Aluminium Distribution Cabinets Resistance to Rifle Fire

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Summary: An unusual historic paper from 1966 where the Post Master General's Headquarters Lines Section collaborated with the Department of the Army to subject aluminium distribution cabinets to ballistics testing ahead of possible rural deployment.

Introduction

The introduction of low-power solid state amplifiers for rural carrier frequency cables in the 1960s brought about underground installation in pits and the elimination of expensive equipment buildings. However, above ground installation has a number of advantages over underground, such as reduced water entry and corrosion resistance.

The existing torpedo shaped aluminium distribution cabinets (or pillars) used throughout the metropolitan area had proven design, ready availability, low cost and sufficient space for amplifiers of up to 60 channels for balanced pair operation.

These cabinets were considered for rural deployment; however as the historical paper written by Mr T N Pimm of the Post Master General's Headquarters Lines Section (TJA, 1966) cautions, "for those familiar with the installation of equipment in the country, the problems of vandalism by rifle fire are well known". Therefore the Lines Section took a more guarded approach before introducing another "probable target" into that rural environment.

The paper describes ballistics testing with the assistance of the Department of the Army of 300- and 900-pair cabinets using 0.22 and 0.303 inch calibre bullets. The tests were conducted at such distances from the cabinet where it was assumed the vandal "had sufficient common sense or hard earned experience of the dangers of ricochet."

Various calculations are provided for strike velocity and the results have been tabulated from extensive field testing. Both cabinets were no match for 0.303 inch calibre bullets which often passed through front and back and were prevalent in Australia following WW2.

This is one of the primary reasons why above ground aluminium distribution cabinets did not find their way into the rural telecommunications landscape.

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Postscript

Cable Pillar Systems

The Melbourne *Age* published an article in April 2013 (Age, 2013) which describes the closing of a business called Cable Pillar Systems in Hallam which manufactured these aluminium distribution cabinets. Cable Pillar Systems supplied Telstra, and its predecessor the Post Master General's Department, with approximately 70,000 cabinets since their design won the contract in 1956. The recent introduction of the NBN meant that the requirements for aluminium cabinets dried up and the company closed its doors in 2013 after more than 50 years of operation.

Australian Firearms

According to the website GunPolicy.Org (GP, 2015) hosted by several local universities, Australians surrendered approximately one million rapid-fire long guns (mainly semi-automatic rifles and self-loading and pump-action shotguns) in the buy-back following the 1996 Port Arthur tragedy. By mid-2012 however, Australians had restocked with single-shot models to pre-Port Arthur levels.

It is estimated that there are approximately three million civilian firearms in Australia currently.

References

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The historical paper

ALUMINIUM DISTRIBUTION CABINETS – RESISTANCE TO RIFLE FIRE

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INTRODUCTION

Distribution cabinets and pillars are used in Metropolitan areas to provide flexibility in the use of pairs in main subscribers cables and to provide cross connection facilities from main to distribution cables. The units are made of cast aluminium (BS 1490 alloy LM 6) and are available in three sizes, 300 pair, 900 pair, and 1800 pair. (See Fig. 1). The principal dimensions are given in Table 1.

* Mr. Pimm is Engineer Class 2, Lines Section, Headquarters. See Vol. 16, No. 1, Page 87.

TABLE 1: DIMENSIONS OF PILLAR AND CABINETS

	300 pr.	900 pr.	1800 pr.
Overall Height	3 ft. ¼ in.	3 ft. 1½ in.	4 ft. 6 in.
Overall Diameter	6½ in.	11¼ in.	11¼ in.
Thickness of Cover	5/32 in.	7/32 in.	7/32 in.

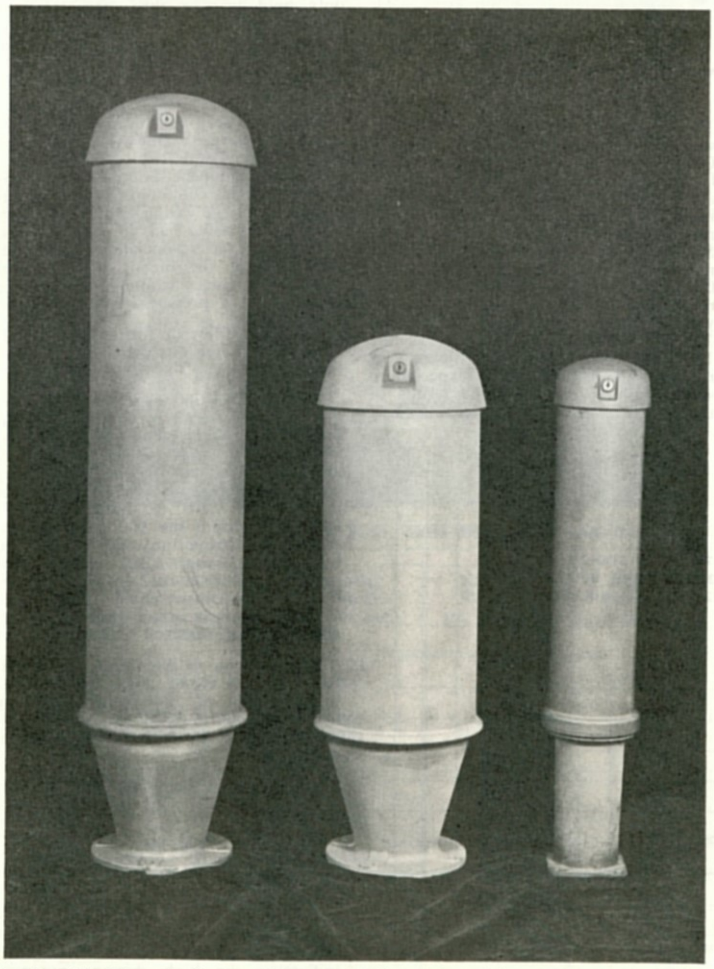

Fig. 1 — Aluminium Distribution Cabinets and Pillar. Left to Right: 1800 pair cabinet, 900 pair cabinet, 300 pair pillar.

Up to the present time they are not in general use in rural areas and the need to investigate their resistance to vandalistic shooting has not arisen. With the advent of solid state amplifiers and their important characteristic of low power consumption, developments are under way for their application to rural carrier frequency balanced pair cables. Due to the small size of the equipment, buildings are no longer necessary and either buried or above ground enclosures are suitable for housing line amplifiers. In the application to rural carrier cables there are many advantages in selecting an above ground housing which is easily accessible for maintenance purposes and largely free from water entry and corrosion problems, which are inescapable when underground installations are adopted. The existing cabinets have the advantage of proven design, ready availability and low cost, and line amplifiers to suit them are now being developed for 12 channel and 60 channel balanced pair operation.

To those familiar with the installation of equipment in the country, the problems of vandalism by rifle fire are well known. Peppered and damaged road signs, buildings, insulators and even vital water tanks are a familiar sight in rural areas. Therefore a cautious approach is being adopted on the introduction into such an environment of another probable target. For this reason, it was decided to carry out tests on the cabinets to obtain information on their susceptibility to damage from 0.22 in. and 0.303 in. bullets at various ranges.

BALLISTIC TESTING

The ranges for the 0.22 in. calibre were chosen on the basis of maximum and minimum probable firing distances. A shooter of the kind considered is unlikely to choose a target at a distance greater than 100 yards owing to the reduced chances of gaining a hit. That is, the vandal is not in the class of the keen and accurate shooter, but is in effect a casual shot who will choose an object because of its proximity and attractiveness. At the short range, the vandal is expected to have either sufficient common sense or hard earned experience to realise the danger of ricochet. A lower limit of 20 yards was therefore considered reasonable and 40 yards was chosen for an intermediate range. The cartridges used for the test were "Civic" high velocity, long rifle type (Fig. 2) with an average muzzle velocity of approximately 1,350 feet per second.

The ranges chosen for 0.303 in. ammunition were based on the sure knowledge of their greater damage potential at much greater distances than 0.22 in. calibre. Distances of 100 yards and 200 yards were chosen, with greater distance being unwarranted as already

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Fig. 2 — Cartridges used in Tests and Examples of Deformer Bullets after Testing.

considered. In order to obtain a high accuracy during the 0.303 in. tests it was decided to use a short range (30 yards) and to vary the charge to simulate longer shots. This then allowed accurate placing of rounds in two or three positions from full face to glancing shots. The calculated velocities were 2,230 feet per second at 100 yards and 2,030 feet per second at 200 yards (Fig. 3).

The tests were carried out at the Army Inspection Staff Proving Ranges at Footscray, Victoria under the guidance of Mr. J. Cook, the Senior Inspector for Small Arms Ammunition. The velocity of the 0.303 in. cartridges was determined by a Photo-Electric Counter Chronometer (PCC) over a 100 ft. base with an instrumental midpoint at 90 ft from the muzzle. The recording of the velocity of the 0.22 in. cartridges was by PCC equipment over a 50 ft. base with an instrumental midpoint at 30 ft from the muzzle. The 0.22 in. cartridge velocity was not recorded during the testing at 100 yards. Testing was restricted to the 300 pair and 900 pair covers as the 1800 pair, having the same thickness of metal as the 900 pair, was expected to sustain similar damage. The results of the tests are given in Tables 2 and 3.

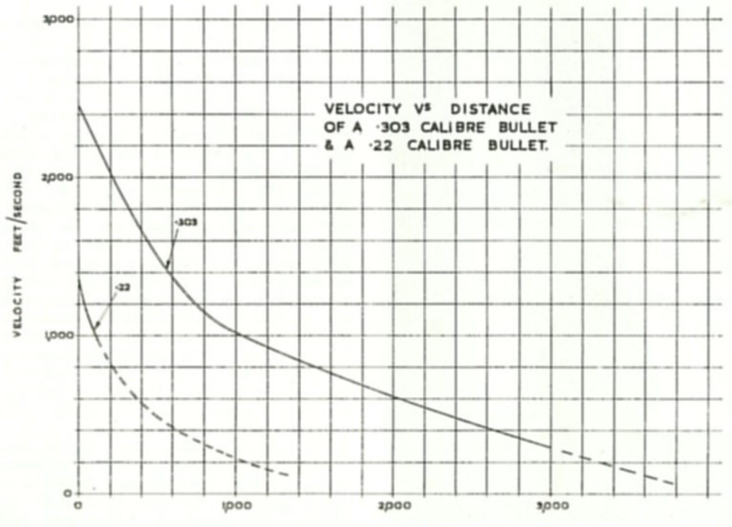

Fig. 3 — Velocity/Distance Curves for 0.303 in. and 0.22 in. Calibre Bullets.

CONCLUSION

From the foregoing results it can be seen that the 300 pair pillar is vulnerable to damage from 0.22 in. calibre high velocity bullets at least up to 40 yards range and probably to 60 yards. However, it is apparent that, having passed through one thickness of aluminium, the remaining energy in the bullet was insufficient to cause any further damage to the inner surface on the opposite side. Furthermore the target width for penetration is only about 2 in. and as accuracy is not expected to be high under these conditions a relatively small amount of damage may be expected on any one unit.

However, considering the large number of shooters using 0.22 in. rifles it would be inadvisable to install the 300 pair unit in large numbers throughout the country areas unless some extra protection was arranged. As this unit will only hold two or three repeaters, its usage in any case would be small and since carrying out these tests it has been decided to concentrate equipment design effort on the 900 pair and 1800 pair sizes.

It will be seen that even at 20 yards range the large casing was not fully penetrated by a 0.22 in. calibre bullet. The maximum penetration was approximately 3/16 in. with some associated deformation of the casing. The inside surface of the casing had, in several cases, star shaped cracks associated with the deformation of the metal (Fig. 6), and these small cracks would allow leakage of air from a pressurised container.

Some examples of the deformed bullets which caused this damage are shown in Fig. 2.

Neither the 300 pair nor the 900 pair casing offered much resistance to 0.303 in. calibre bullets at ranges of 100 and 200 yards (velocities of 2179 and 1998 feet per second). It is of interest however, to consider the range at which a 0.303 in. bullet will just fail to penetrate the 900 pair cabinet. A first approximation may be obtained by assuming that equal energy contained in either a 0.22 in. or 0.303 in. bullet will cause equal penetration. (Strictly this is incorrect owing to differences in both material and shape).

The 0.22 in. calibre long rifle bullet has a weight of 40 grains and a 0.303 in. a weight of 174 grains. Equating the energy of a 0.303 in. calibre bullet to that of the 0.22 in. at 20 yards, we have:

$$E = \tfrac{1}{2} M_1 V_1^2 = \tfrac{1}{2} M_2 V_2^2$$

$$\text{Then } V_2 = \sqrt{\frac{M_1}{M_2}}\, V_1$$

and taking $V_1 = 1250$ feet per second

$V_2 = 600$ feet per second.

A 0.303 in. calibre bullet has this velocity at about 2,000 yards (Fig. 3) indicating the high damage potential of these bullets.

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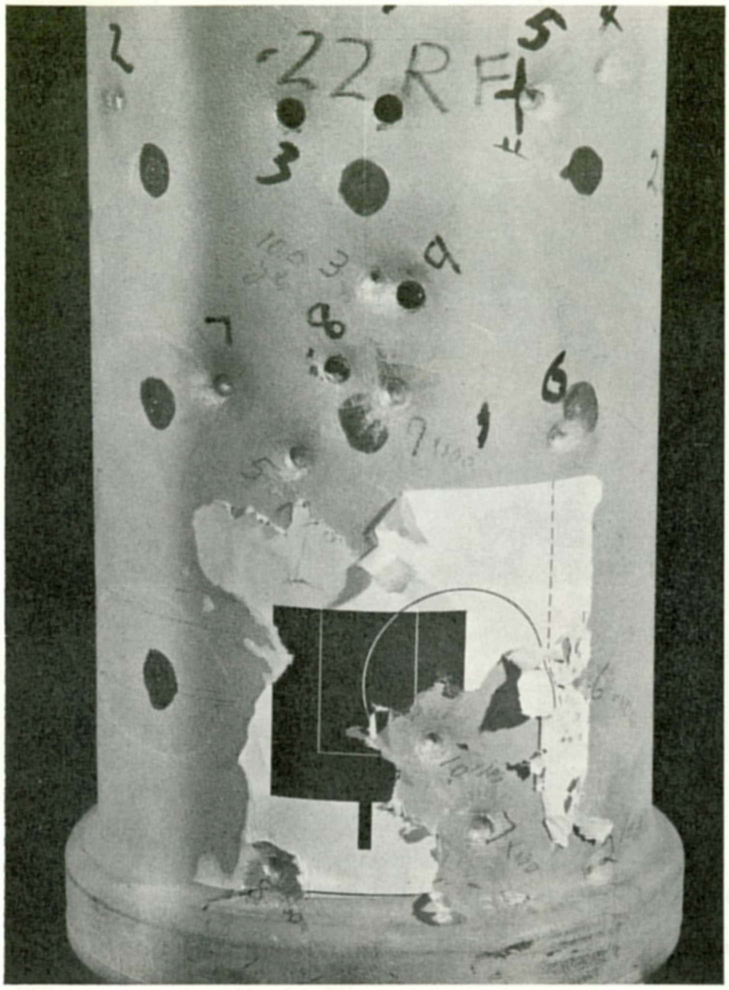

Fig. 4 — Penetration of 0.22 in Calibre Bullets on 300 Pair Cover at 20, 40 and 100 yd. Ranges. (See Table 2).

TABLE 2: TEST RESULTS — 300 PAIR COVER

	Circumferential Distance from centre line (inches)	Velocity at 30 ft. (ft. per sec.)	Striking Velocity (ft. per sec.)	Depth of Penetration (inches)	Remarks
0.22 in. calibre, 20 yards Fig. 4 Top row	¼ 1 1¼ 2¼ 3½	1223 1241 1243 1251 Not Rec'd.	1194 1212 1214 1222 NR	Full Full 1/8 1/32 1/32	Hit centre column No damage to inside surface on rear of pillar. Star shaped crack inside surface.
0.22 in. calibre, 40 yards Fig. 4 Centre row	1/4 1/2 1½ 2½	1218 1284 1215 1145	1131 1197 1128 1058	Full Full 1/8 Negligible	Penetration just complete Fine tear in metal at bottom of hole. Star shaped crack inside.
0.22 in. calibre, 100 yards Fig. 4 Lower shots					Maximum penetration of 7 shots was 1/16 in. with star shaped cracks at inside surface in 4 cases.
0.33 in. calibre 200 yards	Central 3¼		1998 1998	Full, front only Full, front and rear	Hit centre column Large section torn out at rear.

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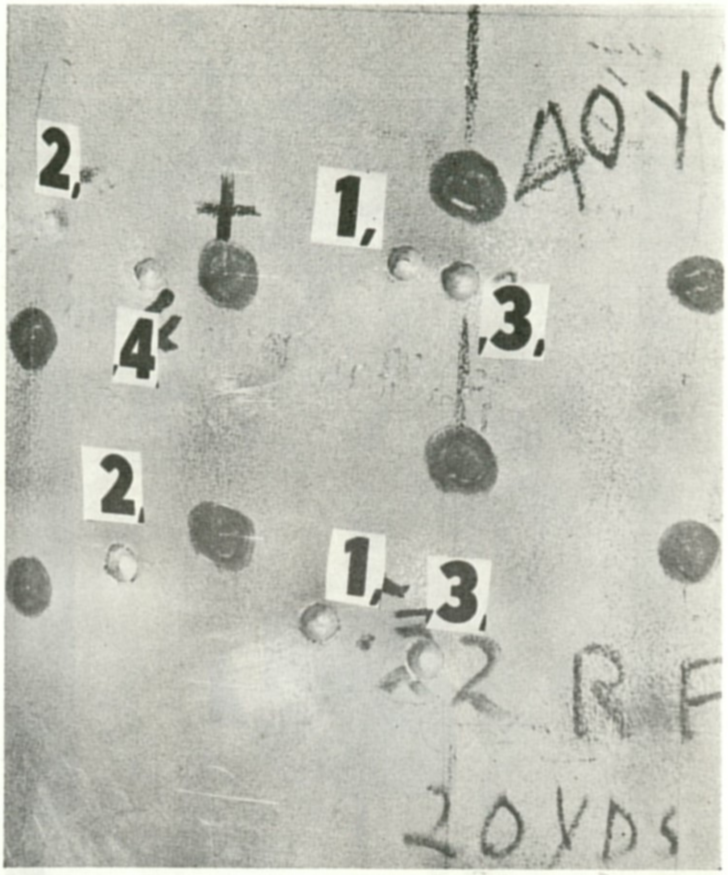

Fig. 5 — Penetration of 0.22 in. Calibre Bullets on 900 Pair Cover at 20 and 40 yd. Ranges. (See Table 3).

TABLE 3: TEST RESULTS — 900 PAIR COVER

	Circumferential Distance from Centre Line	Velocity at 30 ft. (ft. per sec.)	Striking Velocity (ft per sec.)	Depth of Penetration (inches)	Remarks
0.22 in. calibre, 20 yards, Fig. 5 Lower row	1/4	1197	1168	5/32	Local deformation, star shaped crack inside surface.
	1	1232	1203	3/16	Slight local deformation, fine tear in metal at bottom of hole. Star shaped crack inside surface.
	3	1315	1286	3/16	Slight local deformation. Star shaped crack inside surface.
0.22 in. calibre, 40 yards, Fig. 5 Upper row	0	1236	1149	1/8	Local deformation to ¼ in. between these two adjacent holes. Star shaped cracks inside surface.
	1/2	1241	1154	5/32	
	2½	1212	1125	1/16	negligible deformation
	3½	1225	1138	1/32	negligible deformation
0.303 in. calibre, 100 yards	2		2179	Full Front and rear	No denting of surface surrounding bullet entry except for side shots. Severe tearing on rear face of cabinet.
	3½		2179		
	4½		2179		
0.303 in. calibre, 200 yards.	1½		1998	Full Front and rear	No denting of surface surrounding bullet entry except for side shots. Severe tearing on rear face of cabinet.
	2		1998		
	4		1998		
	4½		1998	Incomplete Penetration at rear.	

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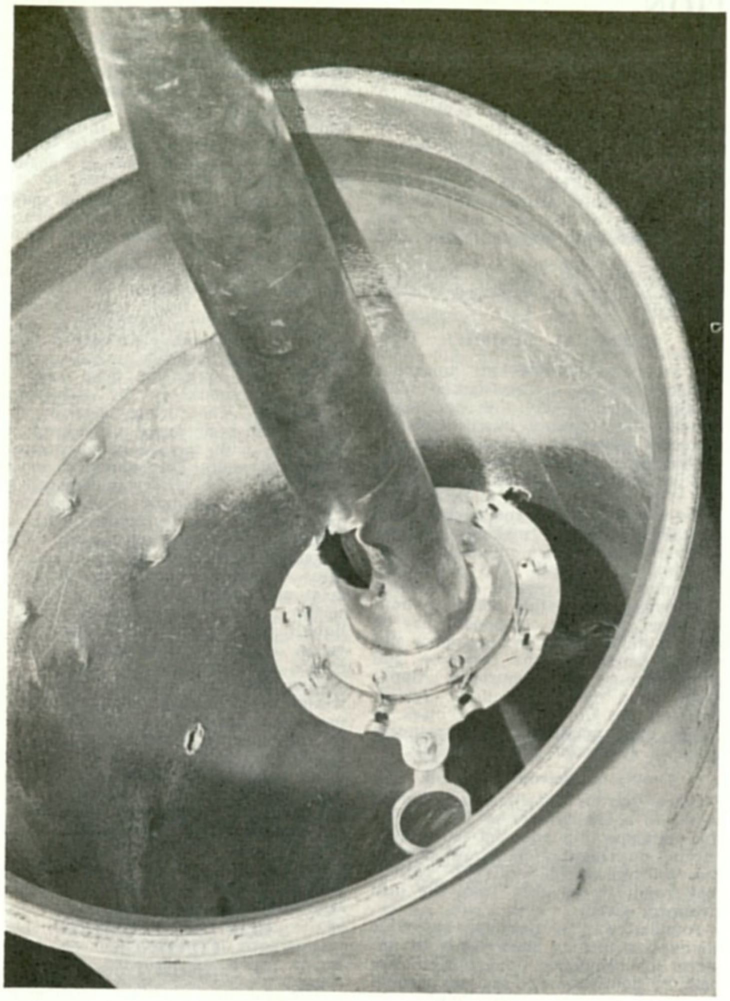

Fig. 6 — Inside Surface of a 900 Pair Cover, showing Star Shaped Cracks from Bullet Penetration.

Consideration may be given to extra protection of the cabinets in order to avoid damage even from 0.303 in. bullets. Such protection however, would need to be of the order of $1\frac{1}{4}$ in. of concrete or $\frac{3}{8}$ in. steel. The cost and weight of this protection severely limits its practical use when compared to installation of a container in a manhole. If, however, the local probability of such damage could not be tolerated and manhole installation was inadvisable for other reasons, a possible method of protection is indicated in Fig. 7 where access is relatively easy and construction cost is not excessive.

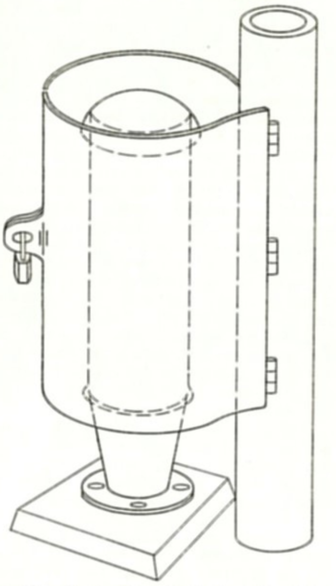

Fig. 7 — A Possible Method of Providing Additional Protection.

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