An Investigation of Weights of Pattern 1907 Bayonets made in the U.K. around the Great War Period

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Abstract

The standard issue bayonet of the British Army immediately preceding and during the Great War was the Pattern 1907. This was manufactured at different times and in varying numbers during that period by one official body, the Royal Small Arms Factory at Enfield, and five private contractors. They were made according to a published official specification based on a ‘pattern example’ provided by the Royal Small Arms Factory. However, examination of a series of these bayonets in a private collection suggested that their weights, at least, varied considerably from the official standard. To establish reasons why this might be so, the weights of surviving Pattern 1907 bayonets held in other collections were determined and compared to establish the degree of variance from the official specifications as originally set out by the Royal Small Arms Factory. Almost all of the 142 bayonets surveyed were found to be above the weight specification. It is speculated that the target weight may have been deliberately set higher by the individual manufacturers to eliminate the possibility of rejection by the inspectors of the Royal Small Arms Factory and so a refusal of acceptance and payment for the work.

KEYWORDS bayonet; Pattern 1907; weights; Great War; statistical analysis

Introduction

The standard issue bayonet of the British Army immediately preceding and during the Great War (GW) was that described in the official records as the "Sword bayonet, pattern 1907 (Mark I)", designed for fixing to the recently introduced Short Magazine Lee–Enfield rifle (SMLE), and approved for service use on 30th January 1908.[1] It consisted of a one-piece, steel blade and tang, the specifications requiring a blade length of 432 mm (17 in.) and an overall length of 552 mm (21.75 in.). This blank was given a crossguard[2] (with an upper opening for the boss on the nose-cap of the rifle and with a lower hooked quillon) and a pommel, both made of wrought iron or mild steel, these parts being brazed onto the tang. A wooden grip (walnut was specified) was placed on each side of the tang and secured by a pair of machine screws passing through holes drilled in the tang, fixed with nuts on the opposite side. A shallow groove known as a fuller was machined on each side of the blade to reduce weight and add rigidity. In accordance with the specifications, the overall weight of the completed bayonet was 468 g (16.5 oz.).[1] During the final stages of manufacture the bayonet received a series of official stamps on the ricasso, the flat part of the blade at its junction with the crossguard. Those on the right (or reverse) ricasso included an 'X' bend-test mark, a War Department arrow, and one or more Royal Small Arms Factory (RSAF)-appointed inspector's marks; those on the left (or obverse) ricasso consisted of the reigning monarch's crown and cypher (ER for Edward VII until May 1910, thereafter GR for George V), the date of the bayonet's official inspection and approval for service (in a numerical month/year format), and the maker's name.

The Pattern 1907 (P.1907) bayonet arose from trials in 1906-7, following concerns that the reach of the new SMLE rifle and its Pattern1903 (P.1903) bayonet was too short for effective combat use. At this time, the view prevailed that a long reach was required for effective one-on-one bayonet duels with an enemy.[3] However, the overall length of the SMLE rifle and its P.1903 bayonet, at ~1.45 m,[4] was significantly shorter than that of the French 1886 Lebel rifle and bayonet, at ~1.82 m, and even that of the German Mauser 1898 rifle and bayonet, at ~1.77 m.[5] The trials resulted in the British army developing and then adopting their own version of the Japanese M.30 Arisaka bayonet of 1897, this becoming the P.1907 as was introduced with the List of Changes, para. 14170 of 30 January 1908; the combined length of the SMLE rifle and its P.1907 bayonet was then ~1.57 m.[4] In its first incarnation, shown full-length in Figure 1a, it retained the hooked quillon (HQ) of the Japanese M.30; a close-up of the hilt area is given in Figure 1b. It is generally believed that this was to assist in direct combat with an enemy soldier. In theory it allowed a rifleman to catch an opponent's bayonet and so at the very least parry an incoming thrust if not actually enabling him to wrest away his opponent's bayonet and rifle. However, on October 29, 1913, the decision to produce the bayonet with a simpler crossguard without the HQ was published.[6] Unit armourers often subsequently removed the HQ from bayonets in service when they went in for repair, although there is as yet no evidence that this was ever required on an official basis. Thus, it is not known if the HQ was deemed simply unnecessary, or if this was a cost-cutting measure. Another change to the design of the P.1907 was ordered during the GW period itself in January 1916, namely the provision of a clearance hole (CH) in the pommel.[7] It was already known from practical experience that the mortise slot in the bayonet's hilt, into which the short bar on the underside of the nose-cap of the rifle slides during attachment to the rifle, could become clogged with earth. As shown in Figure 2, the matter was resolved by drilling a small CH right through the pommel, very close to the wooden grips, to enable debris to be pushed out. Hence this feature had been provided in the hilt of the earlier Pattern 1888 (P.1888) Mk. I bayonet, and in the pommel of the P.1888 Mks. II and III and the P.1903 bayonet. Quite why the original version of the P.1907 did not have this feature is unclear. It is noteworthy that this feature is also absent from the Japanese M.30, hinting that the P.1907 was a clone of this in more ways than one. Evidently, sustained service use in field conditions in the early part of WWI highlighted the absence of a CH and so the decision was made to supply one.

The bayonets available for study today therefore include those that still retain the hooked quillon (HQ), those that were made with this feature but which were subsequently de-hooked (HQR), those that were made without an HQ, those of all three of these versions that were later given a CH and those that were made without an HQ and with a CH. In surveying the weight variations in all of these classes of bayonets, all of these attributes have to be noted. Because the HQ and the pommel are both made of mild steel or wrought iron, removing the HQ and drilling a CH should both theoretically reduce the weight of such a bayonet compared to an unmodified one.

As noted above, the original specifications for the P.1907 bayonet (with HQ, but without CH) included the length of blade 432 mm (17 in.), length overall 552 g (21.75 in.) and weight 468 g (16.5 oz.). It is thought likely that the weight was a result of the design requirements (length, width, flexibility etc.) rather than an inherent value. Certainly the weight of a bayonet was of concern, both with the overall equipment load on a soldier and also the effect on the balance and possibly on the accuracy of the SMLE rifle. In this context, the absence of an allowed weight range (especially an upper weight limit) is surprising and the given specification may best be regarded as 'descriptive'. However, a British War Office publication of 1929 contains a summary of the manufacture and inspection of the P.1907 bayonet.[8] Specifications are not stated as such, but the weight is given as between 454 g and 510 g (16 oz. and 18 oz.). It is not known whether this is an 'allowed' or an 'observed' weight range. In either case, the arguments presented in this paper are based upon the explicit weight specification of 468 g (16.5 oz.). This seems to be a reasonable approach given that the same document states that bayonets were inspected and gauged throughout the manufacturing process.[9] "If one fourth of any delivery is found inferior to the sealed pattern, or contrary to the terms of the specification governing manufacture, the whole consignment is liable to rejection."[10] This seems to imply that underweight, as well as overweight, bayonets could be rejected. The issue of meeting an exact weight specification or even a weight range is described in the 1929 publication only as "The completed bayonets are weighed….."[11]

Given the official specifications and strictures as reviewed above, it seemed remarkable to the authors that the weights of the P.1907 bayonets in a private collection all proved to be above the weight specification of 468 g. This could be explained initially by their being made by different manufacturing concerns. However, further enquiries established that this collection was not an 'exception to the rule'. Thus the decision was made to acquire the weights of more P.1907 bayonets from a variety of sources to determine if this overweightness was a consistent, or incidental, feature of these bayonets. If the former, it was hoped to establish what this might mean in terms of the quality control of the production of these weapons.

Methodology

The sources of data for this survey include examples held in private collections, one museum collection and many on-line sellers. The anticipated value of using examples from the one museum and on-line sellers was the inherent belief that these were probably less likely to suffer from an inadvertent collector bias, in the sense of having been chosen from a collector's preference for an overweight rather than a standard weight bayonet.

What was requested from each source was the weight of individual bayonets as determined on a "reasonably accurate scale" in either grams (g) or ounces (oz.), along with the name of the manufacturer, together with the presence or absence of the hooked quillon (HQ or HQR) in the case of bayonets made before November 1913; and the presence or absence of a clearance hole (CH) on bayonets made after January 1916; and the overall condition of the blade and fittings.

Weights reported by owners in ounces were converted to grams, using 1 oz. = 28.35 g [12], and were rounded to whole numbers using the normal mathematical convention. Comparative analysis, using a typical density of steel as 7.9 g/mL,[13] suggests that drilling a clearance hole removes ~2.8 g, and deleting the hooked quillon removes ~11.4 g. As it was thought that the type of steel might play a role in any variations of weight, bayonets from the various makers of the P.1907 based outside of the U.K. (Ishapore, India; Lithgow, Australia; Remington Arms, U.S.A) were therefore excluded from the study.

The use and aging of 100 year-old bayonets can result in rusting (ranging from pitting to flaking) of the iron and steel components. For this reason, the weights of heavily corroded bayonets are not included in the study. Prolonged and heavy use can also result in the loss of wood from the walnut grips. To allow for this factor, the weight of an original pair of grips (NOS 1942/1943) was established as being 17 g.[14] Because the loss of even an entire quarter of one grip would only, on average, be equivalent to ~ 2g, the condition of the grips of the bayonets that were surveyed was not questioned. However, observation of photographs of most of the bayonets used in this survey, and of a much larger number surveyed for another purpose, showed that none had more than small chips or gouges of the grips. This meant that all differences in weight were essentially due to variations in weight of the iron and steel components.

The data analysis for this paper was generated using Microsoft Excel (2010) spreadsheets with the Real Statistics Resource Pack software (Release 4.3). Copyright (2013 – 2015) Charles Zaiontz. www.real-statistics.com.

Results and Discussion

Six British manufacturers made P.1907 bayonets during the Great War. They are, in order of their alphabetical standing, with the abbreviations used hereafter, J. A. Chapman Ltd. (C), Royal Small Arms Factory, Enfield (E), R. Mole & Sons (M), Sanderson Bros. & Newbould Ltd. (S), Vickers Ltd. (V) and Wilkinson Sword Co. Ltd. (W). Estimated production numbers for these makers are given in Table 1.[15]

From the data given in Table 1, it was anticipated that the surviving bayonets would be heavily dominated by those made by Wilkinson and Sanderson, together with a limited number of those made by Chapman and Enfield; the relatively low production of Mole and Vickers promised that these makers would be poorly represented. This is confirmed by Table 2, which presents a listing of the weights of bayonets made by a given maker and obtained by the survey. In that Table, HQ indicates hooked quillon present, HQR indicates hooked quillon has been removed and a number in parentheses indicates the number of bayonets of that configuration and weight. Unless otherwise noted by an asterisk (*), all bayonets have a clearance hole drilled through the pommel. It will be seen that some bayonets avoided both modifications. As even a cursory examination reveals, there are several surprising features of the data presented in that Table. First, and most striking, is that 135 values (~96 %) out of 142 reported are above, and in many cases well above, the weight specification of 16.5 oz. (468 g) as given in the officially-requested parameters. A second striking aspect of the data is the wide range of reported values returned for each of the major makers. These variations for each data set are summarised in Table 3.

One possible explanation for the preponderance of overweight bayonets is that the heavier the bayonet, the better its chances of war-time survival so that the bayonets documented here are the result of a 'survival of the fittest' type of self-selection. This is, of course, impossible to determine today. Only in the case of unit-marked P.1907 bayonets, which are not common artefacts today, is it possible to say if a particular bayonet was issued to a GW-period unit; even then it may not have seen actual service use. We simply have no idea which, if any, of the bayonets listed in Table 2 were actually used in a theatre of war. All that can be said in this regard is that, by studying examples offered from a variety of sources, we believe that any possible collector bias of favouring heavier over lighter examples of these bayonets for personal collections is unlikely to have any significant effect on the overall data.

Alternatively, it may be speculated that the manufacturers deliberately produced bayonets that exceeded the weight specification, fearing that bayonets below this would not be accepted and so paid for by the government. In which case it is of interest to note that, although the commercial makers were probably not aware, even the government's own factory (RSAF, Enfield) was producing bayonets that were well below the weight specification. See for example, an Enfield example, listed in Table 2 stamped 10 '12 and so indicating manufacture in October, 1912 and weighing 456 g.[16] It is certainly surprising that a below-weight bayonet was accepted by Enfield's own examiners during the pre-war period when there was no great urgency for production that might explain production standards that paid only lip-service to the official publications. The probable explanation in this case is that, as the *Text Book of Small Arms* suggests, instead of individual bayonets being actually examined to determine their weights accurately, only a sample number from each batch were given this attention; the practice as set out in 1929 was to test 'one fourth' of a batch. Indeed, any weighing done may have been of boxes of bayonets so the occasional underweight bayonet would not then have been noticed among a large number of overweight bayonets. As it is, this particular Enfield example avoided the two modifications, removal of the HQ and the drilling of a CH in the pommel, which became common if not *de rigueur* after 1913 and 1915, respectively. It would therefore be expected that this particular bayonet should certainly not be lighter than others made at Enfield. It can be extrapolated that, of the total of 172, 657 bayonets produced at RSAF Enfield in the period to the end of 1913,[17] about 260 bayonets would have been below the weight specification, assuming the weights of these bayonets were distributed normally and if 468 g is three standard deviations (3σ) distant from the mean weight.

Statistical Analysis

It is known from probability theory that with a very large number of observations, a plot of the value of the observation (X-axis) vs. frequency of that observation (Y-axis) gives the familiar bell-shaped curve, known as the normal distribution. Except for Vickers, the data from each individual maker was shown to be normally distributed by the Shapiro-Wilk test.[18]

Because a normal distribution is symmetrical about the mean, setting the mean at the weight specification (468 g) would ensure that about half of production would not meet that specification, and presumably would not be accepted. This would have caused a great loss of production, and an enormous recycling effort of the underweight bayonets. It is reported that manufacture of the P.1907 bayonet with HQ required 146 operations,[19] and probably a lower, but similar number for the non-HQ bayonet. Because bayonet manufacture was so labour-intensive, it is surmised that this loss of production during war-time would have been unacceptable both to the makers and to the War Office.

Mathematical attributes of a normal distribution are that about 68 %, 95 % and 99.7 % of observations occur within ± one (σ), ± two (2σ) and ± three standard deviations (3σ) of the mean, respectively.[20] To ensure that virtually all bayonets (i.e. 99.7%) weighed at least 468 g, the makers had only to set the value of the desired mean (M) such that the condition of equation 1 was met.

$$M - 3\sigma = 468 \text{ g} \qquad \text{Eq. 1}$$

But, the value of σ had to be known, or if not known then it would have to be estimated from prior bayonet-making or sword-making experience. All of the manufacturers, except Chapman and Vickers, had previously produced P.1888 bayonets under government contract and may have been able to estimate an expected value of σ.[21] Chapman and Vickers on the other hand seem to have been newcomers to the large-scale manufacture of edged blades (a connection between the J.A. Chapman Ltd. of Yorkshire and the W. Chapman of Staffordshire who had manufactured India Pattern sword-bayonets during the Napoleonic Wars,[22] is possible but unproven) which presumably explains why they were apparently contracted to produce only a limited number of P.1907 bayonets.[23] As it is, the (M – 3σ) values calculated for each of the makers are given in Table 4 and it can be seen that only Wilkinson has actually come close to meeting the requirement of equation 1. No surprise though, that the relative inexperience of Chapman and Vickers at bayonet-making is duly revealed in their much lower values compared to even Enfield and Sanderson. The failure of the makers, other than Wilkinson, to meet the condition of equation 1 is, nonetheless, somewhat surprising.

Another attribute of the theoretical normal distribution is the coincidence of the mean value, the median value and the mode at the centre of the symmetrical distribution; the mode is that value that occurs with the greatest frequency**.** The combined data of Table 2 has a mean at 493.1 g, a median value of 494.0 g, a mode at 482.0 g and the standard deviation is 15.5 g. Although the mean, median and mode values are not identical, the Shapiro-Wilk test shows that the distribution is normal. Also, the data is summarised visually in the histogram given in Figure 3 which shows that the combined data for all manufacturers has a reasonably symmetric distribution about the mean.

An obvious conclusion from a visual inspection of the data sets is that all makers had produced bayonets that were essentially similar. This of course was the purpose of the government contract. Because each bayonet from each maker had to pass a stringent bending test without deforming or breaking, it is possible that each maker used steel of the same or very similar formulation, possibly from the same supplier. If near-identical steel is assumed, then the major variable in the process was the skill of the operators involved in the machining and milling processes. Not unnaturally, this resulted in bayonets that were very similar in appearance, but not identical in weight.

How then to account for the weight variations observed in this study? On average, only 3.5 % of the weight is in the wooden grips; as noted earlier, loss of even one-quarter of a grip would only lower the weight by an average of ~2 g. The large weight variations are clearly due to differences in the steel or wrought iron components, ten of which go into the production of a finished P.1907 bayonet. They are (a) a single-piece blade and tang, (b) a crossguard, (c) a pommel, (d) a bolt, spring and nut that fit into the pommel, and (e) two pairs of machine screws and nuts. The items listed above in (d) and (e) range in size from small to very small and cannot be responsible for the large weight variations. The pommel and the crossguard fit very tightly onto the tang, brazed into place and again, the relatively small amount of brass used cannot be the cause of excess weight. The tang is of uniform thickness, with one straight edge and one recurved edge, and again is unlikely to be responsible for the weight variations. The standard crossguard from post-1915 is estimated to weigh ~ 40 g, while the pommel is estimated to weigh ~ 88 g. A significant and very visible distortion of the dimensions of the crossguard or the pommel, or both, would have been required to generate a weight increase of more than a few grams. The blade, therefore, has to be the major source of variability in the weight of the bayonet. Not only is this conclusion reached by the process of elimination described above, but it is also derived readily by a visual inspection of such a blade. The blade is thicker along the spine than along the lower edge, and is likewise thicker at the crossguard than at the tip. Also, there is a fuller on each side of the blade. In the days before computer-controlled machining, such shaping of a groove at a machine was done by hand. The judgements of the operators of the milling and grinding machines were then, apparently, the arbiters of the 'correct' dimensions for the fullers.

But, can a very small difference in the dimensions of a fuller make a noticeable difference to the weight of a bayonet? The single measurements of a fuller taken on a bayonet in a private collection are approximately 320 mm long x 8 mm wide x 3 mm deep. For arithmetical convenience, suppose that the depth is truly 4 mm. If it is ignored that the fuller becomes shallower near the tip and the ricasso, the fuller can then be treated for the purpose of this paper as a groove of semi-circular cross section. The volume (V) is then given by equation 2,

$$V = (\pi \times r^2 \times L)/2 \qquad \text{Eq. 2}$$

where r and L are the radius and length, respectively. The weight of steel removed to form this groove is ~ 64 g. Let us suppose instead that there is a difference in the width measurement and the groove is actually 6 mm wide and 3 mm deep. The weight of steel removed to form this groove is ~36 g. Thus a difference of ~28 g is incurred by going from a semi-circular cross-section groove of radius 3 mm to one of radius 4 mm. There are two fullers on a blade, and the same result is derived if the 1mm difference of radius is instead assigned as 0.5 mm to each of them. Similar results are obtained if the cross-section is assumed to be semi-elliptical. Regardless of the geometrical assumptions made, these numbers show that small differences in the dimensions of the fullers can have major impacts on the final weight of a bayonet.

Conclusions

In retrospect, it is perhaps not surprising that the bayonets surveyed for this study are almost all above the weight specification. Such a result derives naturally if the makers had set a target weight that would ensure that virtually all bayonets met the weight specification. In the era before computer-controlled machining, the observed wide variation in weights was almost certain to occur.

Acknowledgements

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Photographs of a P.1907 bayonet with hooked quillon but without a clearance hole (Figure 1a and 1b) and of a P.1907 bayonet without hooked quillon but with a clearance hole (Figure 2) were provided by one author (J. B.) and Dr. Christopher J. McDonald, respectively.

Dr. C.J. McDonald is also thanked for a critical review of the manuscript, comments regarding the overall importance of bayonet weight and for bringing the *Text Book of Small Arms* to the attention of the authors.

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[2] We use here throughout the general modern term 'crossguard' for this part of the bayonet, although the British term for this in the late 19th and early 20th century was 'crosspiece'. See, for example, *Patent Application no. 14,163* for the nose-cap boss system used for attaching a bayonet to the SMLE, as issued on 11 July, and accepted 17 August 1901, which refers to "the hole in the cross[piece] of the sword bayonet"; see also, *List of Changes,* para. 11715, announced 23 December 1902, and introducing the SMLE as the 'Rifle, short, magazine, Lee-Enfield', states specifically that "The nosecap ... has an extension in front on which the crosspiece of the sword-bayonet fits..."

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[21] I.D. Skennerton and R. Richardson, *British & Commonwealth Bayonets*, p. 165-8, 170

[22] *ibid*., p. 55, 57

[23] J.A. Chapman Ltd. was a contractor for the conversion of P.1888 sword-bayonets to P.1903; however, that involved only pommel & crossguard work and there was no blade-making required (*ibid*., p. 182). Also, Vickers Ltd. had made about 1500 of the P.1913 sword-bayonets in 1917 (*ibid*., p. 190).

Figure 1a Full-length of P.1907 bayonet with HQ and without CH

Figure 1b Close-up of hilt of P.1907 bayonet with HQ and without CH

Figure 2 Close-up of hilt of P.1907 bayonet without HQ and with CH

Figure 3 Frequency Plot of Bayonet Weights

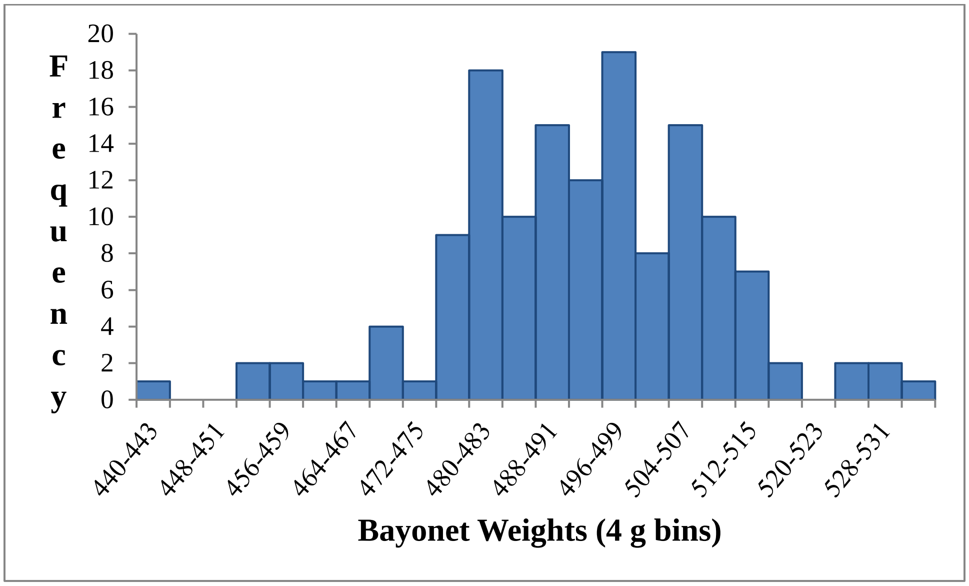

Table 1

Estimated Production Numbers of P.1907 Bayonets by Maker

Maker	**Chapman**	**Enfield**	**Mole**	**Sanderson**	**Vickers**	**Wilkinson**
Production	300,000	500,000	60,000	1,600,000	10,000	2,360,000

Table 2

Weights (g) of Individual Bayonets by Maker

Chapman	Enfield	Mole	Sanderson	Vickers	Wilkinson
456	456* HQ	473	440	454	478
466	476 HQR	479	454	461	479
479* HQ	476	483	470	480	480(2)
482	479 HQR	485	471* HQ	484	482
485	479* HQ	486	471	488	485
490(2)	480	496* HQ	478	489(2)	488
494	481	505	480* HQ	490	490
495* HQ	482(3)		480* HQR	497	491
505	485		480 HQR		492* HQR
511	486		482(4)		493(3)
524*	489* HQR		485		494
	491* HQ		486		496(3)
	500* HQ		487* HQ		497* HQ
	510		488(3)		498* HQ
			490		498
			492		499(2)
			493		500(3)
			494* HQ		502(2)
			494		504(3)
			496(2)		505(2)
			498* HQ		506*
			498		507(3)
			499(4)		508(2)
			502(2)		510* HQ
			504		512(2)
			505(2)		513* HQ
			507		513(3)
			510(5)		516
			513*		524(2)
			514		
			518		
			528		
			532		

( ) numbers in parentheses indicate number of bayonets of that weight and configuration.
* denotes a bayonet that does not have a clearance hole.
HQ denotes that the hook quillon is still present.
HQR denotes that the hook quillon has been removed.

Table 3

Summary Statistics of Bayonet Weights by Maker

Maker	**Chapman**	**Enfield**	**Mole**	**Sanderson**	**Vickers**	**Wilkinson**
Count	12	16	7	50	9	48
Mean (g)	489.8	483.4	486.4	493.0	481.3	500.5
Std. Dev. (g)	18.6	11.6	10.8	16.9	14.4	11.2
Median (g)	490.0	482.0	485.0	494.0	488.0	500.0
Range (g)	68.0	54.0	32.0	92.0	43.0	50.0

Table 4

Value of (M – 3σ) in g, for each Maker

Maker	**Chapman**	**Enfield**	**Mole**	**Sanderson**	**Vickers**	**Wilkinson**
M – 3σ	434.0	448.6	454.0	442.3	438.1	466.9