

metric state of the air causing a difference by the time it comes to the press. It is therefore necessary to alter the exact distance the press-block is allowed to enter the box, with the season of the year, or even according to the prevailing state of the weather. For some centuries gunpowder remained in the form of dust or "meal" being in fact simply the ingredients ground together. Granulating or corning was therefore a step in advance, as it added to the strength of the powder, and as the process is a dangerous one, the machinery has been contrived to be entirely self-acting, so as to preclude the necessity of any attendance. In this process the press-cake is broken up by a series of rollers and drops down on screens of copper wire, to which a shaking movement is communicated, and the grains are thus sifted and distributed according to their degree of fineness; and all that is too coarse is collected and passed back to the rollers, whilst all that is too fine is sent to the incorporating mill again. The grains that will pass through a 12 mesh and be retained upon a 20 mesh would be "rifle fine grain (R.F.G.) powder, suited as to size for the Snider and Martini rifles. All grain from the granulating machine is called "foul-grain" and has to be deprived of its dust in reels which revolve in a closed cage at the rate of 38 times per minute. Glazing is effected by placing the powder in barrels or "churns" which hold about 400 lbs., and are made to revolve at the rate of 34 turns per minute, by which a fine black glaze is imparted to each grain, and after this operation is complete, the powder is again passed through a slope reel and sifted. The glazing process is one of much importance, both with reference to the explosiveness and also the keeping qualities of gunpowder. As regards the former point it undoubtedly modifies the violence of the combustion, and this it probably does by slightly retarding the ignition, a powder with a rough porous surface affording a better hold to the flame than one possessing a highly polished exterior. The addition of a thin coating of the purest graphite to cannon powders, although originally intended merely to modify the explosiveness, also renders the surface of the grains less absorbent. Military small-arm powders are never dressed with graphite; good fine grain gunpowder will take a high finish without it, but, by its aid, a very inferior article can be polished up to a silvery brightness. All kinds of powder are dried, or "stoved," in a special room thoroughly ventilated and heated by steam, not more than 5,600 lbs. being dried at a time. Fine grain powder needs only twelve hours of stoving, whilst from three to four days are required for very large cannon powder, the heat required ranging from 120° to 145° Fahr. The last process is that of "finishing," or final dusting, when charges of 270 lbs. are placed in a horizontal reel, revolving 45 times per minute, and run for about 2½ hours, after which time the powder will have a very glossy appearance. It is then removed, barrelled up for use, but not finally closed until after having been proved, to do which the powder is subjected to the following tests:—

1. That it is of the proper color, has received the exact amount of glaze, is of a sufficiently hard and crisp texture, and is free from dust. These points are judged by the eye and hand alone and require experience on the part of the examiner. 2. That it has been properly incorporated, which is determined by flashing a small quantity on a glass, porcelain, or copper plate. Properly made gunpowder will flash, or puff off, with but few lights or sparks, leaving only some smoke marks on the plate. A badly incorporated powder will give out a quantity of sparks, and leave specks of uncombined saltpetre and sulphur, forming a dirty residue; and if made from very slack-burned charcoal, or charcoal which has been injured by damp, it will flash badly. 3. That the grains are of proper shape, size and proportion, the first being determined by the eye, the second either by counting where the grains are very large, or by the use of two sieves to determine the higher or lower limits of size; and the proportion is determined by using three or more sieves, thus small-arm powder is sifted with 12-mesh, 16 mesh, and 20-mesh sieves; all must pass the first, not less than three-quarters be retained by the second, and only one-sixteenth is allowed to pass the last named sieve. 4. A proof for "density," which is determined by the use of a mercurial densometer, which determines with great accuracy the weight of a globe when it is filled with mercury alone under a certain pressure, and also when filled with a known weight of powder and mercury under precisely similar conditions; then if S be the specific gravity of mercury at the time of the test, W the weight of the globe filled with mercury alone, and W' the weight when filled with powder and mercury, then

$$\text{Density} = \frac{S \times 100}{W - W' + 100}$$

5. A testing for moisture and absorption of moisture, and lastly, the firing proof, which in the case of military powder, is determined by firing a charge from a rifle or piece of ordnance, and the initial or "muzzle" velocity ascertained by the Le Boulengé electric chronograph, which measures the exact time the bullet or other projectile takes to traverse a known distance between two wire screens.—(To be Continued.)

THE DUTIES OF FIELD ARTILLERY IN ACTION.

BY LIEUT.-COLONEL W. KEMMIS, R.A.

(Continued from Page 61.)

Should the second in command take the place of the officer *hors de combat* and tie himself down to perform the whole of that officer's duties? We think not; rather should he be guided by circumstances, and redoubling his energy, give his best attention to the point of chief importance for the moment, preventing, meantime, any slackening in other points by a judicious use of the N.-C. officers at his disposal.

On "cease firing" sounding, having obtained his instructions from the commander, he should return to the wagons; or should the enemy reach the guns, leaving these to the commander and other officers to do the best they may, he should retire and endeavour to secure the wagons.

THE SUBORDINATE OFFICERS.

These officers we assume to be distributed equally throughout the battery, each appointed to the immediate charge of a half battery, or division, according to their number. Their duty in action will then be, primarily, to carry out all the orders of the commander and not to allow any deviation therefrom, lest the effect desired by him might not be produced or lest he should be misled in any particular by forming a judgment on grounds other than what he supposed; secondarily, to supplement those orders, by such additional directions in minor details, as may be necessary for their effectual carrying out.

To this end, dismounted, they must closely watch the service of their guns, particularly seeing that the ordered ammunition is properly supplied and prepared, the tangent-scale set to the named elevation, the due amount of deflection,¹ for any causes which exist to affect the true flight of the projectile, given and the guns correctly laid; they should also see that the guns are fired as ordered and, so far as they may be able, observe and form an opinion of the effect.² When it happens that independent firing is ordered they must exercise such control, subservient to any particular directions of their commander, as they believe will conduce to the greater efficacy of the fire.

The second in command, as already stated, has to watch the expenditure of ammunition, casualties, etc.; nevertheless, it is the duty of the subordinate officers to take account themselves of this, and by notifying to the second in command what they require for the maintenance of the service of their guns ensure the supply they want; they should also report to him for the information of the commander, or to the commander direct, if shorter to do so, anything exceptional which may occur in their charge, at the same time taking steps to put it right.

In the event of the enemy penetrating to the guns, the subordinate officers must see to the maintenance of the fire to the last, then to the guns being disabled and, remaining with their detachments, direct them in any way open for diminishing their danger or securing their safety.

Should it fall out that the second in command becomes *hors de combat*, it does not appear desirable that, in action, the senior subordinate officer should take up his special duties to the prejudice of his own, at the moment of first importance; such course might have a prejudicial effect, and it would seem better that the staff N.-C. officers acting previously under the instructions of the second in command, should continue to the best of their ability to attend to the safety of the wagons and the supply of ammunition, under such instructions as they might receive either from the commander or from the other officers.

We have already adverted to the moral duties incumbent upon the subordinate officers in common with the second in command, and it is unnecessary to say more upon the subject.³

On "cease firing" sounding, the divisional officers, if the guns are not limbered up and moved off, should carefully examine their divisions and report to the commander.

(To be continued.)

¹The deflection being peculiar to each gun must of necessity be judged and determined in the first instance by the N.-C. officer in charge of the individual gun, and not by the officer who has supervision of more than one gun.

²After the range or length of fuze has been ascertained and ordered by the commander it may be that an officer is convinced that a particular gun requires (as is quite possible) some slight alteration of elevation, etc., and, if he is so satisfied, he should bring it to the notice of his commander and obtain his approval for the alteration.

³The subaltern may be disposed to under-rate the duties required of him in action, considering that the commander originates the orders governing the fire, and the Nos. 1 carry them out; he might, perhaps, do so were the Nos. 1 and gunners perfect and were the circumstances of battle set aside, but the former no more than the latter can be. In our opinion the subaltern's duties are now more important than ever, when, by reason of "short" service, he has men less perfectly trained than formerly, and more wanting in essential self-reliance—men who are either comparatively young soldiers or half-soldiers dug out from civil life.