WEIGHT OF RCL GUNS IN COMPARISON TO CONVENTIONAL GUNS

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ABSTRACT

A study has been made of the weight of ordnance and equipment for a given performance. The comparative weights of the RCL and the orthodox equipments have been studied and it has been found that for the same muzzle energy the weight of RCL gun is $\frac{1}{4}$th that of orthodox gun.

Introduction

In the present day designs greater and greater mobility is aimed at for a required fire power of an equipment. In a conventional gun, the backward momentum of the gun due to forward motion of shot is taken up by the recoil system incorporated in the carriage which serves as an elastic link between the gun and the carriage and helps in letting the gun recoil and then pushing it back to the firing position without disturbing the setting of the piece. This system evidently contributes a good amount towards the equipment weight. During the World War II, muzzle brakes were used either for upgunning an existing vehicle or to get greater muzzle energy from the existing equipments. These were a fitting on the muzzle end of an ordnance which deflected a part of the propellant gases towards the rear thus providing a forward thrust to the piece so that for the same recoil the muzzle velocity of the projectile could be increased relatively. The idea could not be applied to most of the conventional guns because the backward momentum added to the piece due to the gas action after shot ejection was not sufficient to give a significant decrease of recoil if the gases were to be reversed. Towards the close of the war, however, recoilless guns were introduced in which the gases were made to leak out through a nozzle provided in the rear of the chamber so that the forward thrust due to the nozzle flow would balance the backward thrust due to the motion of the shot. This necessitated the use of only a light tripod for firing purpose instead of a much heavier carriage. The main disadvantage of the RCL guns were, however, firstly an unbalanced momentum due to the difficulty in obtaining the nozzle start pressure exactly equal to the shot start pressure from round to round and secondly, it required approximately three times the charge that a conventional gun needed for the same velocity of projectile. It is evident that since a major part of the propellant is spent in making the gun recoilless, the idea could not be extended to guns of high muzzle energy due to practical limitations. Also it may not be worth the expense to have a long range recoilless gun from operational point of view.

The object of this note is to study:—(*a*) the weight of ordnance and equipment for a given performance and (*b*) comparative weights of the recoilless and the orthodox equipments and to bring out the saving of weight affected in an RCL gun.

Analysis

Orthodox guns—The weight of an ordnance is dependent on its length, its mean diameter and the thickness which is dependent on maximum pressure developed inside the gun. The shot travel and the maximum pressure govern the muzzle velocity whereas the mean diameter is related to the projectile weight. It was, therefore, considered likely that the muzzle energy of an equipment has some relationship with the weight of the ordnance. For the purpose of this analysis, all equipment has been divided into two categories, one having low and the other higher muzzle energies which are tabulated in Tables IA and IB. Anti-aircraft guns have, however, been tabulated in Table IC because of their being slightly heavier due to their having automatic action and hence complicated breech and firing mechanisms.

TABLE IA—LOW MUZZLE ENERGY

(Field, Tank and A/Tk, guns)

Equipment	Shot wt. lb.	MV ft./sec.	Muzzle energy × 10−6 ft. lb.	Ordnance weight lb.	Equipment weight lb.
75-mm Pack	14·5	1250	0·355	340	1,340
3·7" How.	20·0	1110	0·386	400	1,470
37-mm	1·92	2900	0·250	197	..
6 Pr. 7 Cwt.	6·3	2960	0·813	760	2,520
25 Pr.	25·00	1700	1·120	1000	3,970
75 m/m Tank	14·50	2030	0·930	890	..
95 m/m Tank	15·00	1675	0·66	690	..
4·5" How.	34·5	1000	0·53	920	3,290

TABLE IB—HIGH MUZZLE ENERGY

(Field, Tank and A/Tk, guns)

17 Pr. on carr.	17	2980	2·36	1,822	6,600
17 Pr. Tank	17	2980	2·36	1,822	..
BL 5·5-in.	100	1950	5·96	4,120	12,770
BL 7·2-in.	202	1980	12·50	11,000	29,900

TABLE IC—A/A EQUIPMENTS

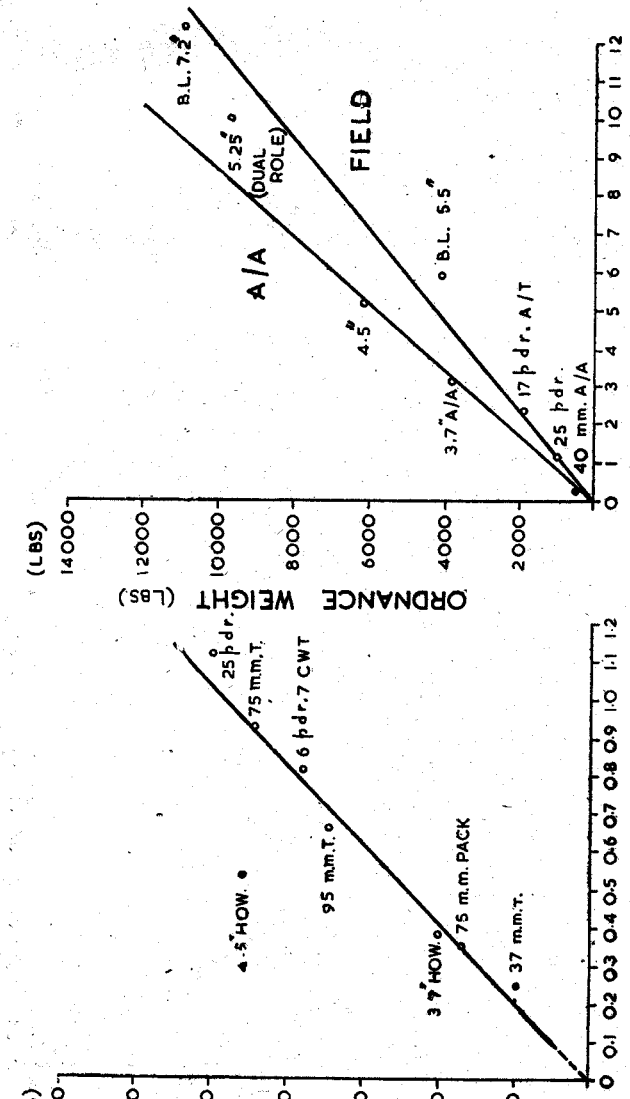
20-mm	½	2860	0·065	126	920
40-mm	2	2960	0·270	423	4550
3·7-in. AA	28	2680	3·120	3833	21300
4·5-in.	54½	2470	5·200	6160	37070
5·25 A/A	80	2855	10·100	9713	67424

Curves in Figs. IA and IB represent ordnance weight plotted against muzzle energy and it can be observed that:

(*a*) Ordnance weight has a linear relationship with muzzle energy.

(*b*) For field, tank and anti-tank equipment both high and low muzzle energy the ordnance weight is approx 0·92 lb/1000 ft. lb. of muzzle energy.

(*c*) For A/A guns the weight of ordnance is slightly higher and is approximately 1·16 lb/1000 ft. lb. of muzzle energy.



ORDNANCE WEIGHT ANALYSIS FOR CONVENTIONAL GUNS

FIG. IB
High M. E. Field & A/A Guns

FIG. IA
Low M. E. Field Guns

Curves in Fig. II represent weight of equipment (Ordnance plus Carriage) plotted against muzzle energy. In the case of A/A guns, however, weight of limber transporting and platform firing has also been added. It can be seen that:—

(*a*) Equipment weight also bears approximately a linear relationship with its muzzle energy.

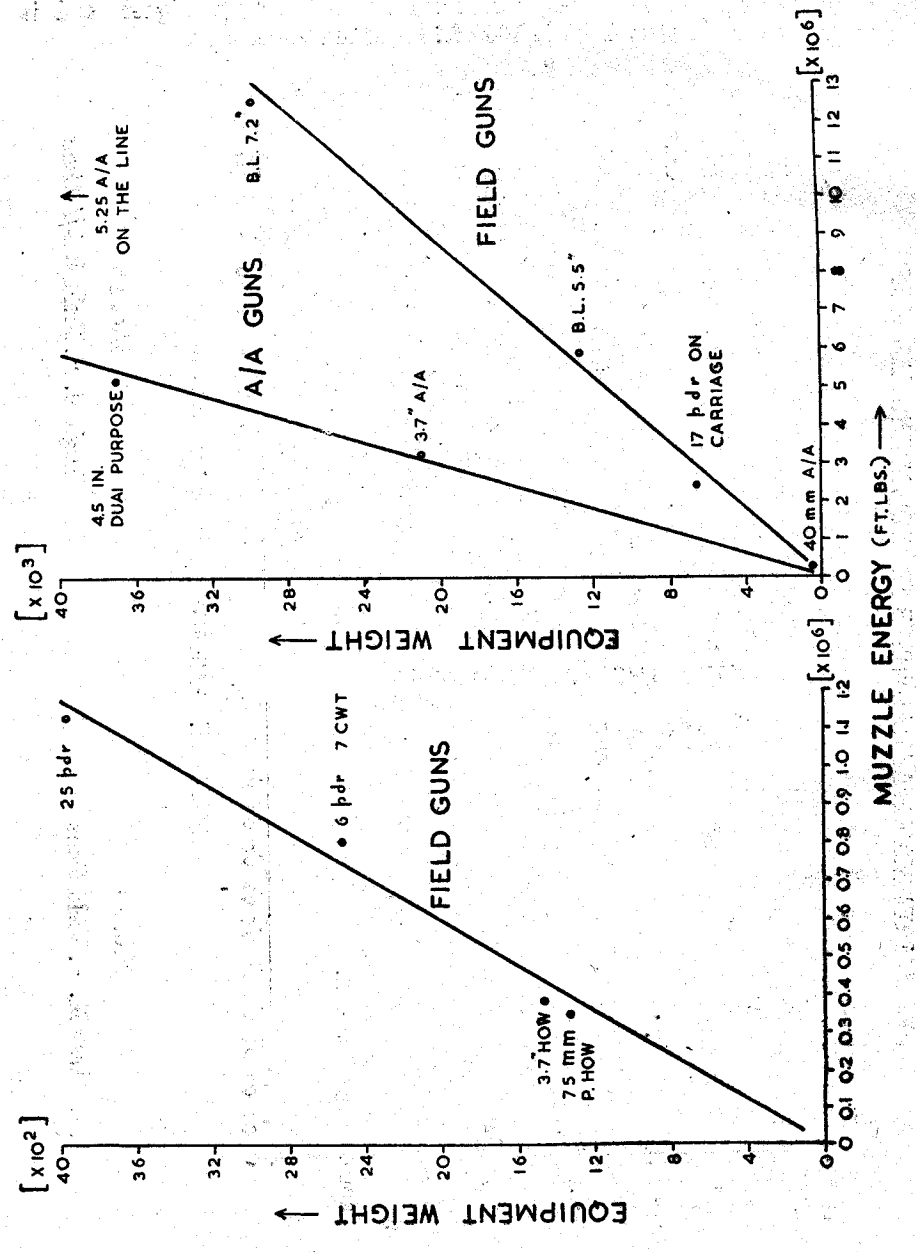


FIG. II

(*b*) Considering Field, Tank and Anti-tank equipments, the slope of the curve for smaller values of muzzle energy is greater in comparison to the slope for higher muzzle energy viz. 3·4 lb. as against 2·25 lb. for every 1000 ft. lb. of muzzle energy. The equations to the lines being given by:

For Low ME:

Eq wt (lb.)=3·4 (ME in ft. lb.)$\times 10^{-3}$ and

For high ME:

Eq wt (lb.)=2·25 (ME in ft. lb.)$\times 10^{-3}$

(*c*) For A/A equipment the slope of the line increases to 6·65 lb. per 1000 ft. lb. of muzzle energy and the equation is given by:

Eq wt (lb.)=6·65 (ME in ft. lb.)$\times 10^{-3}$

It may be observed that for A/A guns, their equipment weight is quite high due to limber transporting, platform firing etc., besides auto-loader, machine fuze setting and all round traversing gear.

Recoilless guns

Recoilless guns are low muzzle energy with much greater mobility and the number of equipments produced are really small. It may be appreciated that it is not worthwhile to have a long range (high muzzle energy) recoilless gun because in such cases mobility does not matter to the same extent.

Table II gives the muzzle energy data for various light guns approved or introduced in the German Army during World War II besides the American recoilless guns.

TABLE II

Equipment	Shot wt. lb	MV ft/sec	Muzzle energy 10^{-6} ft. lb.	Ordnance wt. lb.	Equipment wt. lb.
5·5 cm (German) automatic ..	5·1	2620	·52	NK	390@
57 mm (American)	2·75	1200	.062	65	93·5
7·5 cm LG 40 (German) ..	10·01	1200	·225	210	300*
75 mm (American)	14·4	990	·22	120	168
10·5 cm LG 42 (German) ..	32·6	1140	·64	465	On firing carr w/ shield 1100
105 mm (American) ..	H.E. 32·5	1120	·63	365	On Jeep Mtg 701
	HEAT 29·0	1250	·70	..	On tracked Veh 580
15 cm LG 43 (German) ..	84	1020	1·32	NK	On Carr 1400

@Quite heavy because of its being semi-recoilless for automatic action.

*Mounting for this gun was quite heavy.

The data for analysis is rather meagre so that no definite conclusions can be made regarding the weight of RCL guns in relation to its muzzle energy. In general, however, it may be observed that the American Equipment is lighter in comparison to the corresponding German equipment and that its weight is approximately, 0·85 lb/1000 ft. lb. of its muzzle energy. The figure III, however, shows variations slightly depending on the type of carriage provided.

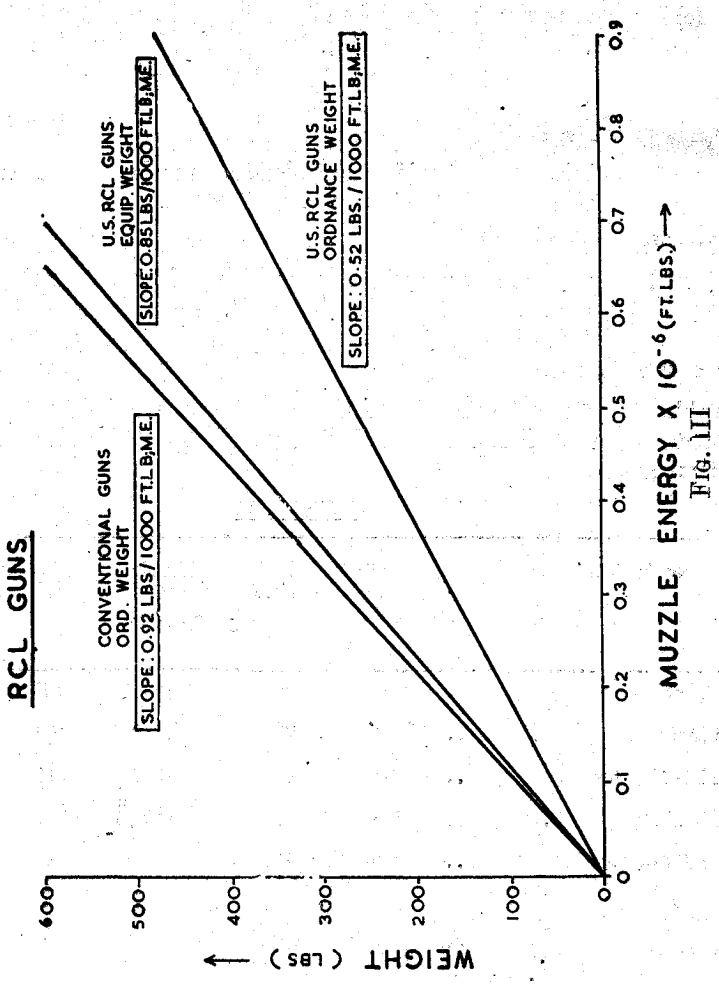


Fig. III

The Ordnance weight may also be approximately expressed as 0·52 lb./1000 ft. lb. of muzzle energy so that it is very much lighter than the ordnance of an orthodox gun. This may be explained by the fact that an RCL gun is subjected to lower pressure.

Conclusion

As a first approximation in design problems it may be safe to assume the ordnance and equipment weights per 1000 ft. lb. of muzzle energy on the following basis:

(*a*) For conventional type of Fd, Tk and A/Tk guns:

(*i*) Ordnance weight—0·92 lb.

(*ii*) *Equipment weight*

(*aa*) Low muzzle energy—3·4 lb.

(*bb*) High muzzle energy—2·25 lb.

(*b*) *For A/A guns*

(*i*) Ordnance weight—1·16 lb.

(*ii*) Equipment weight including limber transporting and platform firing—6·65 lb.

(*c*) *For Recoilless guns*

(*i*) Ordnance weight—0·52 lb.

(*ii*) Equipment weight—0·85 lb. (Assuming a tripod carrier).

The recoilless gun is a fairly light equipment and is practically one fourth the weight of the orthodox type for the same muzzle energy.