If there were any truth in the old saw Captain Wright's left ear must have been unpleasantly warm on Thursday evening last, for probably no individual officer of the field force received higher praise than General Strange in his speech at the Ottawa banquet accorded to the popular commander of No. 2 Company 43rd Battalion. We congratulate Captain Wright on having won such a reputation on an expedition in which hard work and hard fare were much more likely to be found than glory

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The shooting in the P.Q.R.A. matches, the results of which are published in this issue, calls for little comment. The weather was fine, the attendance fair, arrangements good, and big scores were not uncommon as a consequence. The action of the competitors in recommending that future matches should be open to the Dominion commends itself as liberal policy and will doubtless have the effect of augmenting the waning resources of the Association.

This week's general orders contain the vote of thanks passed by Parliament to the Field Force, the release from active service of the two field hospitals, and several militia appointments, amongst which may be mentioned the retirement of Lieut.-Col. Macdonald, of the 19th Lincoln Batt., and the promotion of Bt.-Major Checkley, of the 56th to a full majority.

In this issue Col. Kemmis's prize essay on the duties of Field Artillery in action is concluded, and we are sure will have been read with lively interest by all artillerymen in Canada, being eminently practical, and affording hints for reforms in our batteries. We regret that pressure of matter of more immediate interest has necessitated its appearance over a comparatively long period; the former numbers containing parts of it are 7, 8, 10, 12 and 14.

The D. R. A. have announced that a handsome silver cup has been presented by Col. Wilson, of Bannockburn, Scotland (captain of the English Kolapore team 1884), which will be placed as a prize in the Dominion of Canada match, to be competed for by all previous members of the Wimbledon teams present at the matches of the D. R. A., in 1885, and who have specially entered therefor; the cup to go to the highest score; entrance fee, 50 cents. The association have also received a handsome subscription of $250 from the Bank of Montreal, and a like amount from the enterprising Hamilton Powder Company.

No. 3.—*RIFLES AND RIFLE SHOOTING.—XIV.*

BY CAPTAIN HENRY F. PERLEY, HEADQUARTERS STAFF.

The force of gravity is the tendency of everything to fall in a straight line towards the centre of the earth, and its measure is weight; thus, the atmosphere is said to gravitate towards the earth with a weight of $14\frac{3}{4}$ lbs. per square inch. If a bullet be dropped from a height its velocity at the commencement is nothing, as it started from a state of rest. During the first second of time it will have fallen a distance of 16 feet, and will then have obtained a velocity of 32 feet. At the end of the second second it will have fallen 64 feet, the velocity being increased to 64 feet per second. At the end of the third second it will have fallen 144 feet, and have obtained a velocity of 96 feet per second, and so on. It must, however, be stated that these rates are only obtainable in vacuo, for owing to the resistance of the air these velocities are much retarded, for if they were not, every rain drop falling from the clouds would strike with immense force, and be as dangerous as rifle bullets. When a body falls in the atmosphere there is a certain limit to the velocity it will acquire, and this is obtained theoretically when the resistance of the air has become equal to the accelerating force of gravity, and when this is reached its motion becomes uniform.

Besides velocity, a shot has momentum, which is defined as the quantity of motion in a moving body, and this is equal to the mass of the object multiplied by the velocity, and it is always in direct ratio to the velocity. For instance, a shot moving with a velocity of 1,000 feet per second, has twice the momentum of another moving with a velocity of 500 feet per second. Again, a shot has energy, or the power exerted by a moving body being brought to a state of rest in a second of time. The shot from a gun is simply the means by which energy, or mechanical power, is transferred from one place to another. The gunpowder in the gun developes by its combustion a certain amount of force, or work, as it is now called, and the object of the shot is to carry this force to a distance, and apply it to an object otherwise inaccessible. The energy of an Enfield bullet may be calculated thus: Its weight is 480 grains and assuming that at the time it strikes a target—no matter what the distance may be—it has a velocity of 1,000 feet per second, then the energy with which it strikes is equal to a power capable of lifting 1,065 lbs. one foot high in a second of time.

Let W = the weight of the bullet = 480 grains
V = the velocity per second = 1,000 feet
G = the accelerating force of gravity = 32·2 feet
and E = the energy, then

$$E = \frac{WV^2}{2g} = \frac{480 \times 1{,}000^2}{2 \times 32{\cdot}2} = 7{,}453{,}416 \text{ grains, and}$$

$$\frac{7{,}453{,}416}{7{,}000} = 1{,}065 \text{ lbs.}$$

This energy is expended on the target (if of iron) and in the destruction of the bullet, though it is a question whether or not, sufficient heat is developed at the moment of impact, as to render the ball more susceptible of destruction. It is stated, and on good authority, that in firing a cannon ball against a target during experiments at Shoeburyness, the ball was, after the collision, found to be hissing hot. Mr. Fairbairn, the eminent engineer, has stated that in the gunnery experiments he witnessed, prior to 1863, it was a common thing to see a flash of light, even in broad daylight, when the ball struck the target. Now it is well known that impact, by which is meant a blow or series of blows, will cause heat; as for instance, the hammering of a bar of cold iron on an anvil. Our rifle bullet falling from a height of 16 feet to the earth attains a velocity at the time of striking of 32 feet per second, and generates by its impact heat enough to raise the temperature of its mass $\frac{3}{5}$ths of a degree, Fahrenheit.

Suppose a bullet has at the time of striking a target a velocity of 1,127 feet per second, then the total heat developed at the moment of impact would, if concentrated in the ball itself, raise its temperature to

$$\frac{1{,}127}{32{\cdot}2} = 35, \text{ and } 35^2 \times \tfrac{3}{5}\text{ths} = 735°$$

and this would be more than sufficient to fuze it, as lead melts at a temperature of 612°. In reality, however, the heat developed is divided between the ball and the target; and if a bullet, or what remains of a bullet after impact be examined, signs, or what may be accepted as signs of fusion will be found. Wingate in "Rifle Practice," p. 258, in alluding to the use of a soft bullet—that is, one made out of pure lead, states that such an one spreads on striking, and makes a more severe wound; the lead also melts and flies all over, producing about the same effects as from an explosive shell. This fact was made the cause of complaint on the part of the French that the Prussians, during their late war, used explosive shells.

The questions may be pertinently asked—what is the object of rifling a gun barrel, what to accomplish, and what is gained by so doing?

To the first the answer may be, the power to fire an elongated instead of a spherical projectile, but this is only true in part, for the Brunswick rifle with two groves fired a spherical belted ball. The object in rifling a gun or small arm, is to obtain rotation on a fixed axis, and this object is equally arrived at whether the projectile to be fired is spherical or elongated. In the case of the spherical ball the rotation upon a fixed axis gives increased accuracy by eliminating in a great measure the errors due to the eccentricity and irregularity of the ball. Projectiles cannot in practice be made absolutely and uniformly true as to concentricity, weight and form, and any departure from absolute truth in these points is attended in a ball fired from a smooth-bore piece, with a corresponding loss of accuracy. But if a fixed rotatory movement be communicated to that ball, the uncertain rotation due to the position of the centre of gravity will disappear, and with it one source of error; while the inaccuracy due to any irregularity of form or surface will be greatly diminished in consequence of the pressure of the air being more equally distributed around the projectile, the position of which in reference to this pressure is constantly changing. But rifling is more valuable as rendering possible the use of elongated projectiles with all the advantages which flow from their employment. Why cannot elongated projectiles be fired from smooth-bore guns (cannon)? Because of the pressure of the air acting on their flight. "If," says Lieut.-Col. Owen