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(Continued from page 11)

slowness of the firing. From certain indications in the fragments it is apparent that each gun's projectile is not interchangeable. According to the Vossische Zeitung the weight of the projectile, complete, would be 250 kg.

It is noted that the ordinary shells for naval guns (Krupp) of 210 mm. weigh only 125 kg. and those of guns of 240 mm. of the same type weigh 190 kg. It is not easy to explain the increase of weight given, that the weight of the projectile (250 kg.) is correct it is probable that the calibre would exceed that stated as 210 mm. As regards the calibre, this still remains uncertain, between 210 and 240 mm. and probably they have guns of different calibres. The Germans may not have constructed guns new in all their parts, but they may have utilized obsolete guns of 381 mm. re-tubing them to reduced calibres of 210, 220, or 240 mm.

The most powerful of the Krupp guns have a length of about 20 m.; the length of the bore is about 19 m.; re-tubing this piece to a calibre of 210 mm., the length of the bore would be 90 calibres exactly. The powder chamber for a gun of 381 mm. can contain up to 315 kg. of powder, which is much above the charge of the gun that fired on Paris. There is then no necessity for new studies and calculations as to the resistance of material. These would be reduced to the simple operation of re-tubing guns deteriorated by use. It is true that a newly-constructed gun of 210 mm. may be somewhat lighter than a gun of 381 mm. re-tubed to a calibre of 210 m. whose weight would amount to 100 tons, but it has to be taken into consideration that a gun of such length, with less thickness of metal, would be subject to a more or less pronounced curvature according to its inclination, and the exceptional vibrations in the act of firing which would influence very seriously the precision and regularity of the fire. Instead of this, in a gun of 381 mm. re-tubed to 210, 220, or 240 mm. the exceptional strength of the sides of the bore would cause the vibrations to be less than those in a gun of 381 mm. of 50 calibres. It may be added that this solution would admit of the Germans utilizing the carriages of the type of the guns of 381 mm. employed in the bombardments of Compiègne, Dunkerque, and Nancy, without new studies and calculations as the fire against those places doubtless required the greatest elevation up to 45 degrees if not higher.

The Problem of the Fire with Range of 120 km.—It is necessary especially to bear in mind the character of this very special fire, and the conditions under which it was conducted. The Germans at the commencement of the current year had a target at about a distance of 110 km. from their first lines which had repeatedly been made an object of bombardment from Zeppelins and aeroplanes, which threw bombs up to a weight of 300 kg. with enormous bursting charges of about 180 kg. of powerful explosive, and it is well known that whatever may be the active aerial and anti-aerial defence of a city, it is not possible to prevent some airships from discharging their bombs. So that there was not wanting to the Germans the hope of intimidating the population of the capital. They also had another effective means represented by a projectile of certainly a much less weight than the great aerial bombs. There was also the advantage of being able to fire when the atmospheric conditions did not admit of aerial flights. The problem presented itself in these terms: To hit a target of a superficies of 7,800 hectaires from a distance of about 115 km. (72 miles) of an approximately circular form with a diameter of about 10 km. the increase to the range and the increase to the calibre would evidently proceed step by step; the problem was imposed on the Germans in new terms, as was rightly observed by Fioravanzo in the Rivista Marittima—and tended to surprise the experts, especially those of the marine, who were accustomed to consider the problem of the increase of range and the power of the guns only in relation to an increase of calibre and very few in relation to the increase of initial velocity nor to the angle of projection, given the special character of the fire of ships against armoured targets. This logical view of determining the scope of greatest effect against a resisting target does not apply in the case of a fire of intimidation against a vast horizontal area, and the study of construction becomes concentrated on the points; greatest increase of the initial velocity and the angle of projection. Increase of the angle of projection, and initial velocity are the obvious conditions for obtaining an increase of range in any kind of gun or mortar. But now, in the case of the guns under examination these elements were increased beyond any previously known limits, and the greatest possible advantage presented by obtaining the least possible resistance of the air to the projectile during its passage through the air, which is found to be much rarefied at a great height. As has been stated in several journals, General Rohne at first wrote in the Vossische Zeitung that the guns in question fired with an angular elevation of over 45 degrees and precisely 55 degrees contrary to the universally admitted principle that the greatest range was obtainable with an angle of projection somewhat less than 45 degrees. The reason of this innovation being as follows:—The density of the air increases very rapidly with the increase of height; a litre of air at the normal pressure of 760 mm. and a temperature of 15 degrees weighs 1.293 g. at the level of the sea; at 5,600 metres in height the weight is reduced one-half, at 8,000 one-third, and at 1,000 m. one-quarter; and it may be supposed that at a height of 20,000 metres it would not weigh more than one-tenth. Other data are the following:—

Density of the air at	5,000 m.	—0.54.
"	15,000 m.	—0.15.
"	30,000 m.	—0.023.

It may be remembered that the greatest height gained by man (ascent of Preussen in 1901) was only 10,698 m. The greater heat conferred on the projectile owing to its high velocity contributes to diminish the friction since the air in contact with it is dilated and rarefied.

Finally, in the case of attaining very long ranges with curved fire and a very high co-ordinate, this also agrees to a certain extent with the diminished value of the acceleration of gravity at great heights, and this is always diminishing as the projectile ascends. It is calculated that to attain ranges in a vacuum of 110, 120, and 130 km. with an agle of projection of 45 degrees would require initial velocities of 1,100, 1,200, and 1,300 m., respectively, and that to compensate for the diminution of the range caused by the resistance of