

proposition that two and two make five. Ho did not mean to infer that the members of Section G could have any lingering doubt in their minds as to whether the Woolwich system of rifling big guns eccentrically from their projectiles can produce accurate results. But the association was established for the "advancement of science," and gunnery is, or, rather, should be, a branch of applied science. When, therefore, it was found that in rifling big guns the government officials were acting not only in violation of the plainest and most obvious teaching of science, but also in defiance of common sense, the action afforded an opportunity for a misapplication of public money. The theory of the rifle, whether a big gun or a small one, was that, by causing the projectile to rotate round its axis in the direction of its trajectory, a steadiness was imparted to its flight analogous to that which enabled a top to stand upon its point while spinning. But just as an unskilful schoolboy will start his top with a "wobble," or in other words will cause it to rotate round a line not coincident with its axis, and thus to lose its steadiness, and even to cease to spin at all, so a gun may be made in such a way as to cause its projectile to wobble in like manner, and altogether to lose the directness of its course. Incredible as it might appear, the authorities at Woolwich specially rifled their guns so as to rotate the projectile round some line divergent from its axis. The result was what we had recently seen; the guns themselves are ripped up and rendered unusable, and their shooting was most inaccurate. Yet in spite of all remonstrance, the officials at Woolwich stick to their system with a tenacity worthy of a better cause. It is the practice of the anonymous and inscrutable powers there presiding, and known in the Service only by the name of "They," to allow in the case of big guns considerable "windage," that is to say, the shot is made smaller than the bore of the gun. "They" fondly imagine that the laws of gravity do not apply to heavy projectiles while in the bores of guns, that the shot on entering the guns become suspended midway between the top and the bottom of the bore, so as to distribute the windage equally all round the shot. Ho need not tell Section G that no phenomenon of that nature has ever yet been observed, and that the shot in every case lies on the bottom of the bore, so that the windage is not equally distributed. This being so, it is evident that the circle representing a cross-section of the bore of the gun is eccentric from the circle representing the shot, and it follows that if the gun is rifled round its own axis, it cannot make the shot rotate round its axis, but round some other line. When a Woolwich gun is fired, the rifling acts first, of course, upon the front set of studs of the projectile, and, with a violent jerk, aggregated by the acceleration in the twist of the rifling, wrenches the shot out of the former line of its own axis parallel with that of the gun, and places it to a certain extent athwart the gun—a proceeding which the shot every now and then resents by ripping up the gun with its studs. In a less unfavourable case the shot simply starts from the gun with a "wobble," analogous to that of the badly spun top. Mr. Hope then entered into some calculations, professedly only of an approximate character, to show how much deflection in the flight of a Palliser shell would probably be caused by half an inch of windage; and concluded by strongly denouncing the Woolwich authorities for their neglect of the many valuable suggestions for the improvement of rifling made to them by competent authorities.

In the debate which followed, Mr. Webster made some remarks on the manner of revolution of a shot under the conditions supposed by Mr. Hope. Mr. Fletcher, of Woolwich, stated that the windage had since last March been much reduced; and that now, at the muzzle of the gun, it amounted to no more than five thousandths of an inch. Mr. Froude, F.R.S., said he believed some windage was necessary to allow for the effects of fouling, and expressed his belief that the usual unsteadiness of flight was due to "the final discharge of the unexhausted explosive force of the gases on the basis of the shot as it leaves the muzzle." He further urged that the shot must and does become rapidly steadied, even if at first unsteady, by the same principle, whatever it is, which obliges a rotating shot to conform its axis of rotation tangential to its curved trajectory, as it had now been conclusively proved to do by an experiment with a special shell fired at 45 deg. out of a rifled mortar, carrying a flag-staff in front of it, which, as the charge used was small, and the velocity also therefore small, was visible throughout the flight. The shell followed the flag-staff exactly throughout, even into earth, in which both were buried with the axis tangential to the line of descent. This principle appeared to be identical with that by which a spinning top with a rounded point, when started obliquely, tended to right itself on a vertical axis, while one with a fine point would maintain an oblique or "precessional" axis—for the friction of the side of the point on the plane on which it rested gave that increased velocity to the "precessional" motion which, on gyroscopic principles, continually tended to lessen the inclination of the axis. Mr. Merrifield, while expressing his general concurrence with the explanation of the mechanism of the flight of projectiles given by Mr. Froude, drew attention to the close analogy between a screw of uniform pitch, that is, a screw between two turns of which the distance was always uniform, so that it could turn in a nut without jamming, and a straight bolt sliding in a well-planed groove, or an eight wheeled engine running on a straight line of railway. Altering the pitch or twist of a screw was equivalent to bending the slide or making the engine go round a curve. The bolt would not run in a bent slide, unless the bolt bent also; and in order to make long engines go round a curve, engineers had adopted the device of the Bogie carriage—that is to say, they mounted the front four wheels on a little truck, which allowed them to turn separately from the other four. Now, a rifle shot could not have a Bogie carriage, or even a joint. As a result, instead of the Woolwich shot having flanges exactly fitting the gun, it was made to take the rifling by means of two rings of soft brass studs. The projectile had to be weakened along regular lines, in order to receive these, and they gave lines of weakness resembling those purposely made to facilitate the tearing of postage stamps from one another. Alluding to Mr. Chadwick's remark that the Woolwich authorities were under the disadvantage of having inferior metal to that used by Sir Joseph Whitworth, he fully admitted this to be the case, but he considered that to be an additional reason for avoiding a system of rifling which tried the gun so unnecessarily as the Woolwich system. He called attention to the fact that while the ordinary and proper "life" of a large gun was reckoned at 1200 or 1300 rounds at least, the 121-ton gun in the *Plucky* was not allowed to fire more than 400 shots, and had actually been changed twice for the boat to fire less than 1200 rounds, the guns first used being ro-

turned to Woolwich. He also called attention to the limit imposed by this system of rifling, both on the size of the guns and on the length of the shot; for the increase of these could not be met by a corresponding increase in the distance between the studs. Naval designers were very much hampered in their work by this restriction of the efficiency of the implement, which was really the foundation and mechanical unit of their design of ships of war. He then, after briefly describing the advantages and defects of the Whitworth system, went on to say that the consent of all mechanics and engineers with whom he had ever conversed was absolutely unanimous in the condemnation of the Woolwich system of rifling, and that he had never heard any serious defence of it. He would not attribute personal motives to any one, but he could not conceive of any reason why the authorities persisted in the use of the Woolwich system except sheer obstinacy and unwillingness to admit that they were in the wrong—qualities of great value in an officer entrusted with defence of a fortress, but very bad qualities in officers charged with the superintendence of mechanical work. Mr. Hope, in reply, briefly expressed his great pleasure at the discussion, as well as at hearing that the windage had been lately reduced. As the Woolwich authorities had once listened to reason, and had laid aside one error, he hoped that in the course of ten or twenty years they might lay aside some others, and that so, by degrees, reforms might be introduced into the Service.—*Broad Arrow.*

THE RUSSIAN ARMY.

It has been lately announced that the Russian Army was to be strengthened by the formation of ten new infantry divisions, or 40 additional regiments, and a good deal of alarm has been felt in some quarters in consequence. A St. Petersburg correspondent of the *Journal de Bruxelles*, writing on the 10th inst., says the changes in question are only matters of reorganization, necessitated by the adoption of the new system, and that there will not be any real increase of the strength of the army. In adopting the Prussian system, it is necessary to make arrangements to have reserve battalions in connection with every regiment over and above the battalions ready for immediate reserve. The reserves are meant to be the feeders of the service, to fill up the *cadres* when the army is actively employed, and also to hold the fortresses. At present the Russian army consists of 47 divisions of infantry, each division including four regiments—183 regiments, each of three battalions. To these are to be added ten new divisions of four regiments each, or 40 new regiments; but they are to be formed out of the existing regiments and battalions employed in garrison work and in the fortress. The total army will then consist of 57 divisions, or 228 regiments, every division having also its battalion of skirmishers. The total number of the infantry will be 741,000, to which in a very short time may be added 456 reserve battalions. For the present there are no changes contemplated in the cavalry; but the Cossacks will be converted into skirmishers, and to every cavalry division a Cossack regiment will be attached. Changes in the equipment of the troops are designed. In place of their present kepis, the gendarmes will have a helmet of the Prussian pattern, which is deemed more comfortable than the shakos and kepis. Recruiting for the year is fixed at the rate of six men per 1,000, the last time the old system will be applied.—*Tall Mall Gazette.*