THE MANUFACTURE OF GUNS AT THE WASHINGTON NAVY YARD.

The modern built-up breech loading rifle for service on land and at sea has developed into a very complicated structure, requiring the highest degree of mechanical skill and perfection of tools for its construction. While the rule has been for foreign governments to depend largely on private or ostensibly private concerns as manufacturers of their ordnance, the United States government have embarked with great success upon the business of manufacturing its own guns, both for army and navy use. Army guns are assembled at Watervliet Arsenal, near Troy, New York, and guns for the navy at the Washington, D. C., Navy Yard. At these establishments the forgings for the tubes, jackets, hoops and other parts are received rough finished and oil tempered from the forges, which make them under government supervision. The rest of the operation is done by the government.

The guns for navy and for army use follow essentially the same lines of construction and the tools used in their manufacture are largely identical. Our illustration shows the great 16 inch gun lathe at the Washington Navy Yard, a typical piece of its class and built by the William Sellers & Company, of Philadelphia, Pa. The lathe is used for two essentially different purposes, the one for turning the outside surfaces of the different parts of the gun, in which role it operates as an ordinary lathe does; the other operation is the boring and reaming of the interior of the different pieces of the gun. The interiors are attacked by tools carried on a long boring bar, which tools are of the drill or reamer type. The rifling, a special operation, is analogous to planing.

The lathe bed is divided into two parts. One carries the headstock, tool carriages and steady rests; this portion is 73 feet 10¾ inches long, 9 feet wide and 2 feet deep, made in two sections bolted and keyed together. On this bed are executed all the external turning operations. In prolongation of this bed comes a second or narrower part, which carries the boring bar. This part is 54 feet 5 inches long, 5 feet 2 inches wide and 2 feet deep. To give an idea of the size of the headstock, the dimensions of the main spindle may be cited. Its front bearing is 20 inches diameter, its rear bearing is 14 inches diameter, and the distance between the bearings is 6 feet 9 inches.

The spindle is driven by an 8 inch belt, working on a 7 step pulley, whose diameters range from 20 to 60 inches. The center of the main spindle is 4 feet above the bed. A fixed screw extends along the length of the headstock section of the bed. Each of the two tool carriages carries a long nut which works on this screw. Parallel with the screw are two square shafts, which are rotated from the headstock. These shafts operate the nut, and, according to which one is thrown into gear, the carriage is fed slowly as the tool is cutting or is rapidly traversed back to the beginning of its work. The square feed shaft also feeds the cross slide. By changing the gears on the carriage, the ratio of longitudinal and cross feeds can be modified so as to get nearly 100 different tapers with simultaneous feeding, and, by extra gears, the ratios may be varied almost indefinitely. The swing of the lathe is 70 inches over the carriages.

Four steady rests for the following diameters are provided: 61 inches, 54 inches, 40 inches and 27 inches. By a coupling bar a steady rest can be attached to a carriage so as to be traversed or shifted as required.

The tailstock spindle is 14 inches in diameter and has a steel center 8 inches in diameter. Back of the tailstock is the boring bench, which carries the boring bar on a fixed rest at the front end of the bed, and on three slide rests distributed along it. A very ingenious feature of the boring mechanism provides for the rotation of the boring bar in the opposite direction to that of the gun, so that the boring rate is independent of the turning rate, it being understood that, as usual, the rotation of the gun effects the boring. Thus boring and turning can be simultaneously carried on upon the same piece.

A 16 inch gun consists of a number of distinct pieces. Its basis is a tube the full length of the gun. This tube is first placed on the lathe and brought up to its proper position between centers in order to allow for any possible warping. It is now bored, there being perhaps as much as half an inch of metal to be removed during the boring operation. The finish reamings are given with a reamer consisting of a stock whose head carries a block of hard wood soaked in oil, turned to shape and provided with steel cutters. By these tools the bore of the gun is perfected. Before the final finish reaming the tube is turned on the outside.

In this operation the gun is supported at some intermediate point with steady rests, for whose operation seats are turned upon the exterior of the gun. One of these steady rests, with its block bearing surfaces, is seen prominently displayed. The surface is first rough turned to within about 0·03 of an inch of the shrinkage diameter. The final turning is given with a square nosed tool about an inch wide, and here the utmost accuracy must be observed, no variation exceeding 0·003 of an inch being tolerated. Over the inner tube is shrunk a heavy tube which is termed a jacket, and a number of other tubes superimposed and rabbeted at the ends, termed hoops. Each one of these is prepared on the same lines as just described for the tube, each one being accurately bored and reamed and its exterior turned down with the greatest exactness. For hoops and jacket the general principle is followed that boring and finishing the interior surfaces precedes the final turning of the exterior or shrinkage surfaces.

The hoops and jacket are a little less in interior diameter than the exterior diameter of the cylinder which they are to embrace, about a hundredth of an inch shrinkage per linear foot of diameter being allowed. To put a hoop in place, the part destined to receive it, which may be the interior tube or may be the partially hooped gun, is set up on end in a special centering pit near the furnaces. The hoop is heated in a furnace whose fuel is raw petroleum actuated by a blast. As the piece gets hot its diameter is constantly tested by means of a species of interior calipers termed a fixed star gage. As soon as it has become large enough it is lifted out of the furnace and is lowered into place over the vertically supported gun. These operations are rendered very easy of accomplishment by the very perfect system of cranes employed.

The gun is again put in the lathe chuck, and supported by steady rests and prepared for a new hoop. In this way it is gradually built up. It is to be observed that the shrinkage surfaces are left as they come from the squarenosed tool in the lathe. They are not touched with the file or emery paper. The shrinkage operations slightly diminish the bore, indicating what a tremendous power is exerted by the hoops, and necessitating a final finish reaming of the bore before rifling.

When all the hoops are in place the exterior of the gun is turned in the lathe to its final shape, and then it is gone over from one end to the other with files in the hands of the workmen as it turns in the lathe, so that its exterior surface leaves the shop as perfectly hand finished as any piece of fine machinery.

The interior has to be bored and reamed out to provide an enlarged powder chamber at the breech end. In the 12 inch gun this is about 6 feet long and about 2 inches larger in diameter than the bore of the gun. Then a conical slope 18 inches long comes between the forward end of the powder chamber and the bore of the gun. This is not all. To enable a projectile to enter the bore and for its packing rings to fill the grooves, what is termed the forcing slope must be bored out. This consists in a very slight enlargement of the bore, with a very slight taper at the breech end, over a distance of some 4 feet in the 12 inch gun. This increases the bore at the rear end of the forcing slope a little over 0·05 of an inch, reducing, of course, to zero at the forward end. The complicated breech mechanism has to be provided for by the cutting of the interrupted screw, the gun has to be rifled and at last is complete.

It is needless to say that throughout the most severe inspection is exercised. The bore of the finished piece is calipered by a very ingenious apparatus termed the star gage, which reads to 0·001 of an inch by vernier. With this instrument readings are taken for every inch of length of the gun and in two or three series, so that 400 or more star gage readings are regularly recorded for every large gun. The interior is subjected also to ocular observation by means of an inclined mirror and an incandescent light, which is passed through the gun and enables every particle of its interior to be carefully observed.

An Indication of Foul Air.

In the Zurich industrial exposition, says Gaea (translated by the Literary Digest), an air tester is exhibited which shows whether and in what degree the air in a workshop is contaminated. The apparatus consists of an airtight closed glass vessel filled with a red fluid. Through a glass tube that dips into the liquid and is bent at the top, a drop falls every one hundred seconds on a cord that hangs beneath and that is somewhat stretched by a weight. The fluid from which the drop comes has the property of changing its red color to white by the action of carbonic acid. The more carbonic acid there is in the air, the quicker this change in color takes place. If the air is very foul, the drop becomes white at the upper end of the cord, while the change of color corresponding to a slight proportion of carbonic acid does not take place till the drop has run farther along the cord. The exact condition of the air can be ascertained by observing a scale that is placed alongside the cord and that is divided into convenient parts, bearing the designations, "extremely bad," "very bad," "passable," "pure." This is surely a very useful device, and should be found in every factory, every workshop, and every place where persons are crowded together.

THE Electro-technical Institute of Darmstadt, Germany, has received about $100,000 from the government for the purchase of new ground and for the enlargement of the buildings.

Notice.

A premium of $250 is offered by the SCIENTIFIC AMERICAN for the best essay on

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This paper should not exceed in length 2,500 words.

The above-mentioned prize of $250 will be awarded for the best essay, and the prize paper will be published in the Special 50th Anniversary Number of the SCIENTIFIC AMERICAN of July 25. A selection of the five next best papers will be published in subsequent issues of the SCIENTIFIC AMERICAN SUPPLEMENT at our regular rates of compensation.

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Each paper should be signed by a fictitious name, and a card bearing the true name and the fictitious name of the author should accompany each paper, but in a separate sealed envelope.

All papers should be received at this office on or before June 20, 1896, addressed to

Editor of the SCIENTIFIC AMERICAN,
361 Broadway, New York.

Longevity of Animals.

The Literary Digest translates the following from the Journal d'Hygiene: Man lives to all ages, but in the animal kingdom, on the contrary, the duration of life is almost exactly equal for all individuals of the same species. But we can know with exactness the real duration of life only for animals in servitude; we do not know whether it is the same in the savage state. Rabbits and guinea pigs live 7 years; squirrels and hares, 8; cats, 9 or 10; dogs, 10 or 12; foxes, 14 to 16; cattle, 15 to 18; bears and wolves, 20; the rhinoceros, 25; the ass and the horse, 25 to 30; the lion, 30 to 40 (a lion in the London Zoological Gardens reached the age of 70 years); the camel, 40. The length of life of the elephant is uncertain; according to Aristotle, Buffon, and Cuvier, it lives two centuries; some authors say even four or five. After his victory over Porus, Alexander consecrated to the sun an elephant that had fought for the Indian monarch, and gave it the name of Ajax; then, having attached an inscription to it, he set it at liberty; the animal was found 350 years later. The ancients attributed to the stag a fabulous length of life, but Aristotle observes that what is reported on this subject has no good foundation. . . . Buffon says that the stag takes 5 or 6 years to attain full growth and should live seven times this period, that is, 35 or 40 years.

Though precise observations are wanting, we know that fishes, especially the large species, live a very long time. According to Bacon, eels reach 60 years. Carps have been known to live at least 150 years, and they then seemed to Buffon as lively and agile as ordinary carp. Dolphins, sturgeons, and sharks live more than a century and attain huge size. Pikes have been seen weighing 1,000 pounds, which indicates a very long existence. A pike caught at Kaisers-Lautern in 1497 was 19 feet long and weighed 350 pounds; it bore in its gills a copper ring with an inscription stating that it had been put in the pond of Lautern by order of the Emperor Frederick II, that is, 261 years before. Whale fishers have exterminated the huge whales of the polar seas; those that were formerly met with were of prodigious dimensions. It is supposed, with some probability, that they live several centuries and that they may even reach an age of 1,000 years.

On the other hand, we meet another class of animals whose passions are lively, whose vitality is very active, and who still live a long time—we mean birds. But it is not known with any degree of precision how long these live, except that their longevity is great. We see the same swallows returning to their accustomed nest for a considerable number of years. An eagle died at Vienna at the age of 103 years. According to Buffon, the life of the crow is 108 years, and no observation authorizes us to attribute to it, with Hesiod, 1,000 years. A paroquet, brought to Florence in 1633 by the Princess Provere d'Urbin, when she went there to espouse the Grand Duke Ferdinand, was then at least 20 years old and lived nearly 100 more. A naturalist whose testimony cannot be doubted, Willoughby, had certain proof that a goose lived a century; and Buffon did not hesitate to conclude that the swan's life is longer yet; some authors gave it two and even three centuries. Mallerton possessed the skeleton of a swan that had lived 307 years. This is quite enough to prove that among the larger animals, and also especially among birds, the duration of life, relatively to their bulk and height, is very long; it is, on the contrary, very short with insects; many of these live less than a month, rarely a few years, while the life of the ephemerids is but 7 to 12 hours, and in this brief space they accomplish the principal functions that nature requires of organized bodies—they are born, reproduce, and die.