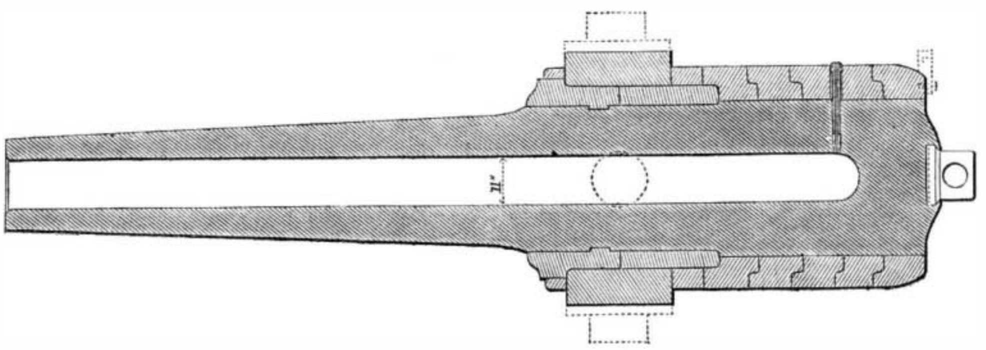
## CAST-STEEL ORDNANCE.

We are enabled to lay before our readers a correct representation, made from a working drawing, of one of Krupp's cast-steel guns. These weapons have become celebrated for their strength and endurance; and the translation which we present, extracted from the *Invalid Russe*, organ of the Russian Government, will serve to show the estimation they are held in by that Power. The Russian Government have ordered of Mr. Krupp 220 guns of 8-inch, 9-inch, and 11-inch bore, all rifled muzzle-loaders, together with a number of steel shot and adjusting cylinders for loading. The value of the contract exceeds 4,000,000 thalers, or about $3,000,000—the gun to be delivered at the works in Essen. The 11-inch gun will weigh about 27½ tuns, and costs $30,000 (40,000 Prussian thalers). The extreme length is 17 feet 2 inches; the diameter at the reinforce is 47½ inches. The whole gun is of cast-steel, and the barrel alone will require an ingot of forty tuns in weight, upon which cast-steel rings of a peculiar form are shrunk, as will be seen by the diagram herewith annexed:—



THE OFFICIAL REPORT CONTAINED IN THE "INVALID RUSSE," No. 271, OF DECEMBER 28, 1863, UPON THE TRIALS WITH A 9-INCH CAST-STEEL EXPERIMENTAL GUN:—

"It has been found necessary, since the introduction of iron-cased vessels, to use guns of the greatest possible caliber in order to destroy the iron coating, and also to do this at the highest practicable ranges. To attain this desired object it has been rendered essential to produce guns from a metal possessing a high tensile strength and capability of resisting the enormous strain of large charges of powder. From experience it has been proved that cast-steel is the best metal, and far superior to all others hitherto applied to gunnery, as it combines with strength the important element of toughness; consequently our Government has ordered for the armament of our iron-cased vessels, and sea-coast defenses, a number of 8-inch and 9-inch guns from the well-known and justly renowned works of Mr. Fried. Krupp, of Essen, Rhenish Prussia—the only establishment capable of executing cast-steel guns of such large dimensions.

"All breech-loading guns tried up to the present time have not possessed sufficient strength to resist the forces they are exposed to, as the soft coating of the heavy shells and shot used with such guns has frequently been stripped off; and to obviate this objection our Government has ordered heavy guns to be loaded from the muzzle. To ascertain by experience which class of rifling might be most suitable, and also the kind of shell best adapted for such heavy guns, and moreover to test the effect upon iron plates, a 9-inch gun was ordered from Mr. Krupp to practically solve these questions. It has been proposed by Sir Wm. Armstrong, in order to obtain the greatest possible accuracy for muzzle-loading rifled guns, to use a plan of rifling known as the "shunt" system, and which has proved in practice to be very good, as the shell is compelled to leave the muzzle of the gun without there being any space between the diameter of the bore of the gun in the rifle grooves, and the diameter of the shell as measured across the projecting studs or wings. This system of rifling possesses not only the advantage and accuracy of flight, but also admits a longer durability of the gun, as it is not necessary to cut the rifle grooves obliquely. The pitch of the rifling is also uniform. The strain upon the soft coating of the wings of the shot is also less than in grooves cut obliquely. This Armstrong system of rifling has also been satisfactorily introduced in our brass guns and also in guns of cast iron, for we have not had to report the bursting of guns rifled upon this system; which, however, has happened with guns rifled upon other plans. A 12-pounder cast-steel gun was supplied from the works of Messrs. Krase, Michailow, and rifled upon the Armstrong shunt-principle, having one turn in the length of the bore. This gun was fired with a comparatively heavy shot and with satisfactory accuracy during 800 rounds. The 9-inch cast-steel experimental gun, supplied by Mr. Krupp, was rifled upon the same system, the grooves having likewise the same twist as the 12-pounder. The shot weighed 300 pounds, and the gun was fired with the extraordinary charge of 50 pounds of powder. The guiding projection, or wings on the shot, were made of zinc. The effect of this gun upon armor plates supplied from the best English manufacturer (Brown, of Sheffield), was all that could be desired, for even cast iron shots pierced plates of 4½ inches thick, and one or two rounds were sufficient to destroy the plate. A Lancaster plate of 5½ inches thick was pierced at the first round by a steel-shot. Two 4½-inch plates, laid one upon the other and representing a thickness of 9 inches of metal, were utterly destroyed by five shots from this 9-inch gun. Upon inspecting the shot after being used it was observed that on some of them the projecting studs or wings were cut off, and it was therefore determined to make them of a harder metal than zinc, but in the meantime not to interrupt the experiments against the iron plates, it was resolved to continue with the same shots. At the sixty-sixth round the gun burst. Near the place where the shot first receives motion, the metal between the grooves was partially flattened down and pressed into the grooves, but nearer to the trunnions the metal between the grooves was pressed quite flat. At the muzzle end of the bore the grooves were quite sound and uninjured. On examining the shot that caused this mishap, it was discovered that nearly all the projecting studs were cut off, and the axis of the shot was much bent. There were also three projecting lumps on the front part of the shot. All this proves that the bursting of the gun was caused through the misleading of the shot which left the rifling and became wedged in the bore of the gun; it would be impracticable to make a gun capable of resisting this jamming-in of the shot, and the accident demonstrated the enormous power exerted by the powder.

The fractures of the metal were quite sound, and showed a most excellent and superior quality of the steel with the highest possible tenacity, softness, and homogeneity. A piece of steel from this gun was drawn out under the hammer and afterwards bent cold into a spiral. Grooves or furrows were also found along the bore of the gun and parallel with its axis, proving unmistakably that not only the last shell but several previously had left the rifles and seriously injured the bore, and it can only have resulted from the extreme tenacity of the metal that the gun did not burst before. This bursting serves to us as a guarantee of the strength and excellence of the cast-steel guns supplied by Mr. Krupp. It also explains many circumstances that will arise in testing guns of heavy calibers, but which could not be ascertained with guns of smaller capacity. We learn by this experiment to avoid the jamming-in of the shot by using projections or wings of greater resistance than zinc. In pressing the shot home it must be carefully observed if the axis of the shot is coincident with the axis of the bore of the gun. To diminish the pressure of the wings and to avoid their cutting down the metal of the gun the pitch of the rifling should be decreased for heavy calibers. By now ordering a large number of Krupp's cast-steel guns, which is undoubtedly the best gun material hitherto known, we have surpassed other States, and there is no doubt that these guns, after having corrected some faults in the projectiles, will bring us an immense advantage by the use of such formidable weapons.

## THE CHENANGO BOILER EXPLOSION.

We gave an account of this disaster on page 283 of the current volume, and since that time the coroner's inquest has developed the facts which we herewith place before our readers. Mr. Chief Engineer Wood, of the United States Navy, gave it as his opinion that the cause of the disaster arose from the accumulation of a greater pressure within the boiler than the stays and braces could sustain, and that they and also the shell gave way in consequence. Mr. Craig, also an engineer in the navy, and the Government inspector, states that he approved of these boilers and that he reported favorably upon them to the Government, but that he afterwards ascertained that the braces were not put in, in accordance with the specifications. Mr. Miers Coryell, superintendent of the Morgan Iron Works, where the boilers were built, had charge of their construction, and considered them safe at a much greater pressure than that which exploded them. Mr. Henry Mason, foreman of the Morgan Works, testified that he ran the engines during the 96 hours trial, demanded by Government, and that he found great trouble in keeping the water at a proper hight, and that the particular boiler which burst gave much anxiety on that account, and required more than ordinary care and watchfulness. Mr. George B. Riggins, who assisted in driving the engines on the trial, states that he also had great difficulty in keeping the water at a proper and safe hight, and that several times the piston struck quantities of water that had been carried over through the steam-pipe, with great violence; so great that the piston rod was forced one-sixteenth of an inch further into the piston than the fitters had been able to drive it in the shop. Mr. Joseph Belknap, a well-known practical and professional engineer of this city, and a person who has had a great deal of experience with steam engines and boilers, says, in effect, that the braces were defective in so far that they did not distribute the strain properly; he also says that it is possible to damage a boiler by hydraulic pressure, and render it less capable of withstanding steam pressure afterward.

The strain exerted by hydraulic pressure is only borne for a few seconds, and some part may be unduly tried, so that it becomes unsafe. Mr. Belknap says it is his opinion that the boiler-makers who were at work inside the boiler disconnected some of the braces and forgot to reconnect them, and that the explosion resulted from an excessive pressure, which parted the other stays, and subsequently ruptured the shell. He testifies that the iron was good, and that the plan of the boiler is as safe as any other when properly made.

Several naval engineers were also examined; and one—Elbridge Lawton—states that he has been in charge of a great many Martin boilers and considers them perfectly safe when properly managed, and that he never heard of trouble caused by foaming. Mr. De Luce, Chief Engineer of the Brooklyn Navy Yard, testified that the arches gave evidence of having been overheated; in his opinion there had been an unequal strain on the braces; one gave way and the others followed.

Mr. Warren Hill, draftsman and engineer of the Continental Iron Works, Green Point, gave very clear and explicit evidence, the most satisfactory that was elicited on the examination. He confined himself to facts, and stated that the number of stays or braces in the boiler, were, in his opinion, insufficient. Estimating the area of the part to be stayed, the pressure upon it and the number of stays put in to withstand said pressure, he found that the average strain upon each one was 21,600 pounds. This is fully one-fourth the tensile strength of the best iron in carefully-conducted experiments, and proves that what we surmised in our first article was correct, namely, that the rupture in the shell resulted from the breaking of the braces, or what is equivalent to it, their detachment from the parts they were intended