

CADILLAC GAGE COMPANY

DATE 5 October 1967

TO Armored Car

FROM F. A. Airhart

SUBJECT: UNIVERSAL TURRET FOR ARMORED CAR

The following summary was compiled as a result of an Armament Group study of the E.F.R. reports on the Armored Car Turret made by both the American and Canadian Governments^f, as well as this company's own experience and observations.

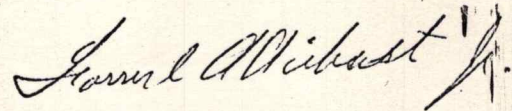
The Armament Group considers it unfeasible to adequately improve or incorporate the items in the following summary and marked with an asterisk (*) into the existing basic Armored Car Turret design and bearing ring size.

Since a substantial redesign program would be required to adequately correct the correctable deficiencies and shortcomings, it is proposed by the Armament Group that a Universal Turret on a larger bearing ring (1 meter) be designed and developed for the Armored Car.

In addition to the features described in the proposal, this new design and development program would be conducted with cognizance of the deficiencies and shortcomings cited in the summary.

FAA:js

Enclosures

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INTRODUCTION

The Armament Group presents the following proposal for the design and development of a Fully Enclosed "Universal" Armament Station compatible with the XM706 Armored Car.

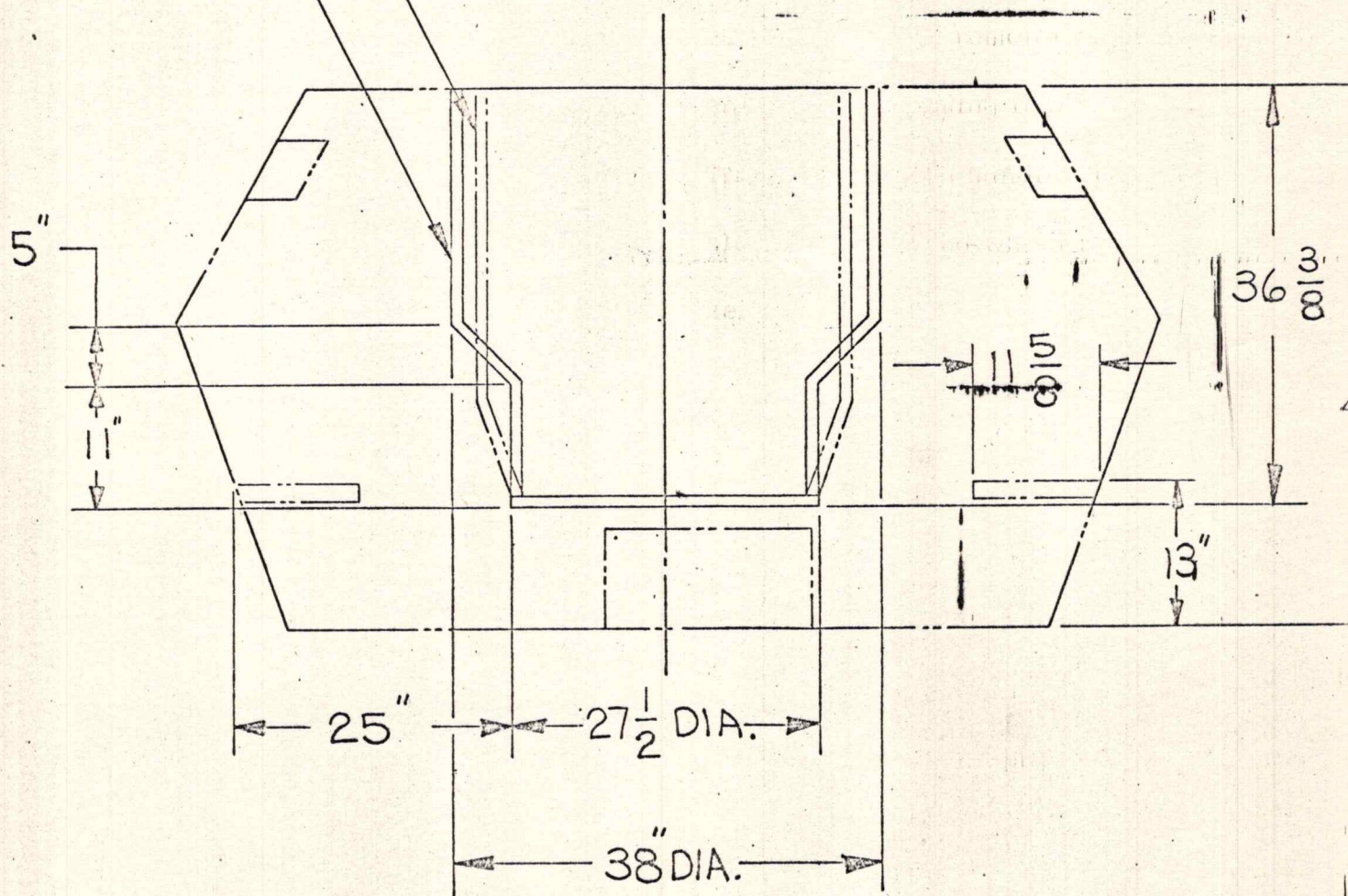
The design concept of the proposed armament station has been studied and proven to be feasible. Briefly, the concept is to provide a fully enclosed continuously rotating turret, which will be capable of mounting a variety of small arms weapons packages ranging from 5.56mm multiple machine guns up to a combination of 40mm Rapid Fire Grenade Launcher and machine gun. The station will provide superior vision and human engineering considerations.

The Universal Station will be capable of being changed from one weapons set to another by merely "bolting on" various cradle assemblies, ammunition boxes, feed members, sights, etc. No alteration to the basic turret/vision ring/hatch assembly will be required.



UNIVERSAL TURRET BASKET

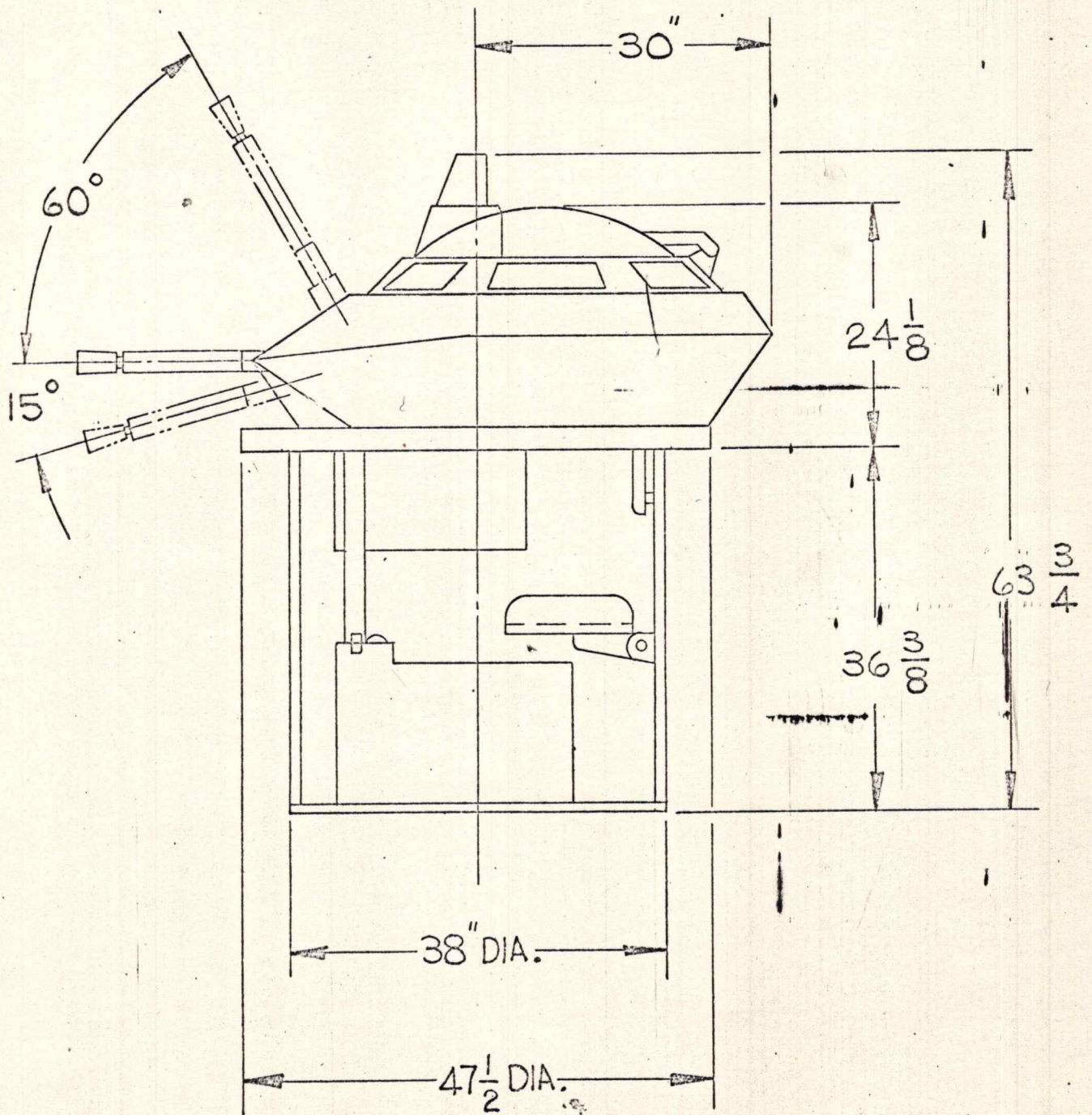
STANDARD ARMORED CAR
TURRET BASKET



PROPOSAL #67-18

CROSS SECTION THRU

COMMANDO BODY AT TURRET



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Introduction

The philosophy of operation of the _____ vehicle retrofit program is such as to require the use of a fully enclosed powered cupola mounting weapons capable of defending against attack from light tactical armored vehicles and infantry personnel. The power controlled cupola replaces a more conventional manually operated system. To maintain a reliability level comparable to that of a manual system and yet provide the improved response, convenience and functional features of power controls, it is apparent that the powered cupola system must be simple and employ components of proven reliability.

In the following pages, Cadillac Gage Company describes its proposed concept for a fully enclosed, powered cupola which offers the necessary simplicity and reliability for use on the _____. The proposed concept and components are based on present state of the art practices and employ systems and materials proven in years of military service.

I. Design Features and Anticipated Design Parameters

Design Features

The fully Enclosed cupola is a powered continuously rotating armament station providing superior vision, fire control and protection for the gunner. Specially developed high hardness steel armor and eight (8) ballistically equivalent vision blocks provide cal .30 AP and antipersonnel grenade protection. 360° overlapping vision provides an excellent visual surveillance capability.

Weapon receivers are located internally to allow servicing while cupola is in a buttoned up condition. Toxic gases and spent cases and links are vented outside.

Cupola weapons are trained via a simple and reliable electro-hydraulic power control system. These power controls provide a light weight means of providing high traverse and elevation rates as well as smooth "fine-lay" capability. Power controls increase the cupola's combat capability and accuracy as well as reducing gunner fatigue. The proposed equipment has been designed to provide the following performance and design features.

- | | |
|---|--|
| A. <u>Cupola Body & Vision Ring</u> | Completely Enclosed, Internally Serviced and Operated |
| Armor..... | Specially developed high hardness armor - cal .30 AP and anti-personnel grenade protection |
| Vision..... | 360° overlapping (8 vision blocks ballistically equivalent to armor) |
| Entry or Egress..... | Cupola roof hatch opening or basket opening |
| Bearing Ring..... | Standard 1 meter ring with 39.37" diameter bolt circle |

Height.....24-1/8" irreducible to deck
 Width.....60" in diameter swept area
 (excluding weapons)
 Cupola Assembly Dry Weight.....1800 lbs.
 (less ammo, gunner & weapons)

B. Basket.....Lightweight, Welded Sections
 Slip Ring.....Channel capacity compatible with
 VRC/12 radio system
 Seat.....Adjustable height for open and
 closed hatch operation
 Floor.....38" diameter
 Depth.....36-3/8 below ring mounting face

C. Weapons System

Elevation - max.....60°
 Depression - max.....-15°
 Ready ammo.....200 rounds cal .50
 50 rounds 40MM grenades
 Spent Case & Link Ejection.....Outside cupola through ballistically
 protected openings
 Toxic Gas Control.....Weapons enclosed in vehicle air
 pressurized boot
 Trigger.....Control handles mounted switches -
 weapons armed and selected at control
 box.

D. Fire Control

Single cal .50 M-85 M.G.
 cupola.....M28C sight - 1.5X magnification
 Cal .50 M-85 M.G./40MM
 Grenade Launcher Cupola.....Special Cadillac Gage sight
 1X and 6X magnification in con-
 junction with 40MM ranging device
 to be selected by customer

E. Power Controls.....Electro-hydraulic
 Operating pressure.....1850 psi regulated

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Accumulator: Capacity.....27 in³
Precharge.....1350 \pm 25 psi

Power Pack Cycle.....On 1900 \pm 50 psi Off 2200 \pm 75 psi

Hand Pump: Displacement.....39 in³/stroke
Effort.....37 lb/1000 psi

Proof Pressure.....3000 psi

Burst Pressure.....4500 psi

Power.....23 VDC, 160 amps @ 1850 psi RFI
suppression; 2 mf 50 VDC 200 amps
max. current draw 200 amps at 2250 psi
and 2650 RPM

Flow and Pressure capabilities.3gpm @ 500 psi
2.3 gpm @ 1850 psi

Relief Valve Setting.....2350 \pm 50 psi

Azimuth Rate.....1 mil/sec. minimum tracking speed,
90°/sec. peak, 60°/sec. continuous

Elevation Rate.....1 mil/sec. min. tracking speed,
60°/sec. max.

100% grade - handles hard over turret will move

25-30° grade - brake will hold

II. Description

The following paragraphs contain detailed descriptions of the operation of the system and its components. Referenced diagrams and schematics can be found in the Appendix.

A. Cupola Body and Vision Ring

The cupola body is fabricated of specially developed high hardness light weight armor plate welded at approximately 30 degree obliquity. This material provides effective ballistic protection against small arms fire and anti-personnel grenades. Vision is provided by a vision ring of eight (8) ballistic vision blocks around the top of the station, so as to provide 360° overlapping vision unhindered by the weapon cradle assemblies. A large hatch is provided to allow rapid entrance and egress of the gunner to and from outside the vehicle.

B. Basket

The cupola basket is a welded fabrication of light weight standard sections suspended from and rotating with the cupola base ring. Included in the basket are provisions for mounting the power control components, ammo boxes, and adjustable gunner's seat assembly and an electrical slip ring assembly. The electrical slip ring has sufficient power and channel capacity to provide electrical energy for the power system and communications for the gunner.

C. Weapons System

The cupola's main armament, a cal .50 M-85 machine gun and secondary armament, 40MM grenade launcher are mounted in a ballistic cradle supported by trunnion bearings. Weapon receivers are located inside the cradle convenient to the gunner for servicing. Ready round boxes provide a large complement of ready to fire ammunition. Spent cases and links are ejected directly overboard through ballistic doors which open automatically and only when the weapons are armed. Toxic gas levels inside the cupola are kept at a minimum by enclosing the weapon receivers and feed chutes in a boot, pressurizing the boot with vehicle air and forcing the toxic gases outside the cupola through the mantelet openings in the cradle.

Electrical connections for weapon trigger solenoid and operating power are provided in the cradle.

D. Fire Control

1. Cal .50 Machine Gun Cupolas

Provisions for mounting an M28C periscope sight or equivalent will be provided. This sight has a reticle compatible with the cal .50 round and is linked directly to the weapon cradle.

2. RFGL/M.G. Cupolas

A sighting device for the 40MM high velocity grenade, suitable for Enclosed Cupola mount, is not yet available. Therefore, Cadillac Gage Company submits the following 40MM sighting device concepts for consideration for development:

a. Compensating Linkage

A mechanical linkage adjusting mechanism external to and in conjunction with an M28C Sight that could be set to a given range, causing the grenade launcher to assume the proper elevation when the sight reticle is "zeroed".

b. Fixed Periscope and Projected Range Indicator

A fixed periscope with an azimuth reticle and a cradle driven range indicator projecting into the field of view, either by lighted range numbers on a driven imprinted tape or a fixed range scale with a driven pointer could be used.

c. Sight Linkage Selector Interlocked with Weapon's Selector (or Vice Versa)

This would be a device designed such that when it is in the "machine gun" mode, the sight is driven 1:1 with the cradle and when placed in the "grenade launcher" mode, the sight would be fixed in a horizontal position, and the range would be read directly from a cradle mounted (elevation) indicator.

d. Liaison with Frankford Arsenal

As part of the proposed research and development, appropriate contact would be maintained with Frankford Arsenal personnel who are aware of the 40MM R.F.G.L. Fire Control problem and are participating in the development of a six power sight for replacement of the M28C.

E. Hydraulic Power Control System

Gun and cupola power controls are very similar to those of the many M-48, M-114, M-60 and M-109 vehicles currently equipped with Cadillac Gage power gun and turret control systems. The proposed system provides the same excellent target acquisition and tracking characteristics which have made the earlier systems so widely accepted. Ease of operation and simplicity of maintenance are similarly carried over into the proposed system. These proven systems are integrated into a single system optimized as to performance and installation for the specific requirements of the vehicle. The utilization of established system techniques and proven hardware items along with a history of successful accomplishment in ordnance fire control is offered as fundamental assurance of the ability of Cadillac Gage to provide reliable, effective, and economical systems for the subject vehicle.

Manual turret operation is accomplished through the use of a handpump. This fluid source replaces the electrically operated pump and supplies oil to operate the system otherwise in the same

fashion as in the power mode. This smooth, silent operational technique is similar to that successfully employed in M-114 and COMMANDO cupola installations.

The proposed system consists of several components ~~packages~~ along with associated tubing and harnessing. An installation drawing (figure _____) of these components is included in the appendix to this proposal as is a drawing depicting the proposed installation of this system in the cupola. The function and construction of the aforementioned components are described in the following paragraphs and hydraulic circuit diagram (figure _____).

1. Power Pack

The power pack unit serves as a hydraulic ~~power~~ supply for the system. In this unit, an electric motor deriving its power from the vehicle batteries drives a hydraulic pump which is contained within the oil reservoir. High pressure oil from this pump is stored in the built-in accumulator. Upon demand from the system, oil is routed through a filter system and into a pressure regulator valve. This valve serves the purpose of providing a source of constant pressure oil to the system. Operation of the motor pump is controlled by a built-in pressure switch. Motor operation is initiated when this switch senses the accumulator pressure to be at a level only slightly above regulated pressure. Motor operation is commanded until the pressure has reached design cut-off level. The pressure switch then turns the

of the weapons. Convenient means are provided for bleeding air from this cylinder.

4. Traverse Mechanism

Azimuth control of the cupola is accomplished through the use of the traverse mechanism. In the device a high performance hydraulic motor drives a conventional precision spur gear train. The gear train terminates in an anti-backlash pinion which in turn meshes with the cupola ring gear. Provisions are made for convenient adjustment of the anti-backlash pinion preload. A spring-loaded brake is used to lock the motor to prevent undesired rotation of the cupola. The brake may be disengaged by either electrical or mechanical means when cupola operation is desired. The ballistic ejection doors are heavily spring loaded, closed and operated by small hydraulic cylinders connected to the main hydraulic system through a valve.

5. Control Panel

Primary control of the cupola and its power system is accomplished through the use of the system control panel convenient to the gunner. All power and weapon system operating controls are mounted on this unit. These controls consist of a power switch to activate the power control system, weapons selection and arming devices and other accessory function controls.

The preceding paragraphs have described the several component items constituting the proposed cupola power system. In

the vehicle installation, these hardware items are interconnected by hydraulic tubing to make up the completed power control unit.

6. Operation Mode Descriptions

Power Operation

Power control operation of the cupola is initiated by energizing the "power control on" switch. This allows the system pressure switch to assume control of the hydraulic system which causes the power pack motor pump to pressurize the system as required. The gunner may now control the cupola solely through the manipulation of this control handle.

Physical displacement of the handles causes the displacement of a spool type hydraulic valve allowing flow of hydraulic fluid directly to the elevation cylinder. Gun depression is accomplished simply by tilting the control handles forward and elevation by tilting the handles rearward from the spring-loaded neutral center position. The rate of gun displacement is controlled by the amount of angular displacement of the handles from their center position. The rate characteristic of the handles intentionally made nonlinear so that the initial displacement of the handles causes only a very low rate of gun movement. This is done to allow the gun operator to control low tracking rates without critical positioning of the handles.

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Traverse operation of the turret is accomplished in much the same fashion as is elevation of the gun. However, in this case the required motion of the handles is in a rotary direction such as that associated with an automotive steering wheel. Squeezing of either palm switch in the control handles will result in release of the traverse mechanism magnetic brake, the purpose of which is prevention of undesired rotation of the turret. With the release of this brake, rotation of the handle assembly causes a flow of oil to the traverse hydraulic motor and in consequence motion of the vehicle cupola. Here again a nonlinear rate characteristic is built into the control spool in order to allow easy low speed tracking control as well as extremely high slew rates in the turret. Direction of handle rotation from center controls direction of turret rotation, counterclockwise handle rotation resulting in counterclockwise turret rotation, etc. Arming the weapons at the control box electrically activates the trigger switches and open the ejection doors by providing hydraulic pressure to their actuating cylinders. Firing of the weapons is accomplished by the gunner from the same handles which he used to control gun and turret motions. This is accomplished through the depression of either trigger switch mounted on the control handles. These trigger switches are installed in such a position as to be conveniently available at the index finger of either hand of the operator.

Manual Operation

In the event of electrical power failure emergency cupola operation is maintained by placing the traverse brake lever

from the "power" to "Manual" position and manipulating the power systems hand pump. The traverse brake is thereby disengaged and a system hydraulic pressure is maintained manually. The control handles function as in the power mode except for the brake and trigger switches. The non-powered weapon may be fired with its manual trigger. Externally powered weapons must be cycled manually.

It is not necessary to maintain full system pressure with the hand pump to operate the cupola in the manual mode.

This manual mode is also used when "quiet" operation of the cupola is desired.

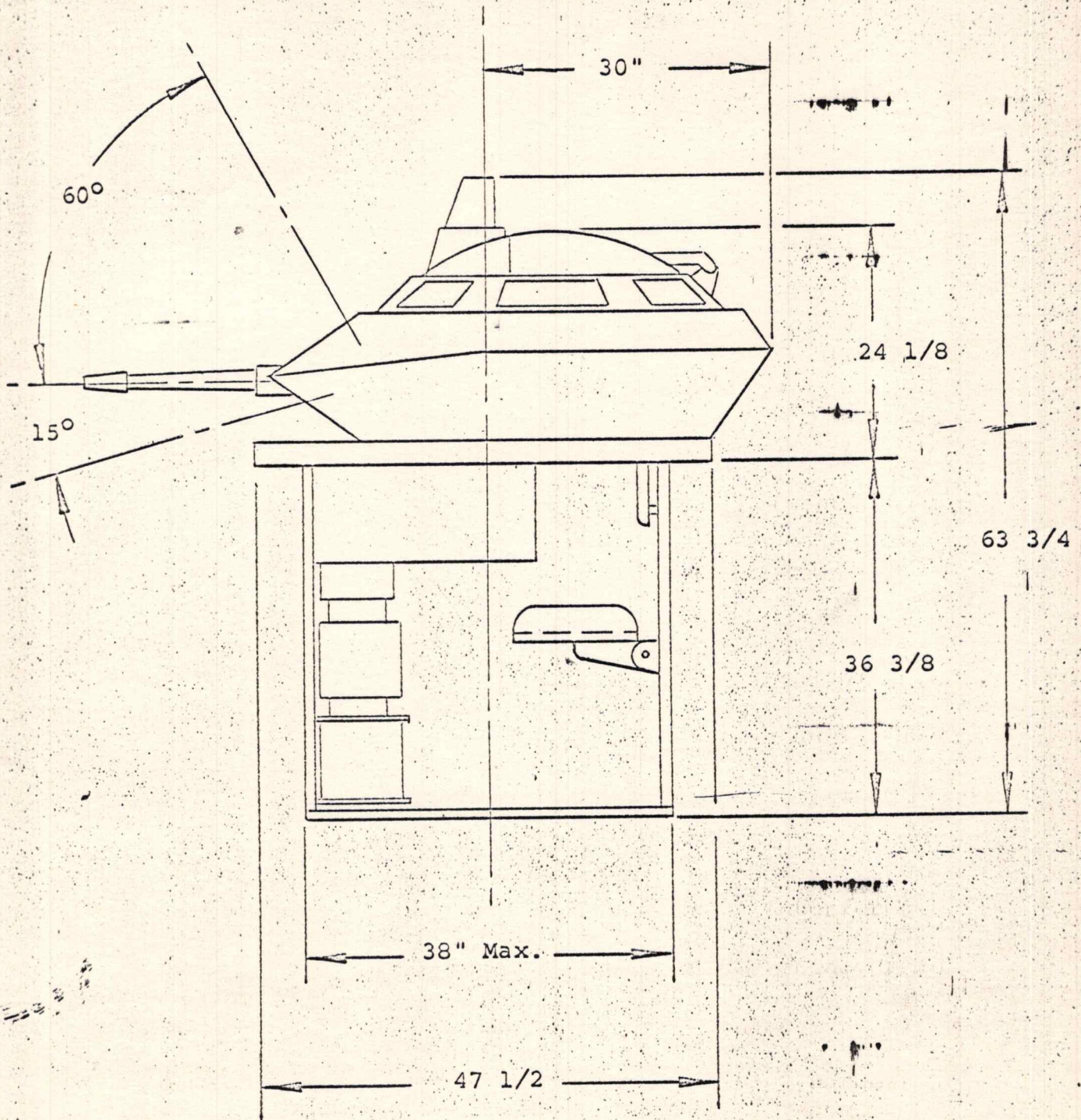
7. Safety Devices

Cross over relief safety devices are built into the power system to prevent self inflicted damage to the cupola and its equipment under certain specific conditions of operation. Crossover relief valves in the elevation cylinder and traverse mechanism circuits, allow the turret and gun to be driven backwards where high external loads are applied. A case in point is the collision of the gun barrel with a tree or other obstacle. Damage to the gun, the turret mechanism, or the power control system might result if safety devices were not incorporated.

F. Options and Accessories

Optional Deck Clearance System

If the physical construction of the vehicle is such that the

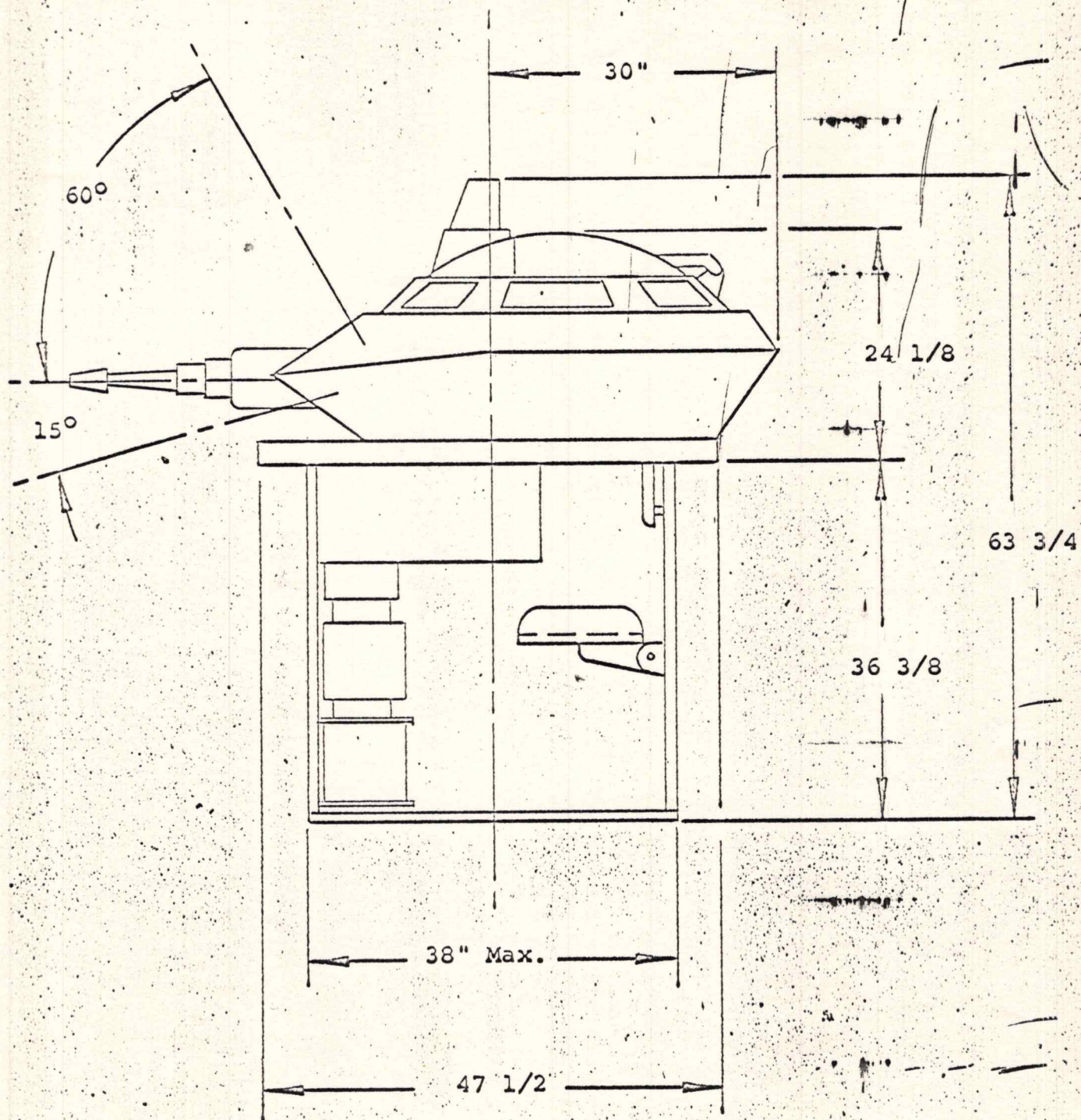


ENCLOSED CAL. 50 M85 M.G.
POWERED CUPOLA WITH POWER CONTROLS

CADILLAC GAGE COMPANY



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ENCLOSED CAL.50 MBS.M.G./40MM GRENADE LAUNCH
 CUPOLA WITH POWER CONTROL

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