

gated projectiles, and this is no less complete than was the change consequent on the gradual substitution of cannon for the old engines of war.

I must apologise for thus suddenly passing from the first introduction of gunpowder to that of rifled ordnance, but to follow the early cumbersome weapons through all the various shapes they have assumed until they arrived at their present state, my time will not admit of. It was very gradual. In proportion, however, as real science advanced, the truth came more and more to be established, that a piece of ordnance cannot be too simple, and the continual improvements in carriages, modes of draft, and driving aimed at, combining mobility with efficiency of fire. Artillery has already played an important part in many a battle field. Napoleon the Great, relied much on this arm. In our own time, the Crimean and Italian campaigns, the siege of Duppel, and the gigantic operations in America, all bear witness that it is now universally acknowledged as the principal arm of offence and defence.

The Battery is the tactical unit of modern artillery. All division of artillery into brigades or regiments is only for the interior economy of the corps, and when we come to talk of armies on the march, or on the field of battle, their artillery is estimated by the number of its guns. Thus we say, that at Waterloo we had 156 guns, and the French 246. This unit, however, is one of unequal strength; its number of men and horses, and its equipment of guns and wagons varies according to the service it is intended for, and here may be remarked a difference that exists between artillery and the other arms, viz. that whereas, cavalry and infantry may, by superior and dashing bravery, make up to some extent for inferior and faulty organization, artillery, however skilfully handled, cannot render efficient service, unless well equipped and armed. Again, the armament of artillery must always be much, very much more complicated than that of the other arms, and this arises from the impossibility of one gun being adapted for all purposes of warfare. By adopting a heavy gun generally, we render our field artillery useless, and by adopting a light gun, as a universal weapon, we render our ships and garrisons defenceless, and our armies incapable of taking fortified places. Artillery is therefore, armed with guns differing in calibres, weight, size and shape, requiring a variety of carriages and projectiles to enable them to perform the duties expected of them. But for all that, a greater simplicity is wanted in our armaments. We have, at this moment, 40 different calibres of guns; we use 15 different kinds of fuzes; we fire 19 different kinds of projectiles, and our guns are mounted on 13 different kinds of carriages. As rifled ordnance replaces smooth-bored we shall, no doubt, have less variety; but, so far, the vaunted simplicity that was to be introduced on its adoption is a myth, for we have been given breech-loading in addition to muzzle-loading; and have five kinds of rifling to bother us. Thus you will see that it is necessary for an artilleryman to be intimately acquainted with the relations of these different branches to one another.

Four materials are generally used in the construction of modern ordnance.

1st, Cast iron; 2nd, bronze; 3rd, wrought iron; 4th, steel. The properties required in a metal cannon are elasticity, toughness, and hardness; and it is also important that the material be manufactured with certainty as well as that the mode of construction be not too costly.

Cast-iron is used for smooth-bored guns, it is not strong enough for rifled guns, un-

less they are fired with very small charges. The Americans have of late greatly improved cast iron ordnance by selecting the most suitable ores, and taking measures to render uniform the contractions of the different portions of the metal in cooling.

Bronze has been used for the construction of the lighter description of ordnance, but it is costly and too soft for bores of rifled guns.

Wrought-iron is an excellent material in most respects for ordnance: it is exceedingly tough, and although not so hard as cast-iron or steel, it is not so liable to snap, and will withstand a greater moving or percussive force. It is this material we use for all our heavy rifled guns.

Cast steel is well adapted for the bores of guns; but the great cost of the metal and its tendency to fly into a number of destructive pieces render it less suitable for the exterior of guns. By hoopng steel with wrought-iron the endurance of the former is much increased, and rendered less liable to destruction.

The steel used for the bores of our heavy guns is tempered in oil, by which means it is rendered both harder and tougher.

There are three methods of constructing ordnance, namely: casting, forming from a solid forging, and building up.

There is little doubt that by casting a gun in one mass much time and expense is saved, many difficulties experienced in making guns in parts avoided; but, as yet, no material has been found of sufficient strength, combined with uniformity in quality, which will bear the strain of large charges of powder, when cast into guns.

The forming guns out of one solid forging has only been attended with success in very small calibres, and is almost universally condemned.

The building up is much advocated in England, and much experience has been gained in it of late years. It is upon this principle that our rifled guns are made. It has its advantages and disadvantages. Among the 1st are that the different pieces being small their soundness may be depended upon; the gun need not be made of the same material throughout, but different materials may be placed at the parts where their peculiar properties are most required; and we can so place our metal that their fibre will run in a direction most calculated to resist the strains they are subjected to; and lastly, the thickness of metal can be made of different layers, each layer having a regulated tension, and thus taking its due share of strain. Every gun when fired is subjected to two strains from the force of the gunpowder. The tangential strain tending to rend it lengthwise, and the longitudinal tending to blow the breech out. Sir Wm. Armstrong built his gun on a plan to meet these two strains. He disposed the bite of the metal round the bore by coiling, so as to resist the tangential strain, the welds at the same time running in the direction of the least strain as regards their separation; his breech-piece, supporting the bottom of the bore, has its fibre running lengthways, so as to resist longitudinal, and all his coils are shrunk on, so that the exterior of the gun takes its due share of the strains, even where it is thickest. Many improvements have been made; but, Sir W. A.'s plan is the basis of all our built-up guns.

As regards the natures of ordnance, every one, doubtless, is aware, that there are four kinds.

1st, Carronades; 2nd, Howitzers; 3rd, Mortars; 4th, Guns. Carronades derive their names from the Carron factory, where they were first cast in 1779. They are light

guns without trunnions, and are attached to their carriages by means of a loop underneath. They were principally used in the navy, and were constructed, by reducing windage and charges, to throw heavy projectiles at short ranges. From the effect this had in the old bull dog style of fighting, when ships came close along side each other, the carronade was termed the "smasher." They are now nearly obsolete; a few, however, remain in our service, and are mounted in casemates and retired flanks of works.

Howitzers resemble guns in form, but are much shorter and lighter in proportion to their calibres, and are consequently fired with smaller charges. Shell and case are fired from them, but not solid shot. They were introduced to fire shell at low angles, and have constantly been found most useful in the field and siege operations during the wars of the last and present centuries. These pieces have the gomer chamber; of these there are two classes: iron and brass. Of the iron we have the 8 inch and 10 inch howitzer; of brass howitzer 32-pounder, 24 pounder, 12 pounder, and 4½ inch.

Mortars are short pieces of ordnance that throw shell at high angles, generally 45°, the charge varying with the range required. They are of cast-iron and bronze, and distinguished by their calibres. Of cast-iron we have 13-inch, 10-inch, and 8-inch land service, and 13-inch and 10-inch sea service for gun-boats principally. These mortars are found most effective in the bombardment of towns, &c., their shell possessing great penetration from their almost perpendicular descent; also, the large flame liberated from them will frequently ignite any combustible near which they fell. Of bronze mortars we have two kinds—5½ inch, or Royal 1½ cwt., 4½ inch, or corhorn ¾ cwt. These are very useful in the attack of entrenched posts, as from their lightness they can be conveyed in countries where guns cannot move. In India for instance, they have been found very effective in the attack of hill forts, &c. they are also used in advanced trenches or by the besieged to annoy the working parties of the besiegers. Mortars are mounted on what are termed beds, those for the heavy land service are of iron, and for the others of wood. Guns are the nature of ordnance most familiar to every one; and of these we have a great variety. I will class them under the two heads of smooth-bored and rifled guns. Smooth-bored may again, according to the material of which they are made, be classed under three heads: 1st, cast-iron; 2nd, bronze; 3rd, wrought-iron. Those of cast-iron are the most numerous, and embrace all the old garrison, siege and part of the position guns in the service, before building up and rifled ordnance were known; we have of this class the following calibres: 10 inch, 8 inch, 68-pounder, 50-pounder, 42 pounder, 32-pounder, 24-pounder, 18-pounder, 12-pounder, 9-pounder, and 6-pounder. Of most of these calibres we have more than one kind of gun. Of 32-pounder we have 13 guns varying in weight; the 50 and 42 pounders are nearly obsolete; and 12, 9 and 6-pounders are now only found in very few of our stations, and were found, I believe, are only used for saluting, so we shall soon, I hope, have only 68, 32, 24, 18-pounders and 10 and 8-inch. 10 and 8-inch guns are what are termed 'shell-guns,' that is to say, they are only intended for firing shell; and are consequently not so heavy as shot-guns of same calibre, and since their introduction 8 and 10 inch howitzers are fast going into disuse. These pieces have the gomer-chamber as they are fired, with comparatively small charges. Of bronze guns we have 12, 9, 6 and 3-pounders. The 12-pounder was