MANUFACTURE OF KRAG-JORGENSEN RIFLES AT THE SPRINGFIELD ARMORY.—I.

Krag-Jorgensen is not the official name of the rifle with which the United States regular troops are armed. Officially this excellent weapon is known, or has been known, as the United States magazine rifle; but the rank and file of the army and the general public have fallen into the way of calling it by the names of its Norwegian and Danish inventors. The fame which it acquired under this name in the operations of the Spanish war has probably settled the matter for all time, and Krag-Jorgensen is likely to become the official as well as the popular designation of the United States army rifle.

It would be an unpardonable omission to enter upon a description of the manufacture of this rifle without first giving attention to the famous Springfield Armory, in which not only this, but all other types of small arms of the United States army have been made from the stirring days of the Revolution to the present time. The selection of Springfield was due to Gen. Washington, who directed one of his ordnance officers to choose a suitable spot, well up the Connecticut Valley, for the erection of a national armory. Hence the spot on which the weapons used in the Spanish war were made is the same which rang with the sounds of warlike activity in the civil war of 1861, in the war of 1812, and in the heroic struggle of the Revolution.

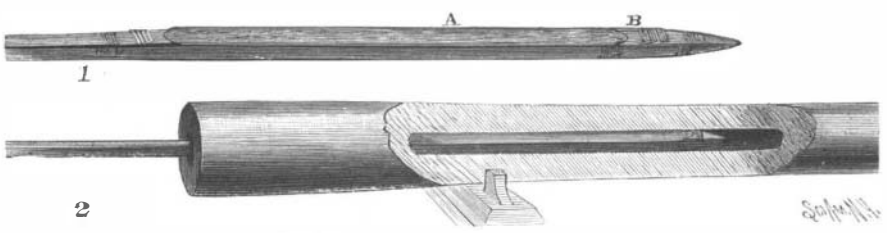
About the year 1776 an arsenal for cleaning and repairing arms, and a powder magazine, were established in Springfield, the former in a building on what is now Market Street. The manufacture of arms was regularly begun in 1794 in rented buildings, and during the next ten years three waterpower sites on Mill River were purchased, upon which shops were erected, the principal one of which is now the Water Shops (Fig. 3), in which about 540 men are at present employed. The other two Water Shops were abandoned years ago.

In 1801 the government purchased a tract of land on the rising ground above the city, which was subsequently enlarged by subsequent purchases. Here the extensive buildings known as the Hill Shops have been erected at different times. During the Mexican and civil wars the shops were enlarged and additional stories added. In 1889 and 1890 new shops were built on the hill by the present Chief of Ordnance, Gen. Buffington, then in command of the armory.

The water shops are occupied exclusively in the manufacture of the gun barrels and in preparing the rough forgings of all kinds that go to make up a complete rifle. The Hill Shops are devoted to the machining and completion of the receiver and the breech mechanism, the manufacture of the stocks and the assembling and testing of the rifles, the newer buildings being given up entirely to this work, while the older buildings on the hill, which did such good duty during the civil war, are now used as arsenals, museums, barracks, and offices. The commanding officer of the armory is Lieut.-Col. Isaac Arnold, Jr.; Major D. M. Taylor has charge of the Water Shops; the Hill Shops are in charge of Lieut. T. C. Dickson, and Lieut. O. C. Harney is paymaster and storekeeper. Our thanks are due to these gentlemen for courtesies extended during a recent visit to the arsenal.

The present article deals with the Water Shops, where finished gun barrels and complete forgings for the other parts of a rifle are turned out at the rate of four hundred sets a day. The raw material for the barrels goes to the works in the shape of round steel bars 1·15 inches in diameter (see Fig. 1). The specifications

5.—Rifling Cutter Head in Barrel.



6.—Finish Reaming Bore of Barrel.

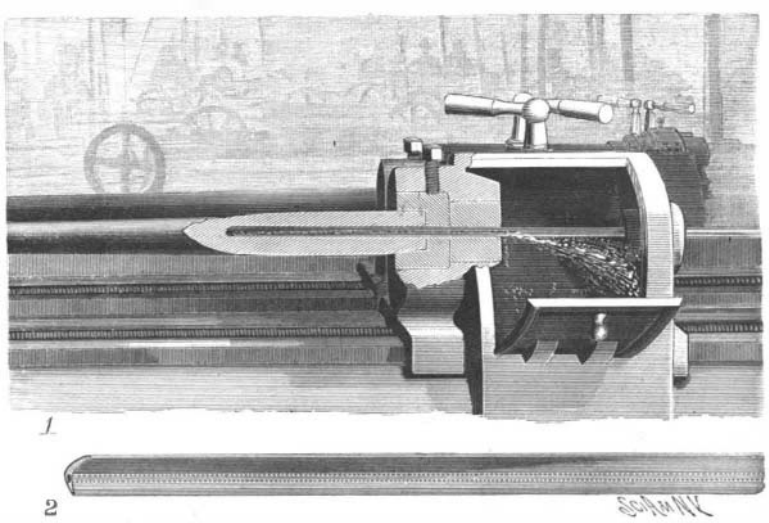
call for a simple carbon steel with an elastic limit of from 70,000 to 75,000 pounds; an ultimate tenacity of from 100,000 to 120,000 pounds; an elongation of from 15 to 20 per cent; and a contraction of from 35 to 45 per cent. The analysis of the steel must show about 0·50 of carbon, 0·80 to 1·00 of manganese, 0·10 to 0·18 of silicon, not above 0·08 of sulphur or 0·06 of phosphorus, and no nickel. The Ordnance Department reserves the privilege of sending an inspector to witness each operation in manufacturing the steel, and seven specifications are laid down governing such points as the quantity of iron used, the recarburization after the blow, pouring the metal into the moulds, and the cutting and rolling of the blooms. The results of this great care in preparing the steel are shown in the small number of barrels that fail on test. Every barrel is tested to a pressure of 70,000 pounds to the square inch in the cartridge chamber, and ten or more barrels made from each new lot of steel delivered are subjected to a special test of 100,000 pounds to the square inch. It is very rarely that a barrel fails to stand the higher pressure, which, by the way, is over two and one-half times as great as the service pressure of 38,000 pounds. It is proposed after July first next to raise the service pressure to 44,000 pounds, with a resultant velocity of 2,200 in place of 2,000 feet per second.

The blanks, which consist of pieces of round steel 1·15 inches diameter by 18 inches long, are heated to a cherry red and rolled down to size and length in special tapered rolls known as the barrel rolls. The grooves are cut with a taper as shown in Fig. 1, the rolls being geared together to insure their keeping in proper relative position. After the piece has been passed through seven times, the ends are sawn off, and it is straightened under a hammer and placed in a box of charcoal to anneal it.

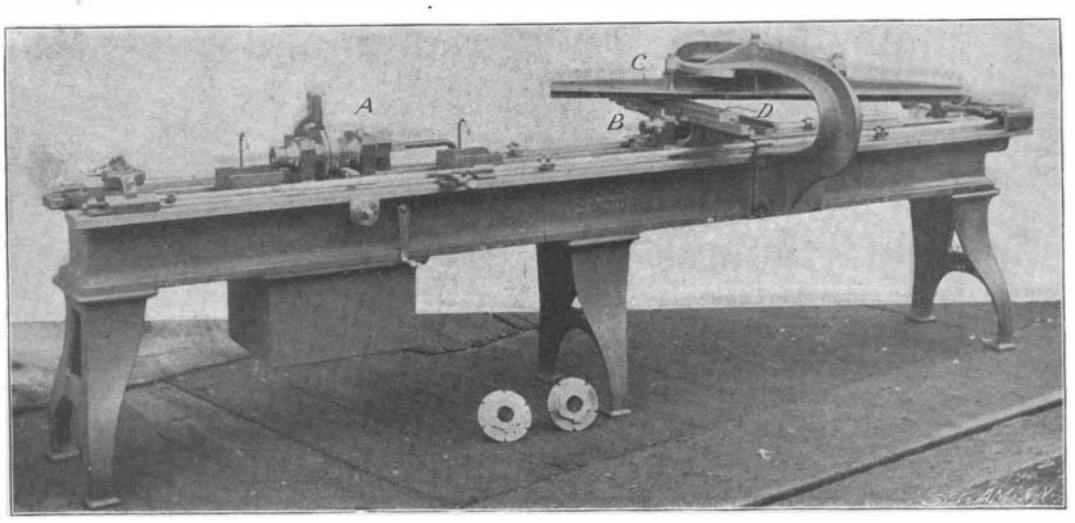
The barrel is now "black straightened" preparatory to machining. There are seven straightenings of the barrel altogether, and in every case it is done by skilled workmen by the time-honored method of a hammer and an anvil. After straightening, it is centered, put in the lathe, and "spotted," that is to say, a rough cut is taken at the butt preparatory to placing it in the gun barrel drilling machine. This very ingenious machine, which is made by the Pratt & Whitney Company, is shown in detail in Fig. 7. The small end of the barrel is clamped to the head spindle and the butt is carried and rotates within the barrel support bushings, as shown. These bushings are held in a steady-rest, which also carries two sets of bushings which act as guides to the drill. Another function of the steady-rest is to serve as a tank to catch the oil and chips. The drill, which has to pass through 30¼ inches of barrel, is provided with a $\frac{1}{32}$-inch oil-hole which extends through its whole length, and feeds oil directly at the point of the drill. This hole, which takes the place of the old channel cut along the side of the drill, is an improvement introduced by Major Taylor. The oil is forced through the drill by means of a small rotary pump, which forms part of the machine. Although the barrel rotates at a speed of 1,200 revolutions per minute, the constant rush of cold oil to the head is sufficient to keep the drill and barrel perfectly cool, and it also serves to carry away the chips which issue in a constant stream from the rear bushing. The barrel is drilled to a diameter of 0·295 inch and it takes 75 minutes to complete the operation.

The barrels are now taken to the straightening room (Fig. 4), where the operator holds them up toward a white surface with a horizontal black line upon it and looks through the bore. If the bend is downward, the curved reflections of the black line on the surface of the bore will be convergent; if upward, they will diverges(see small diagrams to the right of the illustration). A few taps of the hammer quickly straighten the barrel until the reflected lines are perfectly true.

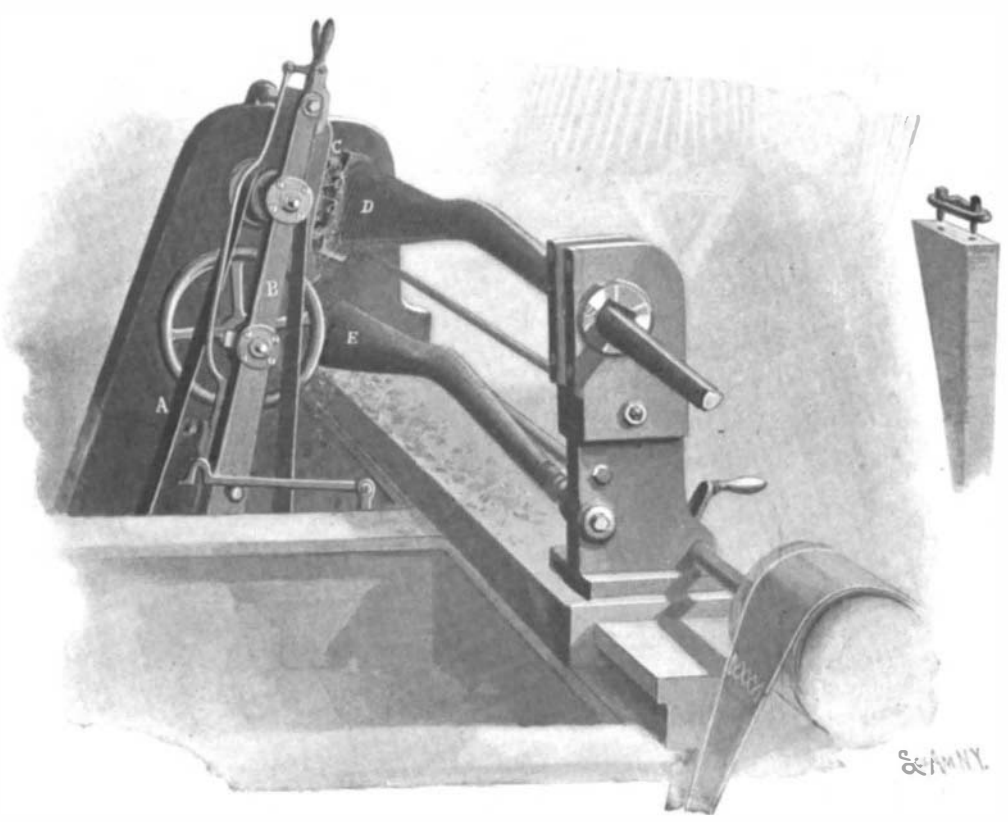
The bore is then given its first reaming with a square reamer of the form shown in Fig. 6, which enlarges the diameter to 0·298 inch. The barrel is next rough-turned; then straightened again and given a sec-



7.—Drilling Bore of Barrel—Shows Exit of Oil and Chips into Oil Tank.



8.—Rifling Machine.



Rough Turning the Stock.

MANUFACTURE OF KRAG-JORGENSEN RIFLES.

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ond turning, after which it is filed down to gage. The next operation is to cut one inch of square thread on the butt of the barrel to enable it to be screwed into the receiver. After another straightening (the fourth), the barrels are chambered to a uniform diameter of $\frac{7}{16}$ inch, ready for the proof cartridge, and taken to the proving house, where they are tested to a chamber pressure of 70,000 pounds to the square inch. They are then brought back to the shops, straightened for the fifth time, and given a finish reaming to a diameter of 0·300 inch. The reamer (Fig. 6) is square in section like the tool used in the first reaming, but it is smaller in diameter than the finished bar. To bring the cutting edge in contact with the bore the reamer is packed with strips of paper, *B*, and a slip of pine, *A* (see illustration). The barrels are straightened and then placed in the polishing machine, where they are revolved and drawn up and down between oak blocks smeared with oil and emery. The barrels are first run for fifteen minutes with a combined rotary and reciprocating motion, and then the finishing polish is imparted by running them for three minutes with a simple reciprocating movement in the direction of the grain. After polishing, the barrels are given a seventh and final straightening; for there is a possibility that the friction of polishing may have heated and slightly warped them.

Next in order follows the important work of rifling. The rifling consists of four spiral grooves, which are cut diametrically opposite each other down the bore. The pitch of the rifling is one turn in 10 inches. Each groove is 4-1000 of an inch in depth, the rifling diameter being 0·308 inch. There are twenty-eight rifling machines at work. Eighteen of them are machines of an old type that have been in the shops for about forty years, and were actively engaged in rifling guns for the Federal army when the arsenal was turning out muzzle-loading rifles at the rate of one thousand a day. The other ten machines are of the new Pratt & Whitney type, shown in the accompanying illustration, Fig. 8. The butt of the barrel is screwed into the fixed head, *A*, of the machine, and the rifling rod is clamped to the traveling head, *B*. The latter is given a reciprocating rotary motion by means of a guide, *C*, which is clamped diagonally above the head at the angle corresponding to the desired pitch of the rifling. A groove in the guide, *C*, is in engagement with a transverse slide, *D*, which, by means of a rack on its under side and a pinion on the spindle, serves to give the desired rotary movement to the rifling rod. The latter is hollow and has two holes slotted through its shell to allow the cutters, *C C*, Fig. 5, to project through and bear against the bore of the gun. The cutters are forced outward by means of a tapered rod, *A*, the outer end of which strikes against a stop, *B*, Fig. 5, while the inner tapered end bears against the cutters. The rod is driven a little further in at the end of each cut, the stop being automatically advanced the required amount until the rifling is complete.

Then follows the operation known as finish chambering, which consists in reaming out the cartridge chamber at the butt. This is done by means of a reamer of the exact size and shape as the cartridge, and, as it is necessary that the cartridge should enter freely and yet fit snugly, this work has to be done with great care and checked by gages corresponding to the three diameters of the cartridge.

The barrels are finally taken to the tempering furnace, shown in Fig. 2, where about 6 inches of the butt is heated to a proper degree, and then cooled from the inside by having a stream of cold oil run through it. The furnace is gas fired, and great care has to be taken that the barrel is not heated too far up, and that it is not warped by being overheated. The object of the tempering is to give special hardness and resisting qualities to that part of the barrel which takes the force of the explosion and whose threaded end has to support the full force of the recoil. The barrel is then "browned" in the hill shops—an operation which will be described in the second article.

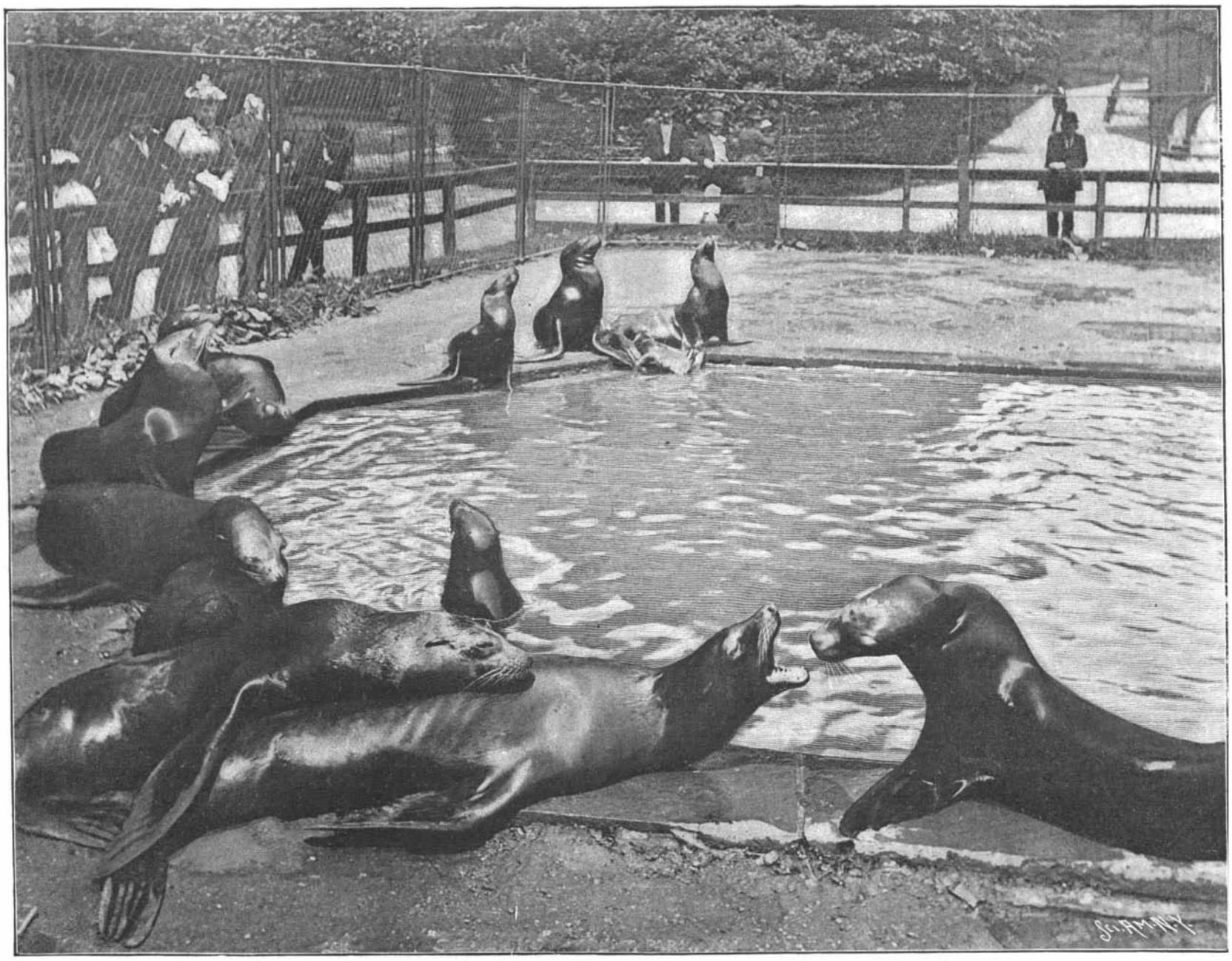
Before closing the description of the Water Shops, mention must be made of the forging room, in which are made all the forgings which enter into the complete rifle, including the bayonets. The solid forgings for the receiver are first roughed up in 800-pound drop hammers, then the approximate shape is given under a 1,400-pound drop, next it is trimmed in a press, and, finally, it is finished under a 1,200-pound drop, ready for the elaborate machining which it undergoes in the hill shops. Trigger guards, triggers, sears, and other smaller work are either roughed under drop hammers, pressed and trimmed, and finished with a single blow of the drop hammer, or they are roughed out under trip hammers and finished with a single blow of the drop hammer. Bayonets are drop-forged out of flat cast steel 0·36 × 0·88 of an inch in section, and are then milled, ground, and polished. We are informed by Major Taylor that in addition to its regular work on barrels and fittings for 400 rifles per day, this department brazed during the late war over 7,000 bayonet scabbards for 0·30 and 0·45 rifles, besides executing a large amount of special work on swords and sabers.

THE CALIFORNIAN SEA LION.

The Californian sea lion (*Zalophus Californicus*) is not restricted to the State from which it derives its name, as it is found on both sides of the North Pacific. This is a smaller species than the northern sea lion, and is readily distinguished from it by the convex crown of the head and the sudden descent of the profile at the eye. The side view at the head somewhat recalls that of the dog-faced baboons. The bristles on the side of the muzzle are very small.

The skull is remarkable for its narrowness and elongation, and also by the great development of the bony crests on the brain case. The color of this species of the sea lion is a dark chestnut brown, becoming blackest brown on the under parts and limbs. The adult male measures from 7 to 8 feet in length from the muzzle to the end of the outstretched flippers. The adult female is somewhat smaller, having not one-half the bulk of the male.

The islands on the Pacific coast are inhabited in many cases by the Californian sea lion. Captain Scammon, writing of his experiences with these animals on Santa Barbara during the sealing season of 1852, states that soon after the arrival of the party, about the end of May, the colonies of Californian sea lions began to augment and large numbers of huge males made their appearance, belching forth sharp, ugly howls and leaping out of the water or darting through it with surprising velocity, frequently diving outside the rollers, the next moment emerging from the crest of the foaming breakers and wading up the beach with head erect, or climbing some kelp-fringed rock, to doze in the scorching sunlight; while others would lie sleeping or playing among the beds of seaweed, with their heads and outstretched limbs above the surface. But a few days elapsed before a general contention with the adult males began for the mastery of the different rookeries and the victims of the bloody encounter were to be seen on all sides with torn lips or mutilated limbs and gashed sides, while now and then an unfortunate creature minus an eye would be met with. As the time for "hauling up" drew near, the island became one mass of animation. Every beach, rock, and cliff was the resting place of a sea lion, while a countless herd of



THE CALIFORNIAN SEA LION.

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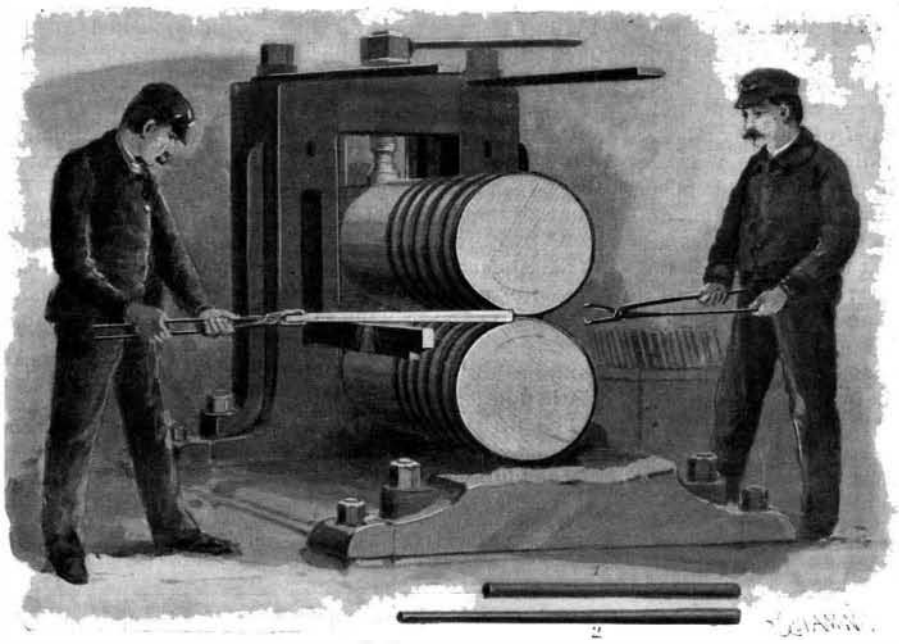
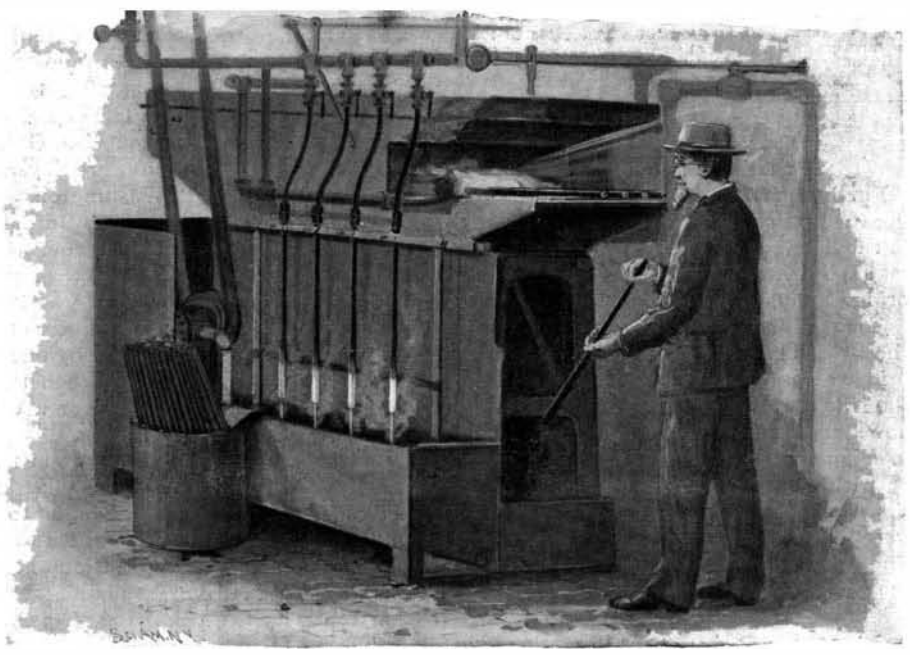
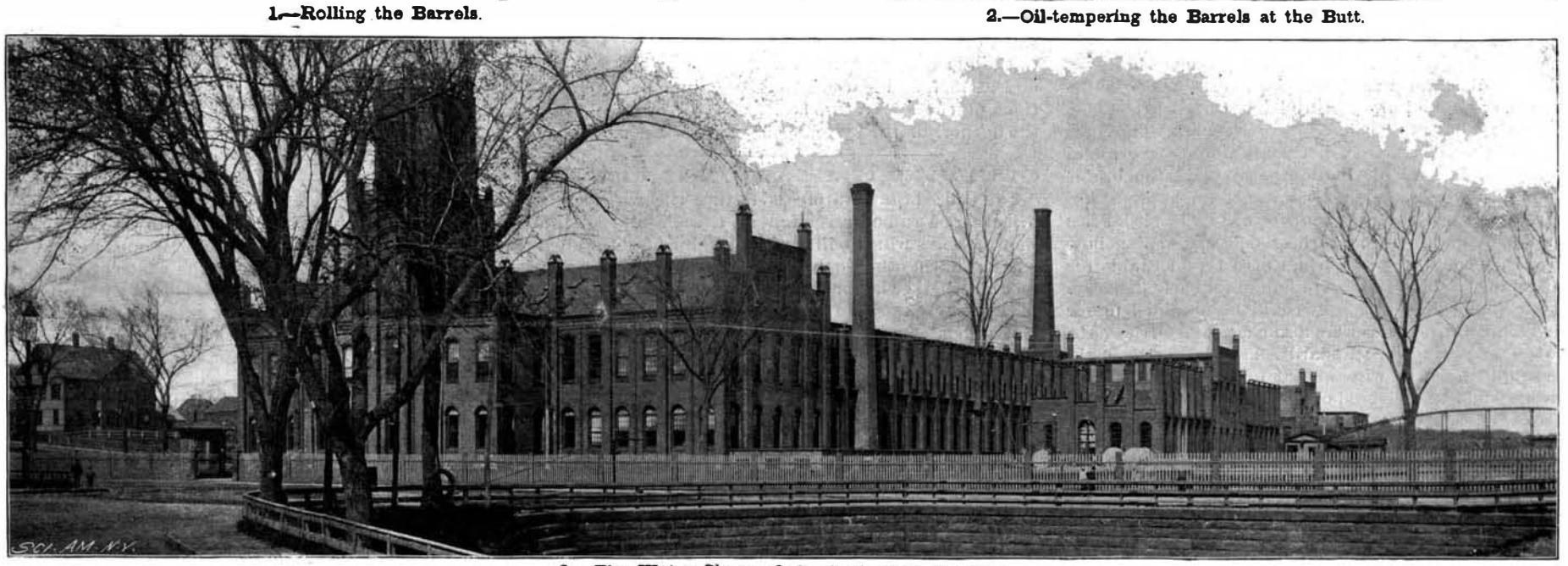


1.—Rolling the Barrels.



2.—Oil-tempering the Barrels at the Butt.



3.—The Water Shops of the Springfield Armory.

4.—Straightening Barrels.

I.—MANUFACTURE OF KRAG-JORGENSEN RIFLES AT THE SPRINGFIELD ARMORY.—[See page 267.]

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