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Evening Meeting.

Monday, March 30th, 1868.

REAR-ADMIRAL SIR FREDERICK W. E. NICOLSON, Bart., C.B.,
Vice-President, in the Chair.

NAMES of MEMBERS who joined the Institution between the 16th and 30th
of March.

ANNUAL.

Kerr, Henry, Capt. 7th Royal Fus. 1l.	Leith, James, V.C., Major, late 2nd Drgs.,
Whitehead, F. G., Lt.-Col. 29th North	Hon. Corps Gent.-at-Arms. 1l.
Mid. Rifle Vols. 1l.	Hales, Arthur, Lt. Cape Moun. Rif. 1l.
Moysey, C. J., Capt. R.E., 1l.	Kendall, William, Col. R.E. 1l.
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SCHULTZE'S GRANULATED-WOOD GUNPOWDER.

By Mr. JAMES D. DOUGALL.

BEFORE entering upon the immediate subject of this paper, I crave your indulgence for a brief space to explain my position and connection with it. In October, 1865, I was waited upon by two gentlemen, both of whom, I believe, are now present, but who were at that time entire strangers to me, who showed me specimens of this new powder, of which I had not previously heard. Having, so far back, as in a work of mine published in 1858, but written in 1857, expressed an opinion, that we were on the eve of some great invention in explosives, I naturally gave the matter some attention, and, having since then seen no reason to alter the favourable opinion I formed of the powder in the first instance, my name has gradually become connected with its introduction into this country. But, my appearance before you this evening is not in the character of a partizan or a speculator. I have no money whatever embarked in the matter, and all I can lay claim to, is an honest and energetic resolution to satisfy my own mind in the first instance; and, in the second, if so satisfied, to give publicity to my convictions for the general good. For this purpose, I have experimented with it practically on a large scale with rifle and smooth-bore guns.

I have visited the manufactory or powder mills at Potsdam, and, I may say have exhausted the subject so far as it affects practical or sporting gunnery, by examination of the mode of manufacture, and, if I may be permitted the use of the term, by *cross-examination* of the talented inventor, Captain Edward Schultze; and, finally, by every practical test I can think of as necessary. I take this opportunity to pass a slight and most imperfect eulogium upon Captain Schultze, a man whom I consider it an honour to know, who, above all degree possesses the most remarkable combination of sense and sentiment I have ever known, and who meets every investigation of the merits of his invention in the frankest spirit. You will shortly be told how this sensitiveness of character bore directly on the invention now before us. I confess that I was not prepared for the remarkable knowledge he displayed of the theoretical nature of this powder—that is to say, that certain results I had practically arrived at for myself, but for the causes of which I could not account, were by him explained in figures, and to minute decimals of the most satisfactory and convincing character.

The history of the powder is as follows:—Captain Schultze, a considerable number of years ago occupied the same position at Spandau, as the talented Mr. Abel now does at Woolwich. At once an artillery officer and a chemist of the highest attainments, he was chief of the *fonderie*, but the Prussian Government's attention having been drawn to gun-cotton, to Captain Schultze was given the important task of solving the question—Is gun-cotton an available explosive for military purposes? He was therefore removed from the *fonderie* to the chief charge of the Gunpowder department. In that position, with every requirement at command, he for years experimented on gun-cotton, and at last gave in his final opinion against its adoption, describing its character in these emphatic words, "It possesses the *beau-ideal* of force, but is quite uncontrollable."

During these experimental years he was also engaged (in the exercise of his official duties) in the daily manufacture of black gunpowder, so that he was master of his subject from the two points of view bearing upon these great rivals, gunpowder and gun-cotton, when an accidental circumstance sent his energies in a fresh direction. A brother officer had been present at Mayence, on the Rhine, when the tremendous explosion of the powder magazine took place, which must be fresh in the recollection of many gentlemen now in this room. Captain Schultze had spent many happy days of his life in Mayence; I have already told you that he is a man possessing much sentiment in his nature, in a word, a man of both quick and deep feelings, and he was so horrified by the details of his friend's description of the effects of the explosion, that he then and there resolved to devote the remainder of his life to the discovery of a powder capable of being manufactured and stored without risk to life or limb. After years of labour and the trial and rejection of nearly every vegetable substance within his reach, he succeeded in the production of this granulated or raw uncharred wood powder, the subject of this paper, and which, after these preliminary remarks, I shall now proceed to describe.

Captain Schultze had, impartially and without prejudice, already arrived at the opinion of the worthlessness of gun-cotton as a trustworthy explosive. He had the most perfect confidence in the propulsive powers of black gunpowder. He did not, and he does not now, depreciate or disparage the merits of the latter, which for centuries has well done its work, and has been one of the chief agents in the promotion of civilization. He set himself to the task of modifying the nature of that black powder, adopting it as a standard of explosive qualities, but being resolved to remove what he considered its objections, and principally these—1. Danger in manufacture and storage; 2. Heating and fouling of the gun; 3. Undue recoil. Other minor matters I have no occasion at present to refer to.

Starting from the position that all explosives should be composed of a granulated substance, the thought at last struck our inventor, that, he might attain his object by means of a powder as nearly approaching black gunpowder as might be, but with the wood uncharred, with little or no sulphur whatever, and above all, with the presence of saltpetre or its equivalent, in solid substance; in a word, an explosive occupying the *juste milieu* between the pyroxyline proper on the one hand, as *gun-cotton*, and black powder on the other. Still giving all due regard to the great merits of the latter, he chose those woods, as the alder, which give the best charcoal ingredient for black powder, at least for fire-arms, and he proceeded to granulate that wood in different sizes of grains, by which as in black powder, the rapidity of combustion is governed. But here, let me mention, *in limine*, that there exists a great difference in the conditions for the government of the rate of combustion, if indeed, with regard to the size of the grains, it be not in the inverse ratio to that of black powder. Hence grave errors have been, and to my knowledge, are now being made by experimentalists, who, however well versed in testing the shooting powers of black powder, have, without seeking advice or guidance from Captain Schultze or his agent, rashly experimented, in small bore rifles for instance, with his powder as made for quite other varieties of fire-arms. Equally deceptive and fallacious results would follow the use of fine-grained black powder where large-grained is required, or *vice versa*. This caution is all the more necessary, that Captain Schultze is now making seven varieties of powder, and I believe that one or more of these has also sub-varieties.

Here, for a purpose, which will now explain itself, I must, with your permission, pause in reading this paper, to initiate one of the more practical purposes of the evening. I shall have occasion to observe that Schultze's powder may be wetted without caking, and be dried without diminution of its force. I shall now wet a small quantity of it in your presence. Ten per cent. of water, I may here mention, may thus be added to this powder without diminishing its force when re-dried, for this reason, that, with that amount of water, the salts are not dissolved. [Mr. Dougall here poured water upon a small quantity of the powder in a wine glass, and handed it to the serjeant in attendance to be dried.]

The wood about to be used is kept in water, so as to give it tough-

ness and adherence under the saw. By fine saws, which can be set so as to govern the size of the grains, the wood,—alder by preference, to which next ranks the *rharnus* of the ancients, I am not certain of its popular name, if it be not "*buckthorn*,"—is cut into cross veneers. These veneers are again punched out into grains. The remaining part of the veneers, after passing through the punching-machine, is utilized by further processes. The main bulk of the wood, you will have an opportunity to observe, is cut into little solid blocks, their size being governed by the setting and thickness of the saw, and the size of the punches. Mere *débris*, or sawdust, a word which has been unhappily connected with this powder, does not at all suit the purpose. The grains must be, as I have described, cubes or rectangular parallelograms, and, by the kindness of my neighbours, Messrs. Murray and Heath,—gentlemen who are always willing to promote science for the sake of science, and not in the mere business sense,—you will have an opportunity of examining these grains through powerful microscopes. Some *débris* will of course be found to exist, its partial or complete removal being a question resolved by desired requirements. After the grains have been so produced, they are submitted to various processes for the removal of acids and other easily soluble substances, after which they are in a condition to receive the first impregnation of an explosive ingredient. Forty parts by weight of concentrated nitric acid 1.48—1.50 are mixed with 100 parts by weight of sulphuric acid (sp. gr. 1.84). This mixture is set aside in some cool place for use. To 100 parts by weight of this mixture are six parts by weight of the prepared grains gradually added, stirring the whole constantly for two or three hours, when this part of the operation is completed. The presence of sulphuric acid is required solely for the purpose of creating a chemical action, by which the nitric acid is driven into the wood. Part of that nitric acid forms a chemical combination with the wood, and remains fixed there. The other part, and the whole of the sulphuric acid are withdrawn from the wood by subsequent operations. I request your especial attention to this great fact, the withdrawal of the sulphur, for on it rests much of the excellence of the powder, and I do this with the greater confidence that, a doubt of this having been expressed by a gentleman of authority on fire-arms at your meeting on the 16th instant, I have pressed the question on Captain Schultze, on whose word I have the most perfect reliance, and he assures me that there is no appreciable TRACE EVEN of sulphuric acid left in his powder, and that his sole reason for mixing it with the nitric, is to drive the latter into the wood, or create a chemical action, by which the wood and the acid form a combination according to a well-recognized law in chemical science. Indeed I know, practically, that the sulphuric acid, so withdrawn, is again utilised, and that at first considerable loss was occasioned by it being allowed to escape.

The grains of wood, now combined chemically with a certain amount of nitric acid, are freed from the merely mechanically adhering remainder of the acids by a centrifugal machine or other process, are placed in cool, running water for a considerable number of hours, afterwards boiled in a weak solution of carbonate of soda, again placed in

running water, and finally are dried and stored, or immediately, if desirable, converted into the finished powder.

I shall now burn some of the grains in this incomplete state. You will observe that their inflammable qualities scarcely exceed those of dry sawdust. In this state they can be kept for any reasonable period, and even in a damp state for safety in shipment or storage.

The whole of the above processes being conducted in a wet state, there is absolutely no danger of explosion attending them. Those who have visited Potsdam must know that it is the pet place of the Royal family of Prussia, a town of palaces and churches, with beautiful environs. So strict are the police laws, that Captain Schultze is not permitted to fire a rocket there, even for the purposes of experiment, or to show to inquirers like myself the immense height to which he can drive that form of projectile with his powder. But, in this beautiful town, certainly not in its centre, but still within its precincts, on ground only divided by a low paling from his own garden, and with neighbours' houses on each side, is the powder manufacture carried on up to this stage. I had the curiosity to measure the nearest point (from the much more extensive factory than I was prepared to see) to Captain Schultze's residence, and found it exactly 45 feet. But I saw something still more unexpected, and that was, Captain Schultze's chief chemist smoking his cigar daily while occupied in his practical duties in a gunpowder manufactory. The grains in this stage are, at Potsdam, now conveyed to Captain Schultze's magazine, situated about two miles from the factory. They are there treated finally with nitrate of potash (saltpetre), or, what I believe Captain Schultze prefers for most varieties of his powder, nitrate of barytes. [Mr. Dougall here read from the Patent Specification the description of this process (page 5):—]

The powder is now complete, and being dried by exposure to a temperature ranging from 90 to 112 Fahrenheit, for a space of 12 to 18 hours, is now ready for use. Even now the danger of accident from explosion is not great. This was on one occasion somewhat sharply tested. Fifteen cwt. of powder in its perfect state was contained in a large iron vessel, having a horizontal flange. A merchant coming to purchase a quantity of the powder was taken, by an assistant, in the absence of Captain Schultze on military duty, to the magazine. A small quantity of the powder was placed on the flange, and ignited with a lucifer match, and both men withdrew immediately afterwards, leaving no apparent cause of mischief. The door was hardly shut and locked, however, when flames burst through the roof of the magazine, a rapid deflagration, but no actual explosion, followed, the copper pipes used for heating the drying-room were melted, but there was no concussion whatever. Although this misadventure cost Captain Schultze a considerable sum, I have heard him say that he never expended money with so much satisfaction, for it proved that his powder, so powerful in fire-arms or in blasting, when unconfined or loosely confined was comparatively harmless.

We have now arrived at the complete powder. This, I have already stated, is made in at least seven varieties, all differing in force as

required, thus proving that its manufacture is under scientific control, and not a merely fortuitous process.

I must here confess a reluctance to describe or dwell upon these various forces. I repeat that I do not treat the subject in the spirit of a partizan. I know the claims of our English gunpowder, its power, its regularity, and its general excellence. Where I am compelled to draw comparisons, it is where I have no other standard of excellence, no other power of illustration. I shall briefly, however, tell you what I have seen done with one variety of this powder. I have seen half an ounce of it only, enclosed in a small glass bottle, such as you may purchase dissolved gum-arabic in, sunk in two feet of water, throw a column of water, containing I know not how many gallons, to a height of 21 feet. Exactly the same quantity of black powder, fired in the same spot, in a similar bottle, hardly elevated the surface of the water, and only produced an ebullition. At my special request, although those present could not understand my purpose, $1\frac{1}{2}$ ounces were then sunk in 15 feet of water. The effect of the explosion was marvellous. I myself was standing at a distance of eight or ten yards from the margin of the river, when, without any noise being heard, I found a violent vibration under my feet, consisting of I should say, five distinct pulsations of the earth. Gentlemen, now in this room, standing at a much greater distance, described the vibration in equal terms. Vast quantities of mud, branches of trees, vegetable remains, and such other substances as may be looked for at the bottom of a river, came to the surface, and, finally, dozens of roach and other fish, in a stunned state mostly, only a few being apparently quite dead. I conclude from the large number of these fish, and their different degrees of suspended animation, that the shock must have extended over a large space of water. On the land the vibration must have extended over at least the space of an acre. This was, I remind you, all done with $1\frac{1}{2}$ ounces of Schultze's powder, as specially prepared for mining purposes, for coal or soft rock; other varieties, quite differing in effect, being prepared for blasting hard rock. What the power of such powder may be in a shell or torpedo, it is frightful to contemplate.

I have purposely, by way of dramatic contrast, described to you the effects of this terrible variety of powder, that what I am about to show you may be the more striking.

I have now in my hand a quantity of the regular sporting powder. You see how comparatively slowly it burns, how rapidly the gases ascend, and with what I may call harmony or consentaneousness they do ascend. All these qualities are elements of correctness of the explosion, for it is by them that Captain Schultze claims great reduction of recoil without any loss of propulsive force.

The exact qualities of the various gases evolved by the combustion of gunpowder or other explosions, I do not pretend to be able to discuss. But, as Captain Schultze has, in a pamphlet or pamphlets published in the German, French, and English languages, given publicity to not only the results of his own analyses, but to those of other distinguished continental chemists, I venture to express a hope that in the following statement I shall not be accused of any invidiousness or mis-

representation. Captain Schultze, then, asserts that, when we burn black gunpowder we evolve 31 per cent. of active and 69 per cent. of inert or even obstructive gases. He argues that these 69 volumes of gas, in the proportion of more than two to one, repel the onward or propulsive motion in a great degree, and cause an increase of recoil. He illustrates this assertion by the following simple experiments. [Mr. Dougall here burned the fill of an open Lefaucheux cartridge fastened to the end of a slender wire in a horizontal position. The wire never vibrated or bent; but when the same cartridge was *one-third* filled with black powder, the recoil was so great that the wire was bent forcibly downwards, and the cartridge was driven right under his hand, in which position it remained.]

He also asserts that a large part of the inert gases rapidly recondense, and so foul and heat the gun.

On this part of the question, I cannot speak authoritatively, much less dogmatically. Captain Schultze's theory is certainly largely borne out in practice, but, speaking impartially and dispassionately, I think that we can arrive, theoretically, at very little exact knowledge of the comparative powers of gases as evolved from explosives in a state of confinement, as in a gun. The expansion must be governed in a great degree by the degree of heat. That heat I should be inclined to term immeasurable. I, therefore, even were I competent to discuss the more intricate and chemical branches of my subject, must avoid such discussion. Were Captain Schultze himself present, I might take a different course, but he is now so closely engaged at Paris, with the French Ministers of War and Marine, and other officials, that he could not possibly attend this meeting, although both strongly urged and being himself desirous to be here.

Having stated his theory of the explosion of black powder, I now give that of his own. For *it*, he claims not less than 90 per cent. of active ordinary gases, and only 10 per cent. of inert! This difference, if borne out in practice, is literally astounding, for even with one half of the weight of charge, which is his professed equivalent, we have 45 driving powers, with 5 inert, against 31 driving powers, and 69 inert, in the charge of a firearm!

But I should be deficient in moral courage did I not acknowledge that experiments, startling as the statement may appear, largely bear out these assertions. Of one of these I shall now give the results, first stating that I shall not take up your time by giving exact fractions, but giving you sufficiently approximate returns. I constructed a target, running on wheels, upon a framework of iron. It is not a highly scientific target, in, so far as it cannot register by measure or weight the exact force with which it is struck, but it must of necessity correctly measure comparative force. At this target, from the same breech-loader, were fired a large number of shots with gun-cotton, with gunpowder, and with Schultze's powder. I may dismiss gun-cotton at once by stating, to use a sporting phrase, it was "nowhere," and now I never think of taking it into consideration. The last experiment made was, as usual, with 82 grains = 3 drachms of black powder, and an equal bulk, something slightly over half the weight of Schultze's

powder. The charge of shot was $1\frac{1}{8}$ ounces of Walker, Parker, and Company's No. 6. I consider this a fair test, because we can arrive at some degree of accuracy in our summing up, whereas with a single ball, or measuring velocity by that most fallacious of all tests, penetration by a soft leaden bullet (I do not include, in this prevalent and mischievous fallacy, penetration by a projectile of any metal hard enough to retain its shape and not be flattened) no approach to comparative calculation can be attained. I can also, at such a test, bring into use my trained judgment as a practical gunsmith.

The result was as follows:—

Aggregate pellets of 6 shots.

Schultze powder	..	1150	Motion to target	..	$10\frac{1}{8}$ in.
Black powder ..	..	1016	Do. do.	..	$6\frac{1}{8}$ in.

134

Now the value of this experiment lies in this, that if we add the above 134 pellets to the 1016, aggregate of the black, being about $\frac{1}{10}$ th of the aggregate of the Schultze pellets, we may extend the dislodgment of the target by the black powder also $\frac{1}{10}$ th, say $\frac{5}{8}$ ths of an inch, near enough for our purpose. This gives $7\frac{1}{8}$ inch motion against $10\frac{1}{8}$. Now, $7\frac{1}{8}$ inches are equivalent to $\frac{5}{8}$ ths of an inch, and $10\frac{1}{8}$ inches to $\frac{8}{8}$ ths. By the simple rule of three we find, then, that if 31, the driving powers of black powder, asserted so at least by Captain Schultze, give this $\frac{5}{8}$ ths, his powder should, if it really possess 90 per cent. driving power, give $\frac{5}{8}$ ths and a fraction, with one-half the weight = 45. We have found that it gave exactly 81, an approximation so remarkable, that we can hardly attribute it to chance. Gentlemen now present can testify to the impartial exactness with which this experiment was conducted.

31 : 57 : 45 (being one-half of the 90 per cent.)

$$\begin{array}{r}
 45 \\
 \hline
 285 \\
 228 \\
 \hline
)2565(82\frac{2}{3} \\
 248 \\
 \hline
 85 \\
 62 \\
 \hline
 23
 \end{array}$$

From experiments with small shot we come to those with rifles. In this branch of practice I have confined myself to my speciality, sporting rifles. I am not now, and at no time have been, occupied with military rifles, but, using immense charges in my guns for heavy game, I naturally have anxiously and closely tested this new powder on my

own behoof, because, if I can find an explosive giving great velocity, with little recoil, and no smoke to speak of, I can put into the hands of my friends in India and elsewhere, weapons possessing great advantages where, as in the jungle, the pursuit of ferocious animals is attended with considerable personal danger. Independently of other considerations then, where life itself may be at stake, I am bound to be more than usually guarded in the recommendation of any new explosive. I now produce a sheet of iron, $\frac{3}{16}$ ths of an inch thick, fired at from 100 yards distance, with one ounce spherical bullets of pure soft lead. You will be able to judge of the comparative velocity for yourselves. I may appear to contradict myself after what I said a short time ago, in thus appealing to penetration for a measure of velocity, but the penetration of a single sheet of iron as this is, without being backed up with other substances, whose reaction can be brought into play, is very different from the penetration of such a backed up substance, or from layers of substances in *contact* with each other. As a comparative measure of velocity, it is a fair and handy test.

The rifle used in this test was a 16 gauge Lockfast breech-loader. The charge of black powder was 4 drachms, about 109 grains, No. 6, that of Schultze powder being equal volume, or as near as may be one-half in weight, or 54 to 55 grains. The results are before you in this plate. I shall not pretend to claim a victory for either explosive. They have both done their work well, and so nearly on an equality, that it may be difficult to distinguish any appreciable difference. I think it proper to state that the Schultze powder used was sporting powder, not rifle. My reason for this was that I wished to try the shooting with such powder as would be likely to fall into a sportsman's hands. Whether or not a still greater velocity might have been obtained with Schultze's rifle powder, I am not prepared to state; but I understand that it is manufactured of greater strength than that of sporting powder.

In direct connection with rifle shooting, I am in a position to inform you that after prolonged trials at Vincennes, extending, with short intervals, over three months, the Committee of Officers appointed by the French Minister of War to superintend the experiments, although at first very dubious of the good qualities of the new explosive, and indeed prejudiced against it, through confounding it with some other powder, unanimously signed the report recommending its adoption in the French Army. The conditions were that it should excel the French gunpowder on six points, viz. :—

1. Absence of fouling.
2. Absence or diminution of smoke.
3. Diminution of recoil.
4. Reduction of heat, so as to permit more prolonged shooting with the Chassepot rifle, the weapon used for the trials.
5. Greater initial velocity and regularity of shooting.
6. Reduction in wrenching or bursting force.

On all these points Captain Schultze was successful, and the report was signed accordingly, as I have said.

In this country, a gentleman of high scientific attainments, a Fellow

of the Royal Society, and well qualified for the task, has experimented largely at 800 yards' range with this powder in the Snider and, possibly, other rifles. His experiments have been carefully and slowly conducted. They are not yet concluded, but they have hitherto given every promise of success.

In very elaborate experiments now being conducted at Spandau, the same success has hitherto attended Captain Schultze's invention. I may state here, *par parenthèse*, that although in Belgium the question has not been taken up by the Government, a well-known nobleman and capitalist of that country has arranged with Captain Schultze for the manufacture, and is about to erect extensive powder works.

The last, and in one sense the greatest, branch of this subject, so far as it treats of propulsive force, is the adaptability of this explosive to cannon. As an Artillery Officer, Captain Schultze is here quite at home. Indeed, it was his practice, when in service, to load one-half of his battery with black powder, and the other with his own. What he particularly claims, however, for this branch is the almost total absence of smoke, and great reduction of wrenching force and recoil. It must be known to you, Mr. Chairman, and to many other gentlemen in this meeting, that no heavy marine gun has yet been made by the French, capable of standing 45 rounds with full charges of English gunpowder. Consequently, the French are now in anxious search of a more suitable explosive, and that is the next task set to Captain Schultze. Immediately on his obtaining satisfactory results at Vincennes with small arms, he was handed over by the Minister of War to the Minister of Marine, and we shall shortly hear of what will have been done on an extended scale with heavy marine cannon at Cherbourg.

But the French are going still further. I beg that what I am now about to announce may be taken at its actual value. Hitherto I have stated Captain Schultze's claims from facts and experience. What I am now going to mention is hypothetical, and it is that several men of science in Paris, including the Emperor himself, believe that in this powder they have discovered what they have long sought for, a "*motor*," to take the place of steam in sea-going vessels. This is a most important matter; not in these days of scientific progress to be dismissed with a sneer as the dream of a visionary. I am quite aware of the danger of over-stating a case, but I beg of you to bear in mind that this is, at least, no dream of Captain Schultze. He has been shown the machines as already constructed, and has been told their requirements. The question has been put to him, can you give us an explosive fulfilling these requirements? His answer is, "I believe I can," and time must alone tell with what correctness this reply has been made, but I should consider him a man most unlikely to commit himself by a rash promise or on insufficient grounds. Failure in this case would be no argument whatever against the general value of his powder. I have referred to this sought-for *motor* principally to prove the great importance which Frenchmen of science attach to the capabilities of both Captain Schultze and his invention, without attaching any value to it whatever in connection with the more legitimate purpose of the latter.

If I have been rightly understood in this necessarily most incomplete and imperfect paper, the claims for Captain Schultze's invention principally rest on the following grounds :—

1st. Safety and rapidity of manufacture, and consequent reduction of cost. 2nd. Safety in transport and storage. 3rd. Less injury by absorption of damp, first, because the imbibed humidity, up to 3 per cent. is not injurious to its propulsive powers ; and secondly, because, if even 10 per cent. of water be added, no mischief has accrued if the powder be re-dried. [Mr. Dougall here burned the powder, which he had previously saturated with water. It exploded, without the slightest apparent diminution of force.] 4th. Great diminution of recoil. 5th. Ample driving force. 6th. The power of almost indefinitely governing its rending force, so as on the one hand to adapt it for immense charges for cannon, or other fire-arms, without bursting ; on the other hand, to increase that rending force up to the effect which I have faintly endeavoured to describe, as exemplified by explosion under water. 7th. Remarkable adaptability to breech-loading fire-arms for the most obvious of reasons, viz., absence of fouling. One of the tests at Spandau was to attempt to foul a Dreyse needle-gun by repeated firing, no difficult task, any one would say, who knows the construction of that weapon. But after 460 rounds, the gun remained clean, and the superintending officer then ordered the firing to cease. A somewhat similar result took place at Vincennes, with the Chassepot.

I have thus, Mr. Chairman, endeavoured to give perhaps in a somewhat desultory manner, a sketch of the history, manufacture, and present position of this new explosive. I trust that I have said enough to elicit discussion, and to engage your future attention to its qualities and career. I make no foolish or arrogant claims for it. To succeed, it has much work to do, many difficulties and prejudices to overcome. I shall therefore finish this paper by reading to you the several objections, raised some time ago, *in the most authoritative quarter*, and my replies, as taken from Captain Schultze's own lips, and immediately converted into plain English.

1st Objection. That the Schultze powder can be exploded by the blow of a hammer on iron.

Answer. That the Schultze powder may possibly be ignited by the blow of a hammer is a quality also possessed in like degree by black powder. The first authorities state that black powder "may be fired by the electric spark, and by percussion." This common quality has come under Captain Schultze's notice in his official capacity again and again, and he is prepared to demonstrate it at any time. Practically, the objection is invalid against either powder, because the conditions of ignition by percussion are such as are impossible of occurrence in storage, transport, &c., but so far as it goes, it in no degree whatever can be advanced against the Schultze powder as differing from black powder. They stand alike in this quality, as opposed to combinations of phosphorus, chlorate of potassium, and such like, which are capable of ignition under common and probable conditions. Whatever test, therefore, may be proposed, Captain Schultze is prepared to show will demonstrate the entirely similar qualities of the two varieties of powder, while, practically, he considers them valid against neither.

2nd Objection. That it is capable of absorbing moisture to the degree of 6 per cent. in twenty-four hours (I presume during an average state of the atmosphere).

Answer. That the Schultze powder is capable of absorbing 6 per cent. of moisture in twenty-four hours is not consistent with fact under the most trying conditions to which it has been submitted, the results of which gave an average of something under 3 per cent., so that in this respect it stands nearly on an equality with black powder, but with one very great difference in final results. While the hygrometric qualities are about equal, the effects of that absorption of moisture are very different, and all in favour of the Schultze powder, from this plain reason, that the combustion evolves gases which Captain Schultze has desired to retain by not charring his wood, and thereby depriving it of all hydrogen, which he actually utilizes in combustion. Captain Schultze does not assert that he desires an addition to the hydrogen gas already existing in his powder, but he does assert that the absorption of moisture in question has not the same diminishing effect upon its propulsive powers as it would have upon those of black powder. This question has also been practically and satisfactorily settled by the Prussian Government, which caused to be placed in the dampest casemate that could be found five barrels of each powder. After six months both were carefully tested by weighing and firing. The hygrometric tests were slightly in favour of the black powder, the actual absorption being of it as 2.20 to 2.80 of the Schultze powder, but the tests by firing were enormously in favour of the Schultze powder. The result of the exposure to damp for six months had reduced the propulsive powers of

The black powder	8½ per cent.
The Schultze powder	4¼ „

These results are on record at Berlin, and the chemical causes of this superiority of the Schultze powder are perfectly understood.

3rd Objection. That its strength is modified by compression.

Answer. That compression exercises any special or peculiar influence on the powers of the Schultze powder is denied *in toto*. The common fact that it is proper to ram the powder well home in a gun is equally shared by black powder, if, indeed, it be not much more absolutely necessary in the latter to acquire equable powers of propulsion. Fantastic and nimious experiments of immense compression form no part of the question, and such pressure would alter of necessity the granular and other qualities of black powder in a much greater degree; in point of fact the objection is quite visionary. This answer is not theoretical, but founded on thorough experiments with both powders; these experiments are scientifically, but in no degree practically, interesting.

4th Objection. That it may be liable to self-combustion.

Answer. Decomposition, and consequently spontaneous combustion, are in the Schultze powder quite impossible. It may be stated here that during many years it was an especial task set to Captain Schultze by

the Prussian Government to test this among the other qualities of gun-cotton. He had every possible means at command, and exhausted the question. He is, therefore, enabled to assert, most authoritatively and without the slightest fear of valid contradiction, that while gun-cotton, by its organic construction, is highly susceptible of decomposition with all its evil results, in his powder it is a physical impossibility.

5th and last objection, that the different kinds of powder sent to England in 1865, 1866, and 1867, were not of uniform strength.

Answer. The difference in the powders sent to England in 1865, 1866, and 1867, arose solely from variations in the orders sent from that country. Any given standard can be absolutely maintained, and the objection is valid in no degree whatever; it would be quite as valid to object to black powder, that it is daily made of different sizes and qualities as ordered. The size of the grain and other conditions of the Schultze powder are simple matters of detail. It may almost be superfluous to state, in explanation, that German sportsmen use guns and shot differing in dimensions from those in use in England, and it is quite as easy to regulate the Schultze powder for the smaller sizes of shot, and wider calibre guns used in England, as it is for the English powder manufacturers to make it of various grains extending over six sizes, for muzzle-loaders, breech-loaders, and for rifles. For instance, an equivalent Schultze powder to No. 3 black powder, or any other size, can be absolutely maintained.

It may be added, generally, that all these objections are exactly those which of necessity presented themselves to Captain Schultze's own mind in the first instance, but which have in every case been so disproved by experience in Germany, that he almost feels it idle to repel them now. Their being raised in England is, however, perfectly natural, and he is prepared to discuss or disprove them practically, if desired. As a practical gunpowder maker, a chemist, and an artillery officer, there is no part of the whole subject which has not engaged his attention. He has succeeded in his purpose—to produce an explosive material to meet the requirements of the age; and, above all, as a source of personal gratification, the manufacture of which is not attended by the slightest risk of property, or of human life.

General BOILEAU, F.R.S. : I believe there is a gentleman in the room who has experimented with Schultze's powder. I allude to Mr. Lang, perhaps he will favour us with the results of his experiments.

Mr. LANG : I have generally found the samples vary, and I have not been able to carry out the experiments as I could have wished.

General BOILEAU : It appears to me that the paper which has been read this evening exhausts the subject, and leaves really little room for more remarks: I can, therefore, say very little upon the question as regards the details which have been laid before us. But there is one point on which it occurs to me that a word or two might be said. It has been for a long time urged as a reproach against chemical science, that while almost all manufactures—with very few exceptions, I believe—in the whole circle of the arts have benefited by our progress in knowledge, gunpowder has not so benefited; and at the present day it is made from the same ingredients, almost in the same proportions, as when first discovered nearly six centuries ago. I think, however, we may conclude, from what we have heard this evening, that the reproach is about to be removed, if it has not been removed already; and that if we cannot take it for granted that Schultze's powder is in a

condition, at present, to be generally used with the same confidence as black gunpowder is, the foundation for its future improvement has been laid, and we may look forward before long to the introduction of this new explosive agent with the same confidence, and with very much greater facilities of application, than in the powder which at the present time is used, both for sporting and military purposes.

Mr. LAMONT, M.P.: As a sportsman of some experience in different parts of the world, I wish to take this opportunity of mentioning, that since the month of October last, I have used this gunpowder at the recommendation of my friend, Mr. Dougall, nearly every day and with the utmost satisfaction, comfort, and pleasure. I have shot out of a common fowling-piece—12-bore—and I have no hesitation in saying, that the new powder will carry as far as black gunpowder. It makes very little smoke, very little noise, and with a total absence of recoil. Beyond that, I can only say that I think a great deal depends upon the way in which the cartridges are made, and especially upon the ramming.

The CHAIRMAN: As nobody else seems inclined to address the meeting, I shall close this discussion, because there is another subject to be brought before you by Mr. Read. He has made some lights which he wishes to exhibit. I think it is a matter of regret that Captain Schultze has not been able to be present himself to-night; still, I think, he has had a very able exponent of his gunpowder. Mr. Dougall has done full justice to the subject. It is certainly one of very great interest. I hope it will be taken up in this country, and that we shall hear of some experiments being made here, as well as in Prussia and France. I have not heard from Mr. Dougall whether any official experiments have been made here. I presume they have not.

Mr. DOUGALL: The powder has not yet been brought before the British Government.

The CHAIRMAN: I hope it may be.

Mr. DOUGALL: I have received a general order from the Lords of the Admiralty for testing, but nothing has been gone into at present.

The CHAIRMAN: I have no doubt, that if it is tested at all, it will be very carefully tested; for I rather think there is a Committee appointed to investigate the whole question of gunpowder and other explosive compounds, with the view of their being brought into practical use. I will now conclude with proposing a vote of thanks to Mr. Dougall for having read this paper to us.

Mr. DOUGALL: I am much obliged to you, Gentlemen, for the patience with which you have heard my paper, and also to Mr. Lamont, so distinguished a sportsman and Member of Parliament, for kindly coming forward and testifying to its qualities. I may state as a tangible proof of the excellence of this powder, that to-day I received from Mr. Lamont an order for gunpowder, for his use during the shooting season, four times greater in quantity than any order I have ever received during my long experience as a gun-maker.

Mr. STEELING LACON: Black gunpowder or Schultze's powder?

Mr. DOUGALL: Schultze's powder.