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ORDNANCE AND SMALL ARMS DESIGN *

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Introduction

At the mention of Ordnance and Small Arms the Royal Ordnance Factories in England invariably flash through the mind due to their pre-eminent position in this sphere. It is a matter for regret that the Ordnance Factories in India are not so widely known. But in view of the excellent class of workmanship that is to be seen in the products of their manufacture, it is the writer's hope that in the near future, now that the Ordnance Factories are forging ahead on projects that will make India self supporting, the Indian Ordnance Factories will command a similar fine opinion.

The design and production of Small Arms has progressed in England from the old Brown Bess, a muzzle loaded weapon which was later modified to a breech loader, through the Martin Rifle, made about 1870 ; the Lee Enfield Mark I made about 1900 ; the Mark III made about 1907 ; and the Rifle No. 4 made about 1926. Whilst Revolvers have advanced through similar stages to the current ·38 on which production commenced about 1929, Light Machine Guns have progressed to the Bren Mark III. Production is now to be undertaken of the Bren Gun, Sten Carbine and pistol Revolver in India.

In India, there was production of Ordnance from the time of the old East India Company and it is a pity that we cannot devote time to that most interesting period in this paper. In this short paper it is not possible to do justice to the subject of Ordnance and Small Arms Design but brief references will be made to the more important aspects of the subject.

The production of modern Small Arms, following the policy and activities of England, commenced about 1904 and the progress made can be visualized from the fact that during the late World War II India was producing about 14,000 Rifles per month.

Now that India is an independant country the question of the design of weapons has naturally to be faced and this brings us to the crux of this paper *i.e.* Ordnance and Small Arms Design.

I am not going into the pros and cons of the various weapons, this being a subject that can only be dealt with by the experts, but I will endeavour to give a few very brief remarks about the various Small Arms and Ordnance with which this country is chiefly concerned at present and then pass on to a few remarks that I would like to offer on points of design that affect the manufacturer.

Small Arms

This term usually applies to Rifles, Light Machine Guns, Carbines and Revolvers, *i.e.*, Weapons that are used by the Infantry units.

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Rifle MK. III.

The rifle has a breech machanism of the bolt type, the bolt being locked by a turning movement which causes lugs on the belt to engage with mating contacts in the body. There is a camming action of the locking lugs to seat the cartridge firmly.

The magazine is directly beneath the bolt and is loaded from the top with two clips of five cartridges whilst the bolt is retracted.

The ammunition used is the ·303″ MK. VII.

Bren Gun MK. III

This machine gun has a gas operated breech machanism. The breech block, representing the bolt of a rifle, is propelled by the pressure of gas, created upon the firing of a round of ammunition, acting upon a piston situated directly beneath the barrel and connected with the barrel by the gas block.

There are cams on the breech block that are operated through the piston post to move the block into a position between a locking shoulder and the barrel face to seat the cartridge firmly at the moment of firing.

The magazine is fitted directly over the breech machanism aperture in the body and is designed to hold 30 rounds.

The rate of fire of this arm is approx. 600 rounds per minute. The ammunition used is the ·303″ MK. VII.

Sten Carbine

The sten carbine is an automatic weapon of a very simple design, sometimes referred to by the layman as a " Tomy Gun ".

It is operated by the pressure of the gases, created when a round is fired, acting directly upon the face of the breech block and causing it to fly backwards; it rebounds again having collected another round from the magazine and so repeats the operation.

The rate of fire of this arm is approx. 575 rounds per minute.

The magazine is fitted at the side of the body and is designed to hold 30 rounds.

9 m/m rimless ammunition is used.

Pistol Revolver No. 2 MK. I

This is six chamber hammer operated revolver of a somewhat lighter pattern than the ·45″ model which it has replaced.

·38″ rimless ammunition is used.

Ordnance

This term usually applies to guns, howitzers and Mortars. modern design and devlopment renders it somewhat difficult to draw a clear line between these weapons but geneally speaking the special characteristics of each type of weapon may be summarised as follows :—

Gun——High Velocity ; Long Range.
Howitzer——Varying Charges ; Steep Angle of Descent.
Mortar——Low Velocity ; Short Range.

The principal systems of construction in present use are Wire Wound (for big Naval Guns etc.) and Removable Liners or Barrels.

The wire wound system has been the British practice for weapons over 3″ calibre for many years (about 50). The principal advantage claimed for this system being that for a given Ballistic value and factor of safety it provides a lighter weapon than if built up.

The removable liner or barrel system which is rapidly coming into favour and is employed on most modern designs has the advantage of the facility with which a worn liner may be removed and replaced by another whilst the weapon is still in the field. The successful development of this system was due, to a great extent, to the autofrettage process of manufacturing the tubes. In this process, the setting up of a stage of residual compression in the inner and a residual tension in the outer layers of the steel is effected by the application of a suitable liquid pressure to the bore of the tube.

The modern high tensile steels now developed are tending to render the autofrettage process redundant.

The present trend of design of Ordnance is to cater for Air Borne weapons *i.e.*, weapons that can be easily dismantled for transport by air.

The two weapons with which India is at present chiefly concerned on the manufacturing side are :—

(1) Ordnance Q.F. 25 Pd.

The body of this consists of a loose barrel, length 92½″ ; Bore 3·45″ ; a jacket and a removable Breech Ring.

(2) Ordnance Q.F. 3·7″ A.A.

The body of this weapon consists of a jacket, autofrettaged loose liner ; length of jacket & liner 185″, Bore of Liner 3·7″ and a removable Breech Ring.

The writer has not had a great deal of experience of Ordnance during the past few years, having been engaged upon the production of Small Arms and therefore regrets that further data on these two weapons are not available at short notice.

Points on design that affect the manufacturer

The method of manufacture of any article is dependant upon quantities required and when an article is required in large numbers, as in the case of Small Arms, the method should be mass production.

To attain this it is advantageous if the design of the weapon is such that it lends itself to this method and consequently has all its details simplified as much as possible.

A Small Arm may be conceived and the design committed to paper by experienced designers who are *au fait* with service requirements and all the ideal features appertaining to the functioning of the weapon but it is often found that, from the manufacturers point of view, the difficulties of production have been overlooked. This is understandable since it is not usual to find persons who are experts in the design of weapons are also production engineers.

In most instances a design, as conceived by the designer, can, with a few modifications, be made to satisfy both the designer, from a functional point of view and the manufacturer from a production point of view.

A few examples of the simplest modifications that are often asked for by the production side which, if included in the original component drawings would ease the essential routine work when going into production of a new weapon are given below :—

(*a*) A component is shown with a threaded portion right up to a shoulder Is this essential ? If so, an undercut would assist machining. If produced with a die head or threading tool and the use of protruding chasers, extending beyond the front face of the die head would be avoided if the thread could terminate a distance away from the shoulder. Similarly a clearance at the end of a spline or key way to enable the tool to run out is often forgotten.

(*b*) A component is shown as made from solid material which to produce as drawn would entail many machining operations whereas a similar article, of equal strength, could be fabricated and the amount of machining reduced considerably.

(*c*) By modification of design a component may be produced as a pressing which, although involving several press operations, would be considerably quicker to make than when machined from a casting or material.

(*d*) Drawings are without tolerances on many dimensions or, at the other extreme, with very close tolerances.

In either case it is a " headache " for the manufacturer since in the former case he is not sure of the accuracy required and consequently has to seek enlightment from the design staff and in the latter case he has to engage more highly skilled operators, who can work to such fine limits, and also in many instances increase the number of operations to maintain the accuracy called for which would not be the case where less exacting tolerances are admissible whilst still maintaining the functional accuracy of the component.

A further point that arises in this country at present, due to India not as yet being self supporting, is the material specified for various components.

In current designs of Small Arms there are several components which have material specified that is not of indigenous supply. In some instances alternative materials, that are being produced in India, could be specified until the special alloy steels etc. as quoted on original drawings, are produced indigenously.

It is the writer's opinion that many of these points of design etc., could be successfully cleared up before production is put in hand if a committee of experienced persons from all the branches of the industry were to be set up and they met to discuss each detailed component drawing before final acceptance of an Arm for production. This would not only broaden the designers field but help to ease the work of the planning staff of the factory who are detailed to produce the weapon.

In conclusion I should like to digress from the main subject to give a brief outline of the work that has to be put in train to enable production of a weapon to be commenced.

First, each component drawing has to be examined and the method of manufacture, in the form of a manufacturing layout prepared; in many instances in Small Arms production this means a hundred to two hundred operations.

Secondly, the plant and equipment required for each operation on the component has to be decided upon and the equipment designed and manufactured; on a Small Arm such as the Bren Gun there would be several thousand fixtures-tools and gauges to be provided.

Concurrently the cutting time for each operation has to be calculated to ascertain the number of machines that will be required to maintain a given output.

Also the type, size, condition and quantity of material that is required for each component has to be formulated to enable provision action to be taken.

Thirdly, the location of the plant has to be planned for the various shops allotted for production to ensure the minimum transhipment of a component during its various stages of manufacture combined with efficient grouping of machines for purpose of supervision.

Thus it will be seen that the design of each component of a weapon needs very careful consideration not only from the functional side but from the manufacturers point of view since the routine work involved, on acceptance of a design for manufacture, before production can be established may take from six months to two years, according to the weapon concerned, and much of this work can be simplified if the design drawings in the first instance have been clearly and concisely defined for the condition under which they have to be manufactured.