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STABILITY OF THE CAL. 0.50 MACHINE GUN, M85 AND THE CAL. 0.50 TRIPOD MOUNT, M3

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Department of the Army Project No. 502-01-009
Ordnance Management Structure Code No. 5520.11.4580002
BALLISTIC RESEARCH LABORATORIES

ABERDEEN PROVING GROUND, MARYLAND

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ABSTRACT

A study of the Caliber 0.50 Machine Gun, M85 - M3 tripod system has shown that the system is unstable at a command height of 14 inches at both high and low firing rates, but may be made stable at low rates of fire by lowering the command height to 12 inches.

The Caliber 0.50 Machine Gun, M85, has a dual role. Its primary role is in defense of vehicles and as small caliber auxiliary armament of tanks. Its secondary role is a heavy machine gun for ground defense. In the development of the gun-tripod system for ground defense, the developing agency was requested to modify the existing Caliber 0.50 Tripod Mount, M3, in such a manner that the M85 Machine Gun could be quickly and easily mounted in the tripod yet produce dispersion comparable to that of the Caliber 0.50 Browning Machine Gun, Heavy Barrel, M2.

To develop the gun-tripod system, a cradle was added to the gun and the pintle of the tripod was modified to engage the lugs located at the bottom of the cradle. The handles, manual sear release and rear sight were combined into a bracket which slid over and latched to the rear of the receiver. A side view of the assembled gun and tripod is shown in Figure 1.

Figure 1. Side View of Cal. 0.50 Machine Gun, M85, Mounted in a Modified Caliber 0.50 Tripod, M3

The M3 Tripod was primarily designed for the Cal. 0.50 Heavy Barrel Machine Gun, M2. It is assumed that this gun-tripod combination is stable and produces satisfactory dispersion. It is also assumed that the Cal. 0.50 Browning Machine Gun, Aircraft, M2, is marginal since it is recommended to be used with the M3 Tripod only in an

emergency. A comparison between the Browning Machine Guns and M85 Gun-Tripod systems should indicate the degree of stability of the M85 system.

In this comparison, the systems are assumed to be rigid bodies and rotate about a line joining the rear feet of the tripod. The forcing function is an average force extending over a time equal to the time between shots. The equations used are:

$$W_g V_g = W_p V_p + CV \qquad (1)$$

where W_g is the weight of gun

V_g, free recoil velocity of gun

W_p, weight of projectile

V_p, velocity of projectile

C, weight of propellant charge

V, average exit velocity of propellant gas.*

$$\bar{f} = \frac{W_g V_g}{gT} \qquad (2)$$

where $\bar{f}$ is the average force and T the time between shots.

With the gun at 0° elevation and 0° azimuth and assuming the center of gravity of the entire system of each gun-tripod assembly lies in a vertical plane three inches rearward of the centerline of the pintle, the relation of the over-turning moment to the restoring moment of the system is

$$\bar{f}H = W(D - 3). \qquad (3)$$

The length of each rear leg is obtained by

$$L = \frac{\sqrt{D^2 + h^2}}{\cos 30^\circ} \qquad (4)$$

*Average exit velocity of the gas at a muzzle velocity of 2800 f/s was assumed to be 4700 f/s; at 3000 f/s, 5000 f/s.

where D is the projected distance of the line bisecting the angle made by the rear legs (60°) and h is the distance from ground to the intersection of the center lines of a rear leg and the pintle.

An illustration of the system diagram is shown in Figure 2.

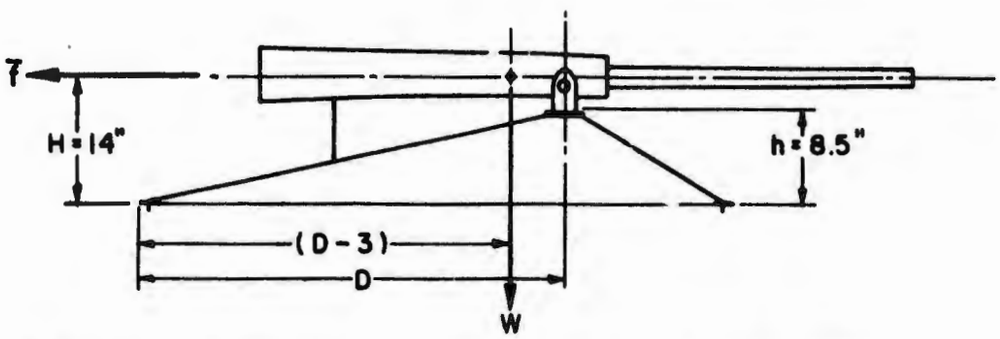

Figure 2. Schematic Side View of the Gun-Tripod System

The observed or calculated parameters of the system are given in the following table:

TABLE 1

Caliber 0.50 Gun-Tripod System Parameters

Gun	Command Height inches	Rate of Fire shots per min.	Time Between Shots, T seconds	System Weight lbs	Average Force lbs
M2, HB	11.4	550	.109	127	137
M2, Aircraft	11.4	750	.080	106	175
M85, hi-rate	14	1000	.060	112	233
M85, low rate	14	550	.109	112	128
M85, hi-rate	12	1000	.060	108	233
M85, low rate	12	550	.109	108	128

The computed leg lengths and the ratio between the actual length of the rear leg of the M3 Tripod and the computed leg lengths are as follows:

TABLE 2

Comparison of Actual and Calculated Leg Lengths

Gun	Command Height inches	Calculated Leg Length inches	Ratio: M3 Leg Length to Calculated Leg Length
M2, Heavy Barrel	11.4	20.2	2.1
M2, Aircraft	11.4	23.4	1.8
M85, hi-rate	14.0	38.3	1.1
M85, lo-rate	14.0	24.0	1.8
M85, hi-rate	12.0	34.7	1.2
M85, lo-rate	12.0	19.9	2.1

The ratio of the actual rear leg length of the M3 Tripod to the computed leg length required by the M2 Heavy Barrel Machine Gun is approximately 2:1. Apparently in determining the length of the rear legs it was observed that the shortest length to produce acceptable dispersion was 42 inches. Intentionally or otherwise in the development, an impulsive force rather than an average force was used to establish the required length of the rear legs of the tripod. If it be assumed that the ratio of actual leg length to computed leg length establishes a criterion that an impulsive force is equal to or greater than twice the average force ($F \geq 2\bar{f}$), the M85 Machine Gun and M3 Tripod will be stable and produce acceptable dispersion only if the command height is reduced to 12 inches and the rate of fire does not exceed 550 shots per minute.

Acceptable stability may be obtained at both high and low rates of fire by extensively modifying the M3 Tripod or developing a new tripod. In either case, the lengths of the rear legs will be much longer than those of the M3 Tripod and may create a problem in stowage

or an increase in dispersion because of bending. Rather than lengthen the legs, it is suggested that the rate of fire be limited to 550 shots per minute and a new tripod or a modified M3 Tripod be provided which will limit the command height to not more than 12 inches.

The stability of the turret has been considered in reference to the rear legs only. During demonstration firings, it was noted that the rear feet were bouncing as well as the front feet indicating that the system is somewhat unstable in the forward direction and that the system is pivoting or rocking first about the rear feet and then about the front foot. It is difficult to estimate the residual momentum in counterrecoil from which the length of the front leg may be calculated. A very approximate calculation indicates that the system is just about stable about the front leg at a command height of 14 inches. With the command height reduced to 12 inches, the present length of the front leg should be adequate.

This study has shown that the M85 Gun-M3 Tripod System is unstable at a command height of 14 inches at both high and low rates of fire, but may be made stable at low rates of fire provided the command height is lowered to 12 inches.

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