G	Cadmium Plated Screw for Backstop	-	3/18/45
17G	Supports for Fuel Tanks in Hull	-	3/18/45
19G	Gun Flange Rings	-	3/30/45
20G	Gears for Gear Box	-	3/21/45
21G	Air Bottle AH-1, Cutting Diagram for Supports & Brackets	-	3/20/45
22G	Copper & Brass Rings	-	3/21/45
23G	Insulating Rings	-	3/21/45
24G	Bracket Plate	-	3/23/45
25G	Bearing & Lock Nuts for Speed Gear Box	-	3/23/45
26G	Grounding Electrode	-	3/23/45
27G	Chimney Hold-Down Lugs	-	4/2/45
28G	Chimney Hold-Down Lugs	-	4/4/45
29G	Inner - Ring	1	7/14/45
30G	Lock Nut	1	7/14/45
31G	Outlet for Fuel Tank FB-1	1	7/2/45
32G	2-1/2" Spec. Welding Neck Flanges	1	7/11/45
33G	4-1/2" O.D. Air Bottles	3	5/10/45
34G	1" Adapter & Dip Pipe for 4" Air Bottles	-	4/24/45
35G	Machining of Ends & Completion of Welding for Fuel Tanks FH-1 and FH-2	-	4/16/45
36G	Pipe Bends	-	4/19/45
37G	1/2" Tube Threaded Adapter	1	6/2/45
38G	3/8" Pipe Threaded Adapter	1	6/2/45
39G	1/2" Pipe Threaded Adapter	1	6/2/45
40G	Modification Details	2	6/18/45
41G	Electrical Wiring Details	1	6/17/45
42G	Flange Forging Blank	-	4/26/45
43G	Alteration of Bolt (B-207727)	-	4/29/45
44G	Alteration of Bolt (B-253374)	-	4/28/45
45G	Alteration of Bolt (B-257837)	-	4/28/45
46G	Tubing Straps for CO_2 Lines	2	7/30/45
49G	Bracket Plate	-	5/18/45
51G	Stowage Rack for .30 Cal. Ammunition Boxes	-	5/25/45

Drawing No. (M.W.K. Co.)	Subject	Revision	Date
52G	.30 Cal. Ammo. Box Holder	-	5/25/45
53G	First Aid Box Holder	-	5/26/45
54G	.30 Cal. Ammo. Box Stowage (To Hold 5 Boxes)	-	5/26/45
55G	Canteen Clips	-	5/26/45
56G	Bracket for .45 Cal. Sub-Machine Gun .	-	5/28/45
57G	Storage Shelf-.45 Cal. Ammo.	-	5/28/45
58G	Stowage Clips for Spare Tracks	-	5/28/45
59G	Support Bracket for Ration Box	-	5/28/45
60G	.30 Cal. M.G. Spare Barrel Bracket	-	5/28/45
61G	Camouflage Net & Tarpaulin Carrier	-	5/28/45
62G	M.G. Tripod Support Bracket	-	5/21/45
63G	Clip for .50 Cal. Spare Barrel	-	5/28/45
64G	.45 Cal. Machine Gun Bracket	-	5/28/45
65G	.45 Cal. Sub. M.G. Ammo. Holder	-	5/29/45
66G	Oil Can Stowage Rack	-	5/29/45
67G	Spare Track Parts	-	5/25/45
68G	M.G. Spare Parts Box	-	5/25/45
69G	Ration Box	-	5/25/45
70G	Flame Thrower Spare Parts Box	-	5/7/45
71G	Spare Flame Thrower Nozzles	-	5/29/45
72G	.50 Cal. Ammo. Stowage	-	5/24/45
73G	Gage & Regulator Manifold for Turret	-	5/20/45
74G	Spare Periscope Holder	-	6/6/45
75G	Forward Stowage Rack Assembly	-	5/29/45
76G	Spare Prism Blocks 5 Gal. Water Can Flame Thrower Spare Parts	-	6/11/45
77G	Driver's Sub-M.G. Holder	1	7/30/45
78G	Miscellaneous Stowage	-	6/11/45
79G	Nameplate - Firing Time	1	6/29/45
80G	Nameplate - Zinc	-	6/19/45
81G	Support for Relief Valves in Turret	-	7/9/45
82G	Details for Relief Valve Support in Turret	-	7/9/45
83G	Pipe Clamp for Air Inlet & Over Flow Pipes on FH-1 Tank in Hull	1	7/30/45
84G	Weld Block & Straps for Tee to Explosion Head Located on Rear Bulkhead of Hull	1	7/30/45
85G	Support for 1" O.D. Tubing in Hull Gage on Turret Wall	1	7/31/45
86G	Support & Clamp for Gauge	-	6/28/45
87G	Clamp for 1" O.D. Tubing in Hull	1	7/30/45
88G	Clips for CO_2 Tubing & Fire Pulls	2	7/31/45
89G	Cone Support Clips	1	7/30/45
90G	Shields Back of Driver Seats	-	6/29/45
91G	Support for Relief Valves R.H. Sponson Near Air Tank AH-1 in Hull	1	7/31/45

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Drawing No. (M.W.K. Co.)	Subject	Revision	Date
92G	Support for 1/2" Walworth Valve & Fire Pulls Located on Port Side of Hull	1	7/30/45
93G	Support for Air Regulator Inlet Valve	1	7/30/45
94G	"Y" Strainer Support for Hull & Basket	1	7/30/45
95G	Main Gen.Reg. Support in Hull	1	7/30/45
96G	Main Fuel Vent Valve Support	1	7/30/45
97G	Support for Grove Regulator Located in Hull	1	7/30/45
98G	Valve Support - Main Regulator Outlet	1	8/1/45
99G	Main Fuel Fill Valve Support	1	7/31/45
100G	Ryalloy Grounding Stake & Support	-	7/9/45
101G	Supports for CO_2 Bottles in Hull	1	7/14/45
102G	Bracket for Fire Extinguisher in Turret	1	7/30/45
103G	Gauge & Regulator Panel Supports	1	7/30/45
104G	Wood Boxes for Shipping. Collector Ring Assembly	-	7/3/45
105G	Support for 1/4" Tubing in Turret	1	7/29/45
106G	Tube Protector for 1/4" O.D. Tubes on Floor of Turret	1	7/29/45
107G	Support Complete for 1/4" to 1/2" Cocks above Sec. Fuel Tank	1	7/29/45
108G	Details for Assembly (See Sk. #107G)	1	7/29/45
109G	Support for Two 3000# Valves Located Over Auxiliary Fuel Tank	1	7/29/45
110G	Support for Solenoid Valve & 1/4" O.D. Tubes for Atomizer Air & Fuel to Gun	2	8/2/45
111G	Walkie-Talkie Bracket Inside Turret	1	8/2/45
112G	Miscellaneous Supports in Hull	1	7/29/45
113G	Supporting Clips for Atomizer Fuel & Air Tubes on RH Rotor Support & Hose to CO_2 Bottles in Turret	-	7/5/45
114G	Support Clips for Atomizer & Air Conn. on RH Rotor Support	-	7/5/45
115G	Nameplate		
116G	Nameplate - Brass	-	7/7/45
117G	Clamp for 5/8" O.D. Tube in Hull	1	7/29/45
118G	Nameplate Supports	2	8/2/45
119G	Support Clips for 1/4" O.D. Tubes	1	7/29/45
120G	Support for Floor Drain Valve Handle Extension	1	7/29/45

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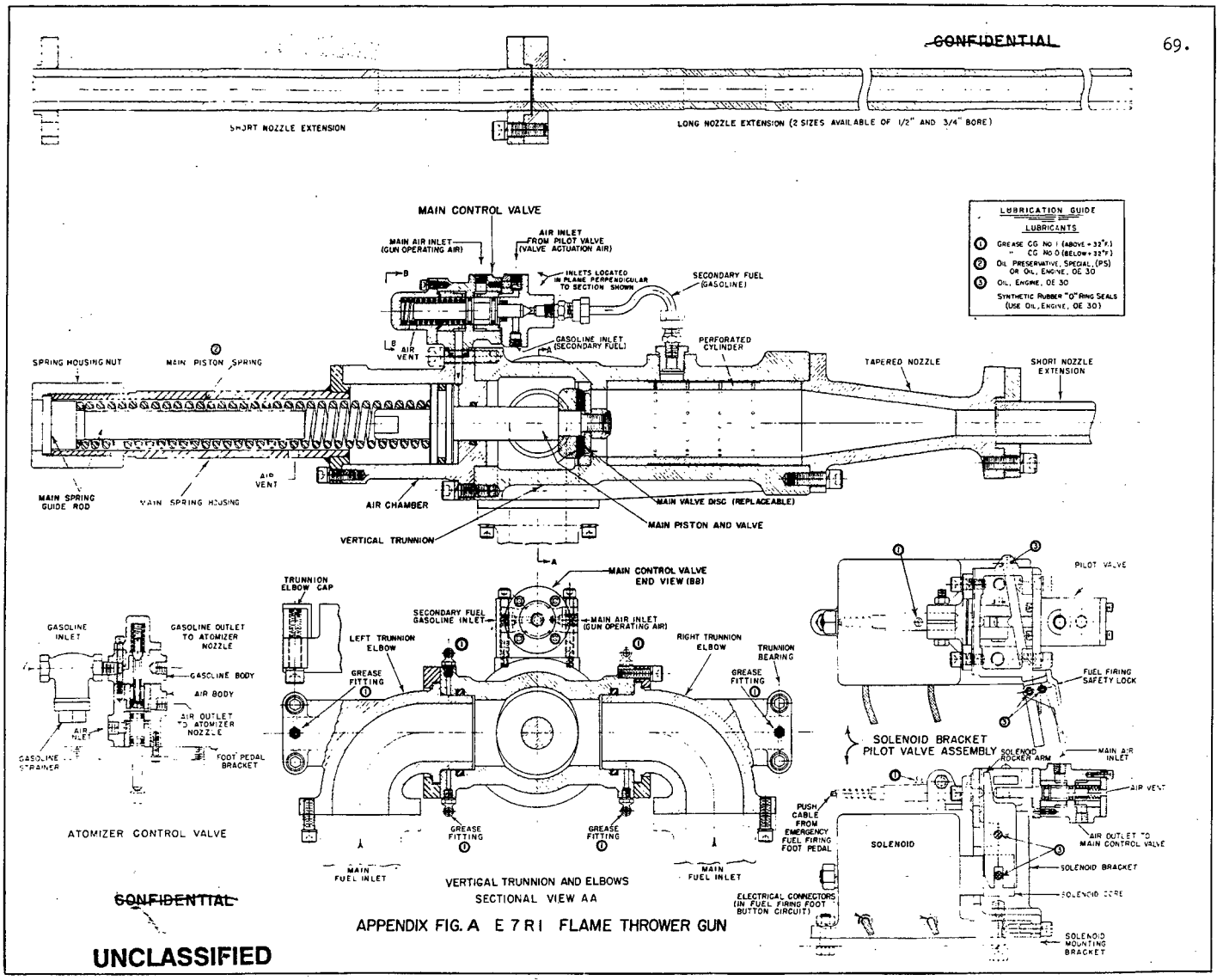
Drawing No. (M.W.K. Co.)	Subject	Revision	Date
121G	Clamp for Three 1/4" O.D. Tubes	1	7/30/45
122G	Pipe Conduit Over Walkie-Talkie Radio for M4A1 & M4A3 E12-7R1 F.T. Installation	1	7/30/45
123G	Bracket for Generator Shield	1	8/4/45
124G	Generator Shield & Bracket	2	8/4/45
125G	Outer Ring	1	7/21/45
126G	Generator Shield	2	8/4/45
127G	Mounting Bracket for Aux. Voltage Regulator for M4A1 & M4A3 Tanks, E12-7R1 F.T.Installation	1	7/29/45
128G	Alterations to 4" Octagon Box For Fuel Switch for M4A1 & M4A3 Tanks,E12-7R1 F. T. Installation	-	7/30/45
129G	Counterweight Safety Plate	-	7/24/45
130G	Supports for Portable CO_2 Bottle in Turret	-	7/25/45
131G	Supports for Stowage Box	1	7/29/45
132G	Support Bracket for Interphone Switch Box B.C. 658-B in Turret for M4A1 or M4A3 Tanks, E12-7R1 F.T. Installation	-	7/25/45
133G	Support Bracket for Interphone Switch Box BC-1361 in Hull for M4A1 & M4A3 Tanks, E12-7R1 F.T. Installation	-	7/25/45
134G	Support for Grenade Box	-	7/28/45
135G	Box for Spare Parts Set (2nd Echelon)	-	7/27/45
137G	Conduit Bracket Support	-	8/17/45
138G	Binocular Mock-up	-	8/22/45
139G	Container for Mounting Binocular on Turret Wall	-	8/28/45
140G	Bracket for Right Main Gen. Volt Reg.	-	10/18/45
141G	Bracket for Left Main Gen. Volt Reg.	-	10/18/45
1-D	Bakelite Electrical Bushing	-	3/22/45
2-D	Cannon Adapter & Copper Strap	1	6/18/45
3-D	Counter Weights	-	4/2/45
4-D	Counter Weights	-	4/2/45
5-D	Counter Weights	-	4/2/45
6-D	Elevating Caps	1	5/9/45
7-D	Ring Gauge	-	4/4/45
8-D	Plug Gauge for Pinion Gear	-	3/22/45
9-D	Shaft for Speed Gear Box	-	3/23/45
10-D	Spacers for Ball Bearing	-	3/23/45
11-D	Shielding Angle & Angle Lug	1	6/17/45

Drawing No. (M.W.K. Co.)	Subject	Revision	Date
12-D	Plug Gage	-	3/31/45
13-D	Decalcomania Stencils	-	4/16/45
14-D	Decalcomania Stencils	-	4/16/45
15-D	Detail of Lead Slab	-	4/16/45
16-D	Electrical Terminal Bolt	2	6/17/45
17-D	Bolt for Modifying Generator	-	4/24/45
18-D	Valve Handle	-	4/28/45
19-D	Lead Counterweight	-	5/7/45
20-D	Drain Valve Plunger Retainer	3	8/27/45
21-D	Locking Bolt for Charging Pot	-	5/7/45
22-D	Spring Clips for Rubber Parts in Chimney	-	5/7/45
23-D	1" Adapter	-	5/11/45
24-D	Stamping of Connections on FH-1	-	6/30/45
25-D	Stamping of Connections on FH-2	-	6/30/45
26-D	Stamping of Connections on FB-1	-	6/30/45
27-D	Stamping of Connections on SFB-1	-	6/30/45
28-D	Stamping of Connections on ATB-1	-	6/30/45
29-D	Stamping of Connections on AAB-1	-	6/30/45
30-D	Stamping of Connection on AH-1	-	6/30/45
31-D	Stamping of Connection on AH-2	-	6/30/45
32-D	Stamping of Connection on 4-1/2" O.D. Air Bottles	-	6/30/45
33-D	3/4" Pipe Locknut	-	5/26/45
34-D	Basket for 1" Angle Type Vogt Strainer	-	6/1/45
35-D	Oil Cylinder Details	-	6/4/45
36-D	Jam Nut	2	7/24/45
37-D	Gasket	1	6/30/45
38-D	Locking Bolt	2	7/11/45
39-D	Drain Connection	3	7/24/45
40-D	8" Periscope Cover	-	6/3/45
42-D	Adjusting Screw	1	6/27/45
43-D	Electrical Terminal Bolt	-	6/14/45
44-D	Spring Clips for Rubber Parts in Chimney	-	6/14/45
45-D	Brass Cap for Flared Tube Fittings	-	6/29/45
46-D	Detail of Template for Scribing Hairlines on Periscope	-	7/1/45
47-D	Detail of Template for Scribing Hairlines on Periscope	2	7/19/45
48-D	Safety Outlet in Charging Receptacle	2	8/2/45
49-D	Nameplates for Kit Boxes	1	7/24/45
50-D	Periscope Scribers	-	8/1/45
51-D	Conduit Clamps	-	8/1/45
52-D	Conduit Clamps	-	8/2/45
53-D	1/2" x 3/8" Hex. Steel Reducing Bushing	-	8/6/45
54-D	Conduit Bracket Support	-	8/23/45
55-D	Conduit Support Bracket	-	10/11/45



APPENDIX FIG. A E 7 R1 FLAME THROWER GUN

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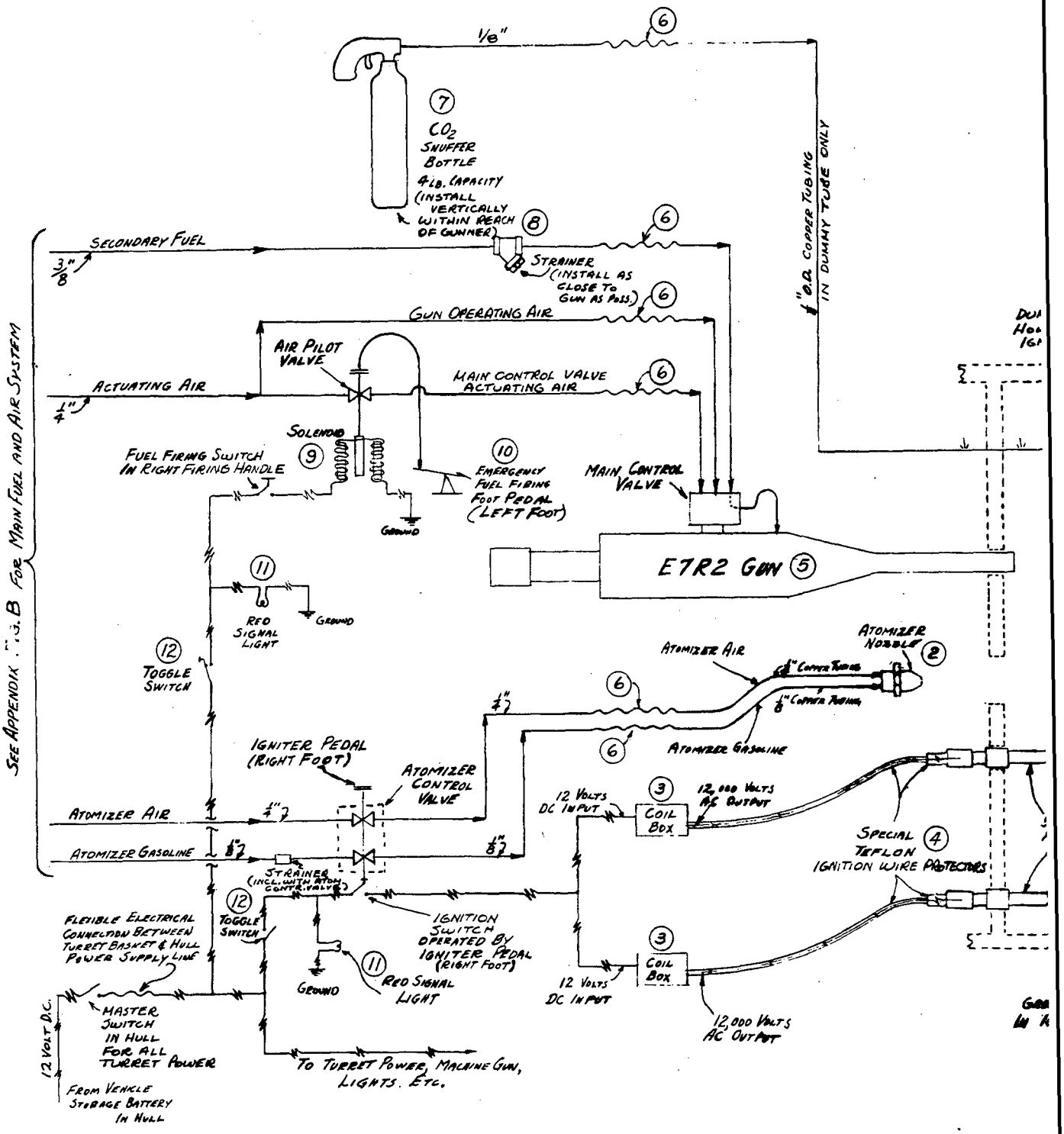

NOTE—
(1) RED SIGNAL LIGHTS & TOGGLE SWITCHES IN IGNITION AND FUEL FIRING CIRCUITS TO BE IN FRONT OF & EASILY AVAILABLE TO GUNNER.

APPENDIX FIG. C FIRING CONTROL SYSTEM – E14-7R2 MECI

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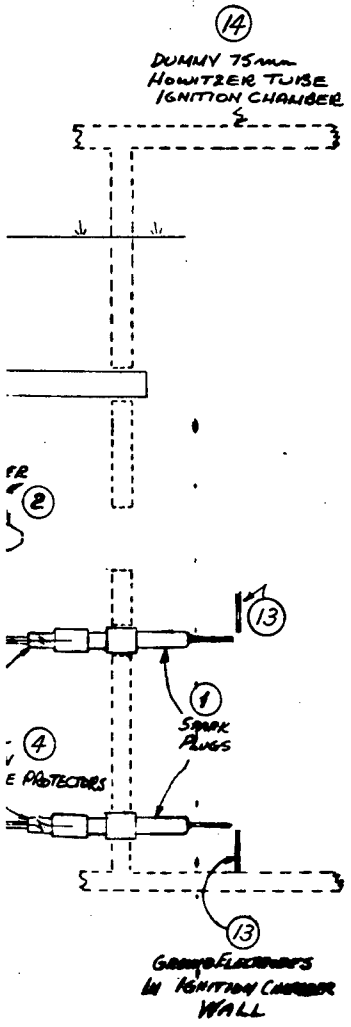
ITEM No.	DESCRIPTION
1	IGNITER SPARK PLUG WITH SPECIAL BALLISTIC MOUNT – MODEL I-11
2	GASOLINE ATOMIZER NOZZLE, IGNITER SPRAY MODEL 5100 – THE DE VILBISS CO.
3	SPECIAL COIL BOX S-1377 B, SPLASHPROOF, TROPICALIZED, WITH HERMETICALLY SEALED VIBRATOR 12V. D.C. INPUT – 12,000 VOLTS AC OUTPUT ~ ELECTRONIC LABORATORIES, INC.
4	SPECIAL TEFLON IGNITION WIRE PROTECTORS
5	E7R2 GUN – SEE DRWG. 31719-201 LECOURTENAY CO.
6	3/16" I.D. SYNTHETIC RUBBER 3-PLY FABRIC REINFORCED HOSE SPEC. AN-H-6a
7	4 LB. CO_2 FIRE EXTINGUISHER WITH PISTOL GRIP ACTUATING VALVE
8	1/2" VOGT No. 2272 FORGED STEEL HORIZONTAL 'Y' TYPE STRAINER HENRY VOGT CO.
9	12 VOLT D.C. SPECIAL SOLENOID, TROPICALIZED, SIMILAR TO LECOURTENAY PART 479-99
10	FOOT PEDAL PUSH CABLE ASSEMBLY, U.S.A. ORDNANCE, EQUIV. TO THAT USED IN E12-7R1
11	RED SIGNAL LIGHT, U.S.A. ORDNANCE, EQUIV. TO THOSE USED IN E12-7R1
12	TOGGLE SWITCH, U.S.A. ORDNANCE, EQUIV. TO THOSE USED IN E12-7R1
13	GROUNDING ELECTRODE (GROUND TO DUMMY TUBE WALL) SPECIAL, 1/8" NICHROME
14	DUMMY "75 mm HOWITZER" TUBE – 1/2" FACE-HARDENED ARMOR PLATE, DEMOUNTABLE WITH REMOVABLE HORIZONTAL COVER – SOD CO. DRWG 31719-205
15	QUICK-ATTACHABLE END COUPLINGS FOR ITEM 7, AN-787-4
16	SALT-WATER CORROSION-RESISTANT 16-GAGE WIRE SARAL PROTECTORS FOR ITEM 7
17	MISCELLANEOUS STEEL FLARED TUBE FITTINGS SUCH AS NIPPLES, TEES, ELBOWS, ETC., CORRESPONDING TO SPEC. AN-816-4, AN-825-4, AN-822-4, RESPECTIVELY, NECESSARY TO CONNECT FLEXIBLE HOSES BETWEEN BASKET PIPING & E7R2 PARTS MOVING WITH GUN IN ELEVATION



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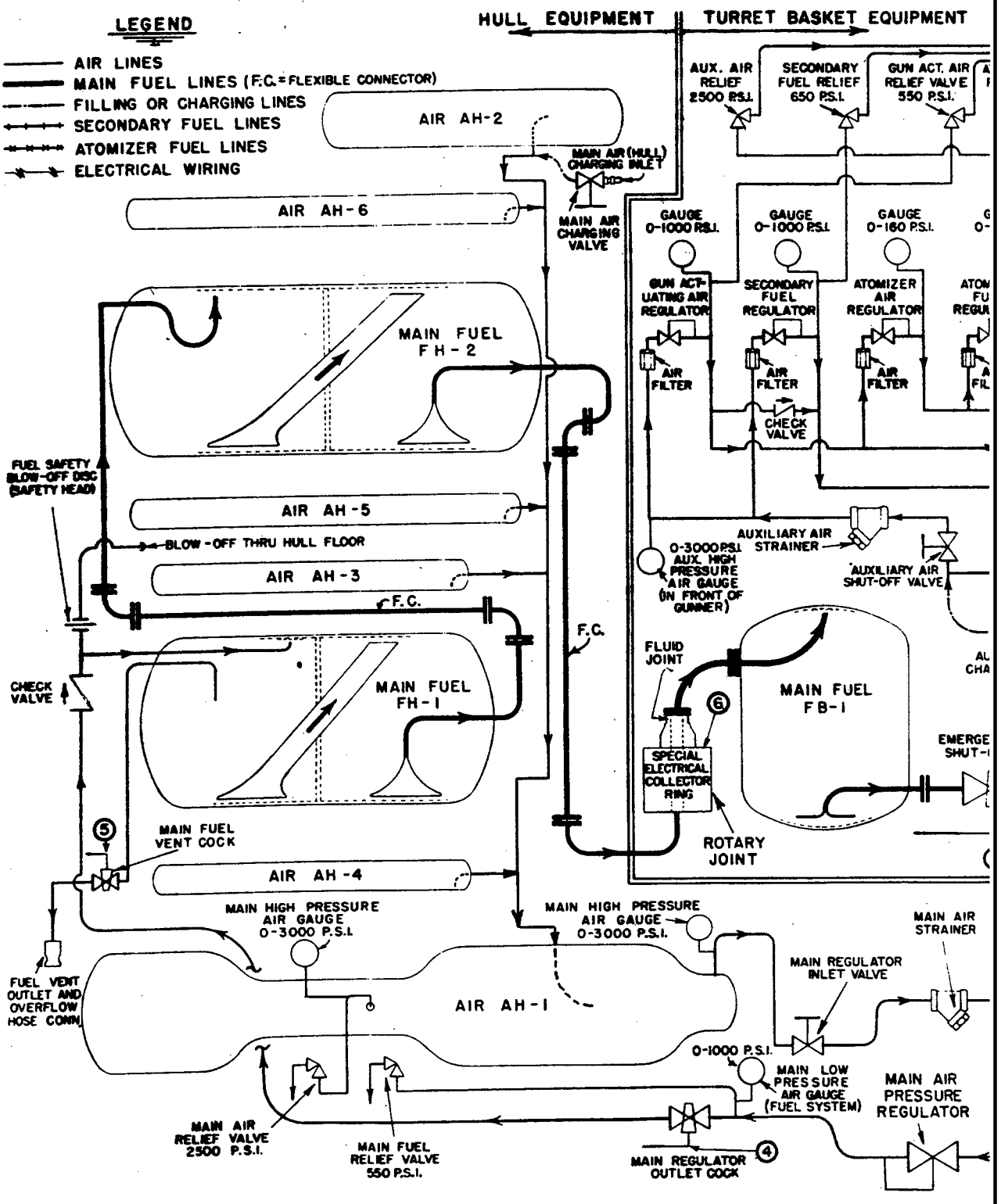
I-7R2 MECHANIZED FLAME THROWER IN LVT-AI AMPHIBIOUS TANK



APPENDIX FIG: B FLOW PLAN M5
IN M4A1 OR M4A3

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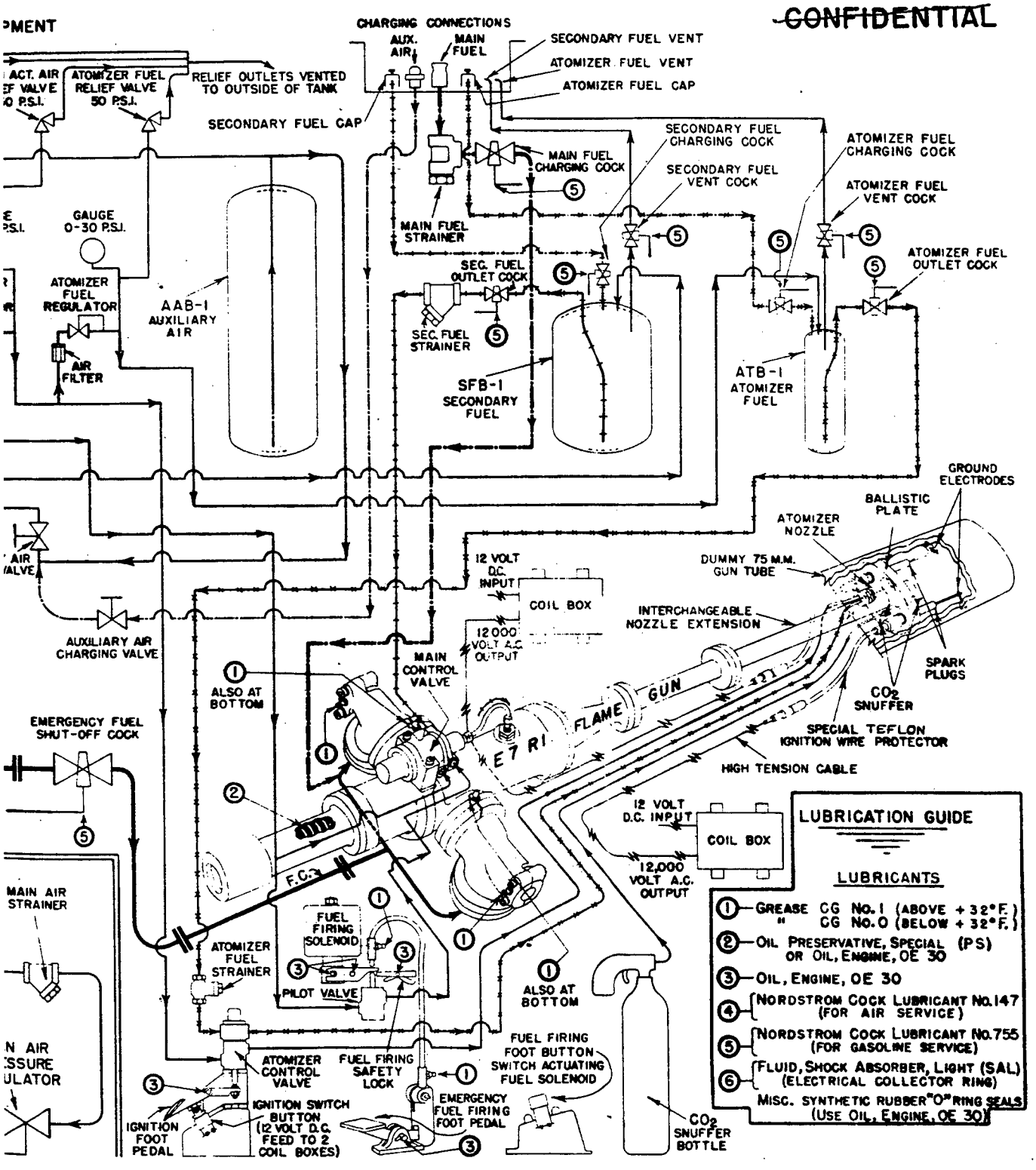

V M5-4 (E12-7RI) FLAME THROWER
14A3 MEDIUM TANK

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