



Gunpowder—Gale's Plan for Rendering it Non-Explosive and Re-Explosive at Pleasure

Mr. W. Saunders

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Evening Meeting.

Monday, February 5th, 1866.

CAPTAIN SIR JOHN C. D. HAY, Bart., R.N., F.R.S., in the Chair.

NAMES of MEMBERS who joined the Institution between the 29th January and the 5th February.

ANNUAL.

| | | |
|----------------------------------|-----|---------------------------------------|
| Wilmot, Fras., Lieut. 33rd Regt. | 17. | Duncan, P., Capt. West Cork Art. Mil. |
| Boileau, W. S., Capt. R.E. | 17. | Mainguy, F. B., Capt. R.E. |
| Keith, W., Capt. R.E. | 17. | Marten, F. Capt. R.N. |

GUNPOWDER—GALE'S PLAN FOR RENDERING IT NON-EXPLOSIVE AND RE-EXPLOSIVE AT PLEASURE.

By Mr. W. SAUNDERS.

MR. SAUNDERS: In acceding to the request of the Committee of this Institution to read a paper on "Gunpowder—Gale's plan for "rendering it non-explosive and re-explosive at leisure," I have not overlooked the fact that I shall be tempted to address myself to certain subjects on which many persons present have far more knowledge and experience than I can pretend to possess. I shall, however, endeavour to confine my observations to such portions of the subject as can be understood equally well by civilians and military men. I think I can see quite sufficient room for the useful and almost universal application of Mr. Gale's invention without insisting upon its use on board ship, or in military trains, or other situations about which civilians remain, and are likely to remain, in happy ignorance. It will be for military and naval officers to determine how far the principle can be applied in actual warfare. On this part of the subject I urge nothing, and yield nothing. I shall simply avoid darkening counsel by words without knowledge.

I cannot but respect and admire the feeling which I have frequently heard expressed by officers that a large amount of safety would be dearly purchased at the sacrifice of a small amount of convenience. The sentiment of the soldier who declared that shirt sleeves were the armour which he liked to fight in seems to be universally re-echoed, and freedom from restraint, not freedom from danger, appears to be always demanded by soldiers in time of action. How far freedom from danger in the use of gunpowder may be made actually conducive to freedom of action I must leave for those who are experienced in warfare to determine. Fortunately, the days of peace are far more numerous than the days of war, and if gunpowder can be rendered harmless during the time that we are not fighting, an important object will be gained.

No one will be disappointed this evening if I do not go into the history of the manufacture of gunpowder. We are all acquainted with the material; we know its value, and we know its power. Our attention to-night will be directed simply to this one point—can we make it a more useful servant and a less dangerous master? It is clear that under the present state of things gunpowder and colonies do and will occasionally explode, and we may well consider whether we can lessen the evils which history has shown to be of constant recurrence.

It is a remarkable circumstance that many of our most distinguished men owe the development of their character to the energy with which they have devoted themselves to the mitigation of evils and sufferings to which they were not themselves personally exposed. About 100 years ago a poor but intelligent lad in the extreme west of Cornwall read in a newspaper an account of an explosion of fire damp—which took place in South Wales. His mind was so much distressed by the sufferings occasioned by this calamity that he determined to give himself no rest until he had discovered a remedy for the danger. He was then poor, and had received but little education, still he had sense enough to perceive that the study of chemistry might lead to the evidently-desired discovery, and he pursued the study of that science until his efforts were crowned with success, and Davy's safety lamp became known throughout the world.

In a somewhat similar manner it was the explosion of a siege train at Inkermann in the year 1855 that turned Mr. Gale's attention to the evils which arise from explosions of gunpowder, and which ultimately led to the discovery of a simple and effective process by which, under ordinary circumstances, they can be altogether prevented.

It is a singular circumstance that the very same means are employed by Mr. Gale to prevent explosions of gunpowder, as were employed by Sir Humphrey Davy to avoid explosions of fire damp. In each case the protection depends upon the suitable use of gauze wire, and in each case protection is obtained by dividing the explosive material and preventing it from burning or exploding in a mass.

Without going very deeply into the atomic theory we may safely assume that practically there is nothing so small, but that there may be something smaller.

Mr. Gale has availed himself of this fact. There are no grains of gunpowder so small that a smaller grain may not be found which can be easily mixed with and readily separated from the grains of gunpowder. The more thoroughly Mr. Gale investigated this principle the more applicable did he find it to be, and it is now well known that the mixture of a fine non-explosive non-combustible powder with gunpowder will not only prevent it from exploding, but will actually prevent it from burning. It has, moreover, been ascertained that when properly prepared this protecting powder can be instantaneously and completely separated from the gunpowder which is thus restored to its original explosive condition.

When Mr. Gale did me the honour to consult me on the subject I had the good fortune immediately to perceive its great importance and utility, and since that time Mr. Gale and I have been jointly devoting our energies to the development of the principle; I, therefore, stand before you as an interested person, whose statements ought to be received with all due caution. I have, however, yet to learn that a person who is interested is necessarily prejudiced. Who can have more occasion than I have to look carefully on all sides of this question? Any reasonable man entering upon any undertaking naturally looks most carefully at the obstacles and difficulties he will have to encounter, and certainly I would not lend a hand to this or any other work unless I felt confident that well directed efforts would ensure its success, which, if the theory is inherently bad, can never be obtained. We have now the assistance of an experienced Board of Directors, every one of whom has entered upon the undertaking after a careful consideration of its actual merits.

We have certainly no reason to complain of the manner in which the invention has been received either by the Government or the public. Our first experiments were made at Plymouth before Viscount Templetown, Commander of the Western District, Sir Charles Fremantle, and other distinguished officers, who expressed their approval of the invention in a most decided manner. We afterwards attended at the War Office and the Admiralty. The Duke of Somerset and the Earl de Grey witnessed the experiments with much interest, and the Minister of War immediately referred the matter to the Ordnance Committee. The Ordnance Committee gave us an early audience, and have instituted a series of experiments, upon which at some future time a report will probably appear. As they have not informed us of any difficulties in the application of the invention, we may fairly assume that no difficulties have occurred which they have been unable to overcome. His Grace the Duke of Cambridge manifested a very lively interest in the experiments, and appeared to be especially struck with the advantage which must result from the protecting powder preserving the gunpowder from damp.

With regard to measures of a more practical nature, but little time has been lost. It is only a few months since the invention was made known, and already a Company has been formed for carrying it out, and measures have been adopted for preparing the protecting powder, and supplying the public with protected gunpowder.

This rapid progress has been owing not so much to any special energy on the part of individuals as to the eminently practical and advantageous character of the invention. It is rarely that the employment of one simple means produces such striking and manifold results. The chief difficulties to be encountered in the carriage and storage of gunpowder are its liability to danger, damp, and dust. These three words describe the three evils by which the carriage and storage of gunpowder are surrounded. Mr. Gale's process meets them all in one operation. It completely annihilates danger by making the gunpowder not only inexplusive but actually incombustible.

As a proof of this the President will perhaps allow me to put a fuze into a bowl of protected gunpowder. [This was done, and the result was that a few sparks only were visible. Some of the protected powder was then separated, and a small quantity of neat gunpowder exploded on the top of the protected powder which remained in the bowl. The neat powder exploded with the usual smartness, and the protected powder was undisturbed.]

The efforts which are constantly made to keep our powder dry are constantly frustrated by the circumstance that the atmosphere penetrates the contents of a barrel and finds its way to every grain, and the powder attracting the moisture of the air, quickly becomes unfit for use. This action of the atmosphere is prevented by the fineness of the protecting powder which entirely excludes the air and keeps the powder in its original condition. If a barrel or a bag of protected gunpowder fall into water, it would not be damaged beyond a mere outside coating.

If gunpowder is packed close in the barrels in which it is placed the grains will adhere to each other, and there is a danger of the whole becoming a solid mass. To obviate this danger, the barrels are only partially filled, and thus when moved, the powder is shaken and the grains are kept from adhering to each other. But this shifting of the gunpowder involves another difficulty. The attrition of the grains causes particles to rub off and the powder is thus made dusty, and rendered unfit for use, for if gunpowder was used in this state, the results would be uncertain, and no kind of practice could be relied upon. When gunpowder is mixed with the protecting material, it can be tightly packed, and thus all friction in the barrel is avoided, and no dust is made.

It is desirable to form some estimate of the value of this protection and to ascertain as far as possible what is the extent of the evils connected with the present system of treating gunpowder, and which would be obviated by Mr. Gale's process. What, for instance, is the extent of the *danger* to which we are now exposed by unprotected gunpowder. We know the number of lives that are lost in various dangerous occupations. We know that a certain number of persons are killed annually in the streets of London. We know that so many lives are lost annually from shipwreck—so many in coal-mining and other dangerous occupations. It will perhaps be surprising to some persons to learn that during the last ten years, three times the number of lives have been lost by explosions of gunpowder that were lost in

that deplorable accident, which has cast a gloom over the whole country, the foundering of the "London." It appears that the accidents from explosions of gunpowder have been regarded as so inevitable that no pains have been taken even to record them. But from a partial inspection of the columns of the public journals during the last ten years, we find that during that period, the loss of no less than seven hundred persons has been recorded.

It may be interesting to trace some of the most remarkable of these accidents.

The explosion of the siege train at Inkermann was the occasion which called Mr. Gale's particular attention to the desirability of protecting gunpowder:—

"It took place in what was technically known as the park, an enclosure about a hundred yards long by fifty deep, and surrounded by a stone wall which separated it on one side from the English siege train. It contained amongst other immense quantities of warlike material, 100,000 lbs. of gunpowder, and was extensively covered with the huts of the officers' quarters. Some French artillerymen were engaged in shifting powder from case to case, and every care was, as usual, taken to prevent accidents. As one of the soldiers was pouring the powder out of a case, he perceived a fragment of shell gliding out of it into the funnel, and, not wishing to let it get into the other case, he jerked the funnel on one side. The piece of shell at once fell upon the stones, which were covered with loose powder, and this is supposed to have struck fire in its fall, for the explosion took place at once. The French had six officers killed and thirteen wounded; sixty-five of their men, mostly of the artillery corps, were killed, and 170 were wounded. The English loss was one officer and twenty non-commissioned officers and men killed, and four officers and 112 non-commissioned officers and men wounded. In the Land Transport Corps of the English Light Division, fourteen horses were killed and seventeen were wounded. The destruction in money value of articles appertaining to the siege train was enormous."

The foregoing is an illustration of the effects of an explosion in time of war. We will now give an illustration of an explosion in time of peace, which took place in the town of Salonica in Turkey:—

"About nine o'clock in the evening of Friday the 11th of July, 1856, a great fire broke out in a Turkish inn, in the Frank quarter of the town, which speedily extended over the houses in the vicinity. The fire was after a time got under, and the people, who had gathered in the streets and thronged the hippodrome, were preparing to retire, when all of a sudden a fearful explosion shook the city from the Seven Towers to the Vardar Gate. It appeared that one John Schlizzi had secreted in his house about 200 barrels of contraband gunpowder, and this exploding destroyed two-thirds of the buildings in the town, shook down the boundary walls, and caused the conflagration, which had been so nearly extinguished, to extend to the newly-built warehouses without the city gates. More than a hundred lives were lost, and the destruction of property represented

"a value of a hundred millions of piastres, or more than a million sterling."

The next disaster of any importance was that which caused a sacrifice of twenty-five lives in the Federal fortress of Mayence. "About three o'clock on the afternoon of the 18th of November, 1857, while the soldiers were at drill in the citadel, the magazine blew up with a shock that was felt at Wiesbaden, on the other side of the Rhine. Two Austrian and nine Prussian soldiers, with fourteen civilians were killed, while seventy-four Prussian and ninety-four Austrian soldiers, with 300 civilians, were more or less dangerously wounded. The loss of property amounted to more than a million florins (£100,000).

"By far the most destructive explosion which has visited the British Isles for a long number of years was that which characterised the blowing up of the magazines at Erith, on the morning of Saturday, the 1st of October, 1864. Although the scene of the catastrophe was fifteen miles from Charing Cross, the shock was heard and felt throughout the Metropolis, and in many cases it was experienced forty or fifty miles from Erith.

"At Erith and at Belvedere, where the shock was most felt, the feeling produced was described as having been awful, beyond description. An immense pillar of smoke rose from the plain, ascending high in the air thick, black, and palpable, with a top like unto the huge spreading foliage of a monster tree. A quarter of an hour elapsed before it died away. Of the magazines, not a single stone remained one upon another, the very foundations were torn up, and the sites marked by vast fissures and chasms in the earth, enormous lumps of which had been scooped out and hurled about the adjacent fields, and an enormous rent was made in the embankment itself, exposing many miles of the country to the perils of an inundation. The chasm was a hundred yards in width, but fortunately it was dead low water at the time, and during the few hours which were available, a host of sappers and miners from Woolwich arsenal, assisted by a number of navvies, succeeded in repairing the breach with sufficient strength to resist the force of the advancing tide. The cause of the calamity is said to have been 'beyond even the reach of conjecture.' The damage done at Woolwich and at Erith was enormous, and altogether represented a sum of £200,000. Ten lives were lost through this terrible calamity."

The quantity of gunpowder exploded was 104,000 lbs.

The unfortunate sufferers by the explosion at Erith find that they have no remedy against the owners of the magazines which caused the destruction of their property. Fortunately most of the land in that neighbourhood belongs to wealthy persons who can bear a loss without personal suffering, but there are some very sad instances where poor persons with a little property have suffered severely from its destruction. The losses to the wealthy proprietors has been prodigious. On one estate the glazier's bill alone amounted to over £2,000. One large source of loss is the depreciation of the value of building sites in the neighbourhood, and it may be imagined that few

persons would like to build within sight of a gunpowder magazine after the experience of the Erith catastrophe.

We next come to an explosion at sea :—

"The Bombay was a screw steam-vessel, carrying 67 guns, and with a tonnage of 2,782. On the morning of the 14th December, 1864, the Bombay left the anchorage at Monte Video under sail. She had proceeded only a very few miles out to sea, and the men had only placed one target for practice, when fire was reported to have broken out in the after part of the vessel, and such was the uncontrollable rapidity with which the flames enveloped the vessel, that in twenty minutes it was seen that the boats must be got out. The sick having been successfully lowered, a number of the crew—altogether about six-sevenths—proceeded to follow, when the main-mast fell, and left the rest to find their own resources of escape from the blazing ship. Clinging to ropes and holding on to spars, there might have been a chance of succour, but for the fatal rapidity of the flames, which in a comparatively short time reached the magazine. On this blowing up the 'Bombay' sank in eight fathoms of water, and ninety-one of her crew were drowned."

It would have been surprising if the American war furnished no illustrations of the danger of unprotected gunpowder. One explosion to which I shall refer is truly American in its magnitude.

"It would appear that on the evening of the 24th of May last, while the ammunition was being removed from the Confederate magazine in Mobile, which had just been surrendered to the Federal forces, the ordnance stores, which were situated in the business centre of Mobile, blew up with a terrific explosion. Three hundred persons are said to have been killed, many wounded, and, according to the chronicler, thousands were buried in the ruins. Eight entire squares of the city were demolished, 8,000 bales of cotton destroyed, and the steamers 'Colonel Cowles' and 'Kate Dale,' which were lying at the pier, immediately sank with all on board. The value of the property destroyed was variously estimated at from \$3,000,000 to \$8,000,000. The cause of the explosion was unknown."

Tremendous as the explosions have been, to which reference has been made, we have reason to be thankful that we have not to refer to explosions of a still more terrific character. If the explosion which took place on the south side of the Thames had taken place on the north side, and if Purfleet instead of Erith, had been the scene of the disaster it is impossible to estimate what the extent of the calamity would have been. We know not and we can scarcely calculate what would be consequence if ten or twenty times the quantity which exploded at Erith was to be fired at Purfleet, and yet within a comparatively short distance of London many hundred tons of gunpowder are stored, and if an accident should happen there it would be destructive beyond all precedent.

Without becoming alarmists or prophets of evil we cannot but see that our modern ships of war are particularly well adapted to act as huge bomb-shells calculated to scatter destruction all round if an accident should happen in the magazine. The iron plates which are

bolted on to the ships' sides would fly off in all directions, and in their flight would not discriminate between friend and foe, but overwhelm with destruction whatever came in their way.

It is not, however, from extraordinary explosions like these that the chief danger and inconvenience arise to the public, but rather from smaller explosions which are of more frequent occurrence.

In the autumn of every year we hear of numerous explosions on the premises of fire-work manufacturers; it is the stock of unprotected gunpowder contained on these premises which renders them so dangerous. Nothing can be easier than to protect the gunpowder required for use by fire-work makers, as it would be perfectly easy to arrange a small machine which would separate the protected powder, and, at the same time, reduce it to the degree of fineness which the makers require. The losses arising from actual explosions represent but a small portion of the total loss and expense occasioned by the dangerous character of gunpowder. It is the care and expense necessarily bestowed upon the gunpowder for the prevention of accidents that furnishes the chief cost arising from its dangerous character. Hence the carriage of gunpowder is from three to six fold the cost of the carriage of other articles of commerce. If a ship takes but a small quantity of gunpowder, her rates of insurance are largely increased. The same increased insurance takes place on land, and if a man takes out a licence for keeping only 200 lbs. of gunpowder, the premium on the insurance of his whole premises will be greatly increased. The difficulties connected with the storage and transport of gunpowder are known only to those who are engaged in the business. A manufacturer who ships a considerable quantity of gunpowder stated that two pounds per ton would not pay him for the inconvenience and expense occasioned by the necessary regulations which are now imposed on the movement of gunpowder as compared with other articles of commerce. The same gentleman stated that, during the period in which he had been engaged in the business, his firm had lost, on an average, one powder-vessel annually, which had been lost without anything having been heard of it.

The difficulties and cost imposed on the regular shipment of powder causes a large clandestine trade to be done in the article, and it is not an uncommon thing for vessels to receive gunpowder on board under a different name, and in many cases shipments of it are made after the vessel has cleared out of port, and nothing of the kind appears on the ship's manifest.

The only way by which gunpowder can be carried cheaply is by shipping it in very large quantities on board of one vessel, the owners of which are tempted by means of increased freight to incur the risk. As far as the ship is concerned the risk is much the same whether the quantity of gunpowder put on board be large or small, but these large quantities expose the public to a terrible and unnecessary danger. As much as 400 tons of gunpowder have been put on board one vessel in the Thames, and when we remember that this is eight times the quantity which caused such destruction at Erith, we may well ask for some protection against such a dangerous neighbour as such a ship

must be. The "Lotty Sleigh" caused consternation throughout Liverpool by the explosion of 12 tons of gunpowder; what would have been the consequence if a vessel containing thirty times that quantity had exploded?

In addition to the losses by accident and the cost of precautions, must be added the anxiety and consequent suffering which the traffic in gunpowder occasions.

A shipowner, who was formerly a captain, informed me that on one occasion he took on board 20 tons of gunpowder, and during a voyage of three weeks he suffered so much from anxiety, that he determined never again to ship that article. The inhabitants of Liverpool, Edinburgh, Southampton, and other places, have recently expressed their anxiety as to the storage of gunpowder, and now that it is shown that perfect safety can be obtained, the public will scarcely be satisfied to remain in a state of danger.

The other evils which are removed by Mr. Gale's process, viz., the liability of gunpowder to damp and dust are less conspicuous than the dangerous character of the material, but they are scarcely less important. Gunpowder must be granulated. If it were reduced to impalpable powder or dust its action would be greatly impaired. In a state of granulation, air passes readily through the mass, and, as it carries more or less moisture, this moisture is imparted to the gunpowder. Unfortunately, different parts of a barrel of gunpowder will be differently affected by this action of the atmosphere, and the consequence is that in use it gives different results. A slight change will make much variation in the effect produced by gunpowder, and hence the importance of keeping it uniform. When packed in Mr. Gale's protecting powder, the atmosphere cannot affect it, as the powder is so extremely fine that air cannot penetrate. Mr. Gale's protecting powder is passed through a gauze-wire with 14,500 holes to the square inch; this will convey some idea of the fineness of the material. The effects produced by the powder becoming dusty from shaking; are much the same as those caused by damp—in both cases the results from the use of the powder are rendered uncertain.

The Government have constantly to sell large quantities of powder which have become damp or dusty, and after all the care that is bestowed on the matter, it is to be feared that powder is often supplied for use in very imperfect condition.

The transit of powder necessarily makes it dusty, and under these circumstances, the further the powder is used from the original source of supply, the more likely it is to become dusty, and, therefore, uncertain in its results. On this point I may appeal to the evidence of Colonel Vigley, who appears to have given much attention to the subject of gunpowder in India. He states:—"The great loss experienced when gunpowder is transported, especially over the rude tracts in some parts of India, causes it to be ground down to fine dust at the bottom of each barrel, and thus creates a very considerable waste and loss, which is greatly aided by the custom of allowing 20 per cent. of space in each barrel to permit the powder to be

"shaken, and thereby to preserve the gunpowder from caking by damp, which commonly occurs when packed in the ordinary way in barrels."

It would be altogether beyond precedent if Mr. Gale's invention had passed unchallenged; and if other claimants for the honour of the discovery had not arisen, we might almost suppose that the discovery was of little importance. A writer in the *Times*, who signs himself "V. D. M.," and dates from Woolwich, is anxious to claim for Monsieur Piobert, a Frenchman, the merit of anticipating Mr. Gale. It appears that Monsieur Piobert made experiments with the view, as expressed by "V. D. M.," of "depriving the gunpowder of its dangerously explosive character," and he recommended that one part of powdered saltpetre should be mixed with two parts of gunpowder. It would be scarcely fair to experiment with the prescriptions of others, but if I were to mix one part of saltpetre with two parts of gunpowder I should certainly ask the ladies to retire before applying a fusee. An application which leaves gunpowder in a highly combustible state does not appear to possess much value. If a few tons of gunpowder in this state were to be fired on board a ship, the total and rapid destruction of the vessel would be inevitable, for the fire could not be checked. Monsieur Piobert's own estimate is, that gunpowder in this state may be reduced in combustibility to the condition of mill-cake, the explosion of which is a constant source of accident in powder-mills. Monsieur Fadereff, who pursued similar experiments at a later date, relates, as the triumph of his process, that a barrel of gunpowder so prepared by him took 71 seconds to burn, the flame was six feet high, and, although it did not amount in the open air to an explosion, it is clear that such powder confined in a ship or building would cause a very serious explosion, and prove destructive to all around it.

About four months after Mr. Gale's invention was announced to the world, Lieut.-Colonel J. S. G. Riley, late of the Royal Cavalry, appears in print, and states that for many years he has been endeavouring to do what Mr. Gale has done. It seems that in December, 1864, he informed the War Office "that gunpowder, when stored agreeably to his plan, instead of exploding en masse in the usual manner it would merely burn like a squib." The reply he received was, "that the plan had been duly considered, but that it was not found to possess sufficient advantage to warrant its adoption," and he now appears to feel injured because a different reception has been given to Mr. Gale's invention.

Colonel Riley's proposition, as given in his own words, is essentially different to Mr. Gale's. It is easy to see that a plan for storage which would leave the gunpowder to burn like a squib, gives no assurance of safety, and cannot be said to be a protection. Mr. Gale does not allow his powder to go off like a squib, or to go off at all. He is not satisfied until the powder is absolutely protected, not only from any approach to explosion, but also from combustion. Mr. Gale's protected gunpowder will not burn, and if a store containing his protected powder was destroyed by fire, it would be impossible to burn the gunpowder,

the greater portion of which would remain untouched either by the fire or the water which might be poured in to put out the fire.

The course adopted by Mr. Gale in announcing his invention was such as to enable Colonel Riley, if he pleased, to test his claim for priority of invention. Unlike most other inventors, who wait until their patent is fully completed before announcing it to the public, Mr. Gale published his discovery far and wide the moment that he had taken the preliminary steps for receiving a patent, and it was therefore open to Colonel Riley or any other person to claim priority, and their claim would be at once investigated and decided without the usual tediousness and costliness of legal proceedings. Colonel Riley appealed neither to the Patent Office nor to the public. Mr. Gale did both, and both have acknowledged his claim.

In conclusion it will be desirable to notice some of the objections which have been made to Mr. Gale's plan.

The first and most obvious objection is the increase of bulk, but as this does not involve increased cost, the objection is not a very serious one. The charge for the carriage of gunpowder is usually about six-fold that of ordinary merchandize, and protected gunpowder can therefore be conveyed at a less cost than unprotected, for with the element of danger removed, the charge for carriage will be reduced to ordinary rates, and where the carriage of one ton of gunpowder now costs say £6, the carriage of one ton of gunpowder and three tons of protecting powder will cost £4. The cost of storage is in like manner reduced. Under the present system expensive magazines must be constructed in out of the way places, but let the powder be properly protected, and it can be placed in ordinary warehouses in convenient localities.

The supposition that the gunpowder would separate from the protecting powder in transit has been repeatedly urged as an objection to Mr. Gale's process. This objection is purely imaginary. It is of course very easy to take a bowl of the protected powder, and, by giving it a peculiar motion, some of the grains may be brought to the top, but the question arises is such a motion given to the powder in actual transit, and experience answers in the negative. We have sent protected powder to all parts of England, to France, and to America, without the slightest symptoms of separation being discoverable. Mr. Cossham, who took out some protected powder and introduced the process to the American Government, thus writes on the question of transit:—

"Hill House, near Bristol, Oct. 27th, 1865.

"Dear Sirs,—I am happy to be in a position to answer most satisfactorily your inquiries as to the effect of transit on gunpowder mixed with your protecting powder. You will remember that on the 25th of August you placed under my care a box filled with the mixture. I took charge of it at Liverpool, and had it placed in the hold of the 'Scotia,' where it was subjected to all the rolling and tossing of over 3,000 miles of sea voyage. At New York it was tumbled about in a most unceremonious way, and subjected to the test of a very rough ride through the streets of New York in a cart without springs. I then took it with me for some thousand miles by railway in the States, the roughness of transit over which I can only compare to being drawn over a saw the wrong way; and at the end of the journey I found the mixture as perfect and the powder as completely protected as it was the day I left England. I have no hesitation, therefore, in bearing my unqualified testimony to the

fact that gunpowder mixed with your protecting powder will bear any amount of carriage without danger or risk.

"I am, my dear Sirs, very truly yours,
"HANDEL COSSHAM.

"To Messrs. Gale and Saunders."

Experience is the safest ground on which to rely, and with the experience we have gained we might safely undertake to send powder anywhere without danger of separation, but still it is interesting and useful to know why it is that the apprehended separation does not take place. In the first place there is no special tendency to separate, as both the gunpowder and the protecting powder are of the same specific gravity. In the next place no separation can occur without an extension of the bulk, and if no room is allowed for expansion the powders cannot separate. A small experiment will illustrate this. [The lecturer here filled a measure with protected gunpowder, which was then separated, and it was found that when separate the protecting material and the gunpowder much more than filled the measure.]

In barrels properly packed it is clear that the powder cannot separate. If, however, it is contended that in the shaking-by carriage the powder will become more compact, and thus leave room for separation, it is obvious that this danger might be prevented by putting false heads to the barrels, so that if the powder was reduced in bulk, the false head would fall down on the powder and prevent it from separating. A still simpler plan is to put the powder in bags instead of barrels. Even if the bag was only partially filled, the weight of the bag resting on the powder would prevent it from separating.

One more objection may be referred to, although it is scarcely worthy of notice. It is said that the grit of the protecting powder is dangerous and injurious to the gunpowder. Any one who will take the trouble to feel the powder which we have here will at once see the folly of this objection. Powder which has passed through a sieve with 14,500 holes to an inch, is not likely to be gritty.

The necessity for sifting the gunpowder I look upon as far from being an objection. The fact is, that gunpowder, whether protected or not, ought always to be sifted immediately before being used, in order that the dust may be taken away, and any tendency to adhesion of the grains may be removed. If this was always done the results of rifle and other practice would be more uniform.

Any further objections which may be noticed in course of the evening I shall, by permission of the President, have pleasure in replying to at the close of the discussion.

The CHAIRMAN: There are several gentlemen who have heard this lecture with great interest, who are desirous that explanations should be given as to what the character of the protecting powder simply is, and they would also be glad to see any experiments that the lecturer may be induced to give.

Mr. SAUNDERS: This protecting powder is a mixture of powders, as we have found by experiment (one powder contains one quality, and another another) that a mixture of powders is very much better than any one simple powder. The quality required is that it should be dry, having no tendency to damp; that it should absorb moisture; that it should be non-adhesive, and that it should be non-combustible.

The CHAIRMAN: Can you not give us more information, because you are protected by patent.

Mr. SAUNDERS: There is no secret in it. We use a great variety of mixtures. For instance, glass powder is a very good protector. Glass powder and ivory black form also a very good protector. But we should use a variety of powders according to what we require. For blasting powder we should use a very simple and cheap protector. For sporting powder, of course, it would be very important to have the most perfect protector that we can have, a powder that would come off from the gunpowder as easily as possible; and also that would leave the gunpowder without change of colour; because, although that might not be of great importance practically, yet it would be of great importance as far as the prejudices of the sportsman are concerned.

Mr. STERLING LACON: The efficiency depends upon the fineness of it?

Mr. SAUNDERS: A good many qualities are required in the protecting powder, which we find out by practice. Mr. Gale has a remarkably fine touch, and directly he passes his fingers into the powder, he can tell in a moment whether it is a good protecting powder or not. But I can scarcely tell you what those qualities really are. We have found them out by practice.

A MEMBER: Cannot you tell us what those powders are composed of?

Mr. SAUNDERS: This mixture is composed of glass powder and ivory black. But we do not limit ourselves to that or any other mixture.

A MEMBER: In the course of your remarks regarding the accident during the process of moving the powder at Inkerman, you said that some foreign substance had got into it, by means of which this explosion took place. Is it not possible for such a thing to happen on board ship, unless the men are very careful? Looking at the manner in which sailors, who we know are not celebrated for their carefulness, handle things, might not something in the nature of a foreign subject get into the sieve while they are sifting, and cause an explosion which might be as tremendous? For as you observed, a small quantity will do as great an injury as a large one in blowing up a ship. Might not that danger occur? and have you any means to guard against it?

Mr. SAUNDERS: I am glad you have asked the question, because it gives me the opportunity of saying that this sieve is copper, consequently the powder coming into contact with it would not explode.

The CHAIRMAN: Perhaps it would be better to wait and answer all the questions at once.

A MEMBER: Will you be good enough to fire some powder in a protected and some in an unprotected state, that we may see what will happen?

A MEMBER: Would you state the cost of a ton of protected powder, and its liability to waste from being so fine and light? Judging from what we have seen of its being passed through the sieve just now. What would be the cost, and what would be the weight, by reason of the operation of sifting?

Captain SELWYN, R.N.: Mr. Chairman, however, we may doubt a little of the value of a process for making that which we only think of as an explosive compound, in explosive, we cannot doubt, I think, the extreme fluency and command of language with which the lecturer has put the subject before us. But although he has carried us from the explosions of magazines to the use of wet blankets, yet I do not see that he has given us any reason to spare him as naval and military men, whose opinion he solicited in the opening of his paper. He comes before this Institution knowing that it is principally, if not entirely, composed of members of those two professions; and that they estimate the paper entirely from their own point of view. If he seeks that we should express our opinion as to how far the process may be a valuable one in the storage of gunpowder on shore in large quantities in magazines, then we shall also want to know what are the dangers from explosion now existing? how far they may be eliminated without the use of any such mixture? how far the question of increased contents, increased bulk, and everything of that kind will influence the process? even if we do not go a step further, and ask what is the point at which you begin to bring back your compound into an explosive state? Do you do so when it leaves the magazine? do you do so when it gets into the

expense magazine? or, at what point, in short, between the gun and the manufactured powder do you begin to render it again an explosive compound, which it must evidently be at last? Now, with regard to the elimination of danger from magazines on shore, it is a remarkable fact, and one which I have had the opportunity of observing, that if a ship explodes at sea, almost invariably the effect of the explosion is confined to an upward direction. I do not see my friend, Sir Edward Belcher, here to-night; if he had been here he would have told you that I, as he says, attempted to blow him up in China. He had given me orders to set fire to a junk which had been taken, and he is an officer who likes his orders to be carried out promptly. He was at the mast-head with his sextant, and by the time he came down, and we had got a boat's length off the junk, she exploded. The incompressibility of the water generally determines the force of the explosion in an upward direction. Now, to a certain extent, that is also the case on shore. And if it were the practice to bury magazines to a certain depth underground, to carry them below the level of the ground, we should then find the total result to be confined to the crateral action of the gunpowder, and that the results would be expended in that direction without influencing the surrounding buildings very materially. The question of how far it might be desirable to rely on this compound in action is, I think, one which can only be fairly attacked by naval and military men, as the lecturer has indeed observed. We cannot, in considering the question, entirely forget that Mr. Gale has proposed to mix a very large proportion, 3 to 1, I think was the mixture of the compound substance, which is not in any degree conducive to the effects which we seek, of giving us projectile force. He forgets that although comparing the rate of freights and insurance on unprotected with the case of protected gunpowder, he may be able to show no increase whatever in the cost of transit; yet, that when he has to take, as in the Crimea, through a sort of Slough of Despond, a number of artillery waggons loaded with powder up to the front, the question of weight to be carried is very considerable; that in a ship the magazine occupies a certain space, and that we cannot afford to treble the space occupied by our powder; that in the hurry of a night action it is utterly impossible to suppose that we could stay to sift our charges before putting them into the cartridges. It is true that a certain proportion of cartridges are filled and are ready for action; but if the action is prolonged, necessarily a certain number of men are there filling the cartridges into the flannel bags, and if they are to stay to sift the powder, I am afraid one man will sift a charge with a certain proportion in it, and another man with another proportion in it, that, then, our ranges will be found to be utterly unreliable, and often for doing what we require, our guns will disappoint us. If it were an action with a fortress where mortar fire is required, then everything would depend upon the certainty of our range with given charges of powder. It follows that the slightest difference in the quantity of powder left among the sifted charges would produce a serious difference in the range, which at night we should be utterly unable to rely upon. We cannot see where the shell falls. We only know we have put in a certain charge, and laid the gun at a certain elevation, and that this ought to produce a certain effect. Those are practical objections which I am sure Mr. Gale will be obliged to officers of the two services for bringing forward. These are things which make us hesitate before we adopt anything, however beautiful it may seem. Although we have had some harrowing descriptions given of the effect of explosions, yet I do not consider that the proportion of explosions to the amount of powder stored, justifies us in saying that we are ready to sacrifice so large a proportion of efficiency for the sake of the elimination of that danger. I think it may be done in other ways. I think if even it is not to be done in other ways, that we soldiers and sailors will say, "Well, give us something that will do our work well and quickly," and we will consent to stay in danger, and to sleep over it, as we hitherto have done, who have been on board ship night after night, without ever thinking whether there were ten tons or one ton of gunpowder underneath us.

A MEMBER: I should like to ask the lecturer the price of the protecting powder with regard to transport. If you had to transport four tons of gunpowder you would have to add to the cost the expense of taking the three tons of protecting powder back?

A MEMBER: I think the lecturer said, if a building were set on fire, the protected powder would neither be exploded nor burnt; nor would it be damaged by the water that would put out the fire. I cannot understand that.

Major LEAHY, R.E.: Without detracting in any way from the merits of the invention by which the explosive character of gunpowder may be diminished by mixing it with a non-explosive material. I think there is one point upon which the lecturer has laid stress that he should be asked to explain. It is this, with reference to the accident in the siege train in the Crimea, to which he alluded; he referred that accident to the fact of the powder having been manipulated, and he claimed for this invention, mixing it with non-explosive material, a total absence from danger on that score. It appears however that you cannot use this protected powder without going through the process of manipulation, sifting it from the non-explosive material, and that the danger, with regard to the explosion of powder, arises more from the manipulation than the storage of the powder. You must go through this process of manipulation to get the service powder, and it has been already pointed out by previous speakers that it is very hard to draw the line at which you are to protect the powder and where the non-protected powder is to be used; and the lecturer has admitted that a small quantity of non-protected powder will do all the damage that a large quantity would. There is another point with regard to the explosion of the small arm ammunition in the catastrophe in the Crimea. I think it will be found that the small arm ammunition did not explode; but that the cartridges burned without exploding. Gunpowder, when it is divided into cartridges, the particles being separated by a non-explosive material, will not explode, but burn. I have seen a quantity burning like a bonfire.

Captain SELWYN: Permit me to add one other observation, which is, that occasionally, like Captain Wake, we want to blow up our ships or our forts; and then we want a sufficient quantity, to do it well.

Captain BURGESS: I should like to ask whether any experiment has been made to ascertain that gunpowder, after it has been mixed with the compound, is as strong as it was before?

Mr. DILLON: I should like to ask how Mr. Saunders, when he mixes the powder, insures that it shall be perfectly mixed, and the grains of gunpowder perfectly separated, because when it is thrown into a barrel a great portion of the gunpowder might remain together without any portion of his protecting powder going near it.

The CHAIRMAN: I think every one has made the observations he desires to make, and that the meeting would be served by Mr. Saunders replying to those observations.

Mr. SAUNDERS: I have a very interesting list of questions to reply to, and I have much pleasure in replying to them. The first observation was with respect to the nature of sifting; and in relation to that it was also mentioned that a small quantity of powder exploding did as much harm as a large one. With regard to the present manipulation of powder, I believe it will be found that it would often be necessary to shift the powder from one barrel to another in order to preserve it from caking, and to keep it in proper condition. Of course, with Mr. Gale's process, that would have to be done once only, and that is as soon as possible before it is actually used; and when I said there was as much danger in a small quantity exploding as a large quantity, I meant that a few tons exploding was as dangerous to a vessel or a house as a hundred tons. I did not mean that a few pounds, which it is alone necessary to expose when this process is used, would be as dangerous as a few tons which must be kept under ordinary circumstances. With Mr. Gale's process it is necessary to sift the powder immediately before requiring it for use. Mr. Bidder's estimate is that two men, who might be the most common labourers you could imagine, would supply powder as fast as it could be required for a 100-gun ship. The process of separating is exclusively mechanical. It cannot be done wrong; it is so very simple that it is impossible to make any mistake about it, and the labour would be of the cheapest character. Surely, if two men can supply powder as fast as it can be required to keep 100 guns at work, I think, under any circumstances, they might be spared for the purpose. With respect to the cost of this protecting material, the

would vary much with the kind of powder which you have to protect. For blasting powder I expect that the protecting material would cost about twenty shillings per ton. Probably, for Government powder, a more costly material would be used, but that would be entirely for the Government to determine. A powder which would protect the gunpowder with certainty can be supplied for thirty shillings per ton, but it is very probable that a higher priced powder would be better. Some gentleman has observed that to the cost of the protecting power has to be added the cost of the carriage back. He forgets that if you bring the powder back your second supply would only cost the cost of the carriage back. With regard to the point at which we make the powder re-explosive, that, as I said before, is a question more for military men to determine than for me; but from the little experience which I have had with gunpowder, I am strongly of opinion that gunpowder ought to be sifted immediately before it is used, because it is liable to cake and get damn which causes have produced a great variation in the results under present circumstances, unless the powder is sifted just before it is used. I have no doubt that powder in cartridges does quickly alter its character. It may become caked or slightly dusty, in which case the character of the powder would be materially altered; therefore, I think the proper process would be to fill your cartridges as late as they can possibly be filled previous to action, and the powder kept in a protected state up to that time. With regard to the taking of the powder through the Slough of Despond, and the weight, and so on, which is added to it under these circumstances, I believe you will find that almost under any circumstances it is easier and cheaper to carry three or four tons of a material which is not dangerous than to carry one ton of material which is dangerous. I had a striking illustration of that a short time ago. A gentleman connected with the mines at Mexico came to us and said he was anxious to get our protecting powder. They had to take blasting powder over mountains on the backs of men, and with these men they were obliged to send an escort to see that they took the greatest possible care of it; yet, for all that, he said, "They blow up themselves, and blow up the gunpowder to such an extent that we lose a very large portion of it before it gets to the mines." Therefore, he said, he would far rather have our powder, which is four times as heavy to carry, than he would have the unprotected neat powder. That strikes me as a practical reply to the question as to the carriage of gunpowder through the Slough of Despond, which was referred to just now. Then, with regard to the space occupied by powder. Of course, on board ship that is extremely important; but my impression is that no increased space whatever would be required. At the present time you have to provide magazines with very thick walls; you have to give 20 per cent. space in your barrels; you have to allow a great deal of room for your barrels; you have to divide, and all the rest of it; and you are limited to one part of the ship to keep it in. You might dispense with your thick walls; you may put the powder in any part of the ship most convenient; and under these circumstances I do not believe you would require an inch more space than you do now. You would have more dead weight, which is decidedly an objection. But the question is whether the advantages overbalance that objection. Then with regard to the irregular sifting which was referred to, it is impossible for the sifting to be irregular. In practice probably a series of sieves would be arranged, to be worked by a handle, and the protected powder would be shovelled in at the top, and the two kinds of powder would come out completely separated at the bottom,—so that the workmen would have no chance of making any mistake, or any irregularity in the result. I think the remarks I made at the opening of the lecture were sufficient to show that I never contemplated the sacrifice of efficiency for the elimination of a small danger. I am quite aware that a military man would never allow that for a moment; but it does strike me that both on land and sea it would be a great relief if it could be known that if an enemy's shot or shell came into a magazine it could not do any harm to the gunpowder. If a red-hot shell were fired into the midst of this protecting powder it would do no harm whatever. Another question asked was—how is it that the powder would not be damaged by water? Why, the water runs off this protecting powder the same as it runs off a duck's back, consequently it would not penetrate it.

A MEMBER: Can you show us that by and bye?

Mr. SAUNDERS: We can show you this by putting this powder into a glass and pouring water over it.

The MEMBER: Can you put it into the sieve afterwards?

Mr. SAUNDERS: You have a slight film of wet on the top: remove that, and you, can afterwards sift it.

The MEMBER: You get your powder intact?

Mr. SAUNDERS: You get your powder intact; of course, Mr. Gale's plan is not adapted where an occasional blow up is required; still, a blow up can be had if required, so that I do not think we need apprehend any danger on that score. Half an hour would enable a couple of men to give you sufficient powder to blow up any ship. Here is the powder as strong as it was before? I think any one can see that the character of the powder cannot be altered by being mixed with another powder which is easily separated from it. This morning I bought a pound of Curtis and Harvey's powder, and mixed it with this protecting powder. It has been separated from it, and the powder is quite as clean as it was before it was mixed. It is obvious that the character of the powder remains unchanged: and, more than that, not only does the character of the powder remain unchanged, but the protecting powder prevents it from being changed. Powder is so liable to damp and dust that a barrel of powder filled this week would not be the same thing next week, it would not be uniform throughout. Lord Bury, when he gave his attention to the process, said he thought the great advantage was the preserving the uniformity of the powder, inasmuch as he found, constantly, that different results were obtained from different parts of the same barrel of gunpowder, as one part had been more exposed to the damp than another. Then, the question is asked, how is a perfect mixture guaranteed? I am glad that question is asked for it gives me the opportunity of explaining how the process of mixing is done. We take, say 40 lb. of gunpowder and 120 lb. of the protecting powder, and place it in a machine which may have come under the notice of some gentlemen present. It is a machine which is invented for the purpose of washing barrels, and it is very effective for that purpose. It turns the barrel in two directions at once. By putting these two powders into that machine, and by turning that machine, in a minute and a half the mixture is made in a most perfect manner. That is very easily tested, by mixing it in one barrel, then filling another barrel with the mixture, then divide that barrel into several parts and you see that you have the same proportions in every part of that barrel. The result in every case where we have made the trial has been perfectly satisfactory. Therefore, the mechanical difficulties of the mixing and the separation have been entirely overcome. With regard to the quality of the protecting powder used, I have no doubt that a good deal is to be learned on that score. It is possible we shall find out something better than we have yet on that point. It will be, of course, essential to use a powder which does not in any way affect the gunpowder, and which leaves it without deterioration in any respect. It is also very desirable to have the easiest possible separation; and although we have attained to a very great perfection in both those points, yet there is still, perhaps, room for improvement, and I dare say that improvement will be by practice obtained.

The CHAIRMAN: There are several gentlemen who would be glad to see some experiments.

Rear-Admiral Sir F. NICOLSON, Bart., C.B.: May I ask one question more upon what has just fallen from the lecturer? I am afraid he has been rather harassed by our questions. But I think if in his paper he had devoted his time a little more to the process, and to all the details which we have now heard from him, we should not perhaps have troubled him with so many questions. He stated, I think on the authority of Mr. Bidder, that two labouring men can supply 100 guns with the sifted powder. I wish to ask him whether he has any data on which that statement has been made? because I must say that, knowing the rapidity with which guns may be fired when necessary, I feel a little sceptical as to whether two men in action on board ship can supply 100 guns with the requisite powder.

Mr. SAUNDERS: Mr. Bidder is a remarkably quick calculator, and when the

question was put to him he said, after a rapid mental calculation—"100 guns!—two men could do that!" That is all I heard him say, and that is all I know about the matter. Still I have very great confidence on the result. Although I do not know the process entirely, still I think you may form something like an idea in your own minds by remembering how very simply and quickly men do separate by sifting. I daresay you have seen men in the streets separating gravel. One shovels it in and the other sifts it, and very soon a large heap is formed.

A MEMBER: How many cwt. of powder do these men separate in one minute?

MR. SAUNDERS: I did not hear the particulars.

MR. GALE: 1,200 lbs. I was present when Mr. Bidder spoke. He calculated that an old man of war carried 60 tons of gunpowder, and supposing the guns were fired off at the rate of 50 rounds in each minute, with a 12 lb. charge, it would take two men, with a little machine which we have, to supply the requisite amount of powder to fire off 50 guns in a minute on board ship.

A MEMBER: Suppose they fired 200 guns in a minute?

MR. GALE: A thing not achieved by any naval or military man here. Mr. Bidder said, from his calculation, it would not be necessary to go on firing at this rate; that you would not have 50 guns in a minute fired with 60 tons of gunpowder right through.

SIR F. NICOLSON: The question is how much can these two men sift in a minute, sift and separate in a minute, so as to be useful?

A MEMBER: Might not that depend very much on the means used? If you had a powerful machine you might sift a great deal more than by hand.

MR. SAUNDERS: It would depend very much upon arrangements such as the last speaker suggested. It would not be easy to give an answer off-hand. On board ship I take it the arrangements would be these: That the powder would be at the bottom of the ship; that an elevator would be provided to bring the powder from the bottom of the ship to the deck, or as near to the deck as it might be desirable to bring it for use; that the very same handle which shakes the sieves would turn this elevator and raise the powder from the bottom to the top of the vessel, separate and sift it at the same time. You might by the use of two, or four, or six, produce a flood of powder in that way, as fast as it could be possibly required. In fact, it would be as easy to bring up the powder and separate it, as it would be to bring it up only.

A MEMBER: Would you load the guns with loose powder?

MR. SAUNDERS: Of course you have to fill your shells.

THE MEMBER: No, the cartridges, how would you fill them? Would the two men do that?

MR. SAUNDERS: We are comparing the use of loose powder. This process does not profess to fill cartridges. If you have to fill cartridges under the present system, of course you would have to do it under Mr. Gale's system. The only question is as to a supply of neat powder.

SIR F. NICOLSON: May I say a few more words, if I am not too troublesome? We came here, most of us, naval and military officers, to hear a lecture that would have some sort of bearing upon the practical use that this powder is to be put to. Granted that this powder can be protected, what we are very anxious to know is, if it is not really troubling Mr. Saunders too much, how, having mixed his powder and made it safe, we are to use it in action? It is for that reason I asked my former question. Now Mr. Saunders seems to suppose that the powder is brought up loose, "in a flood," I think he said. Then the guns are to be fired with it. I will ask any gentleman here how is that to be done? The powder must necessarily be made into cartridges before it can be used. If Mr. Saunders will be kind enough to tell us by what process this powder, after it has been sifted, supposing Mr. Bidder's somewhat vague calculation is correct, is to be put into cartridges ready to be used in the gun, we shall be obliged to him.

MR. SAUNDERS: Do you do it by two men now? We have nothing to do with the filling of the cartridges. You want a supply of explosive powder, with a certain degree of rapidity. All that I can tell you is, that you can obtain that supply of explosive powder with any degree of rapidity which you may require. Of course,

if you have to fill cartridges under the present system, you will, also have to fill cartridges under Mr. Gale's system.

A MEMBER: We have not to do that. Our cartridges are ready filled on board men-of-war; but according to your system we must fill them in action.

MR. SAUNDERS: I do not suppose that for a moment. You may carry a sufficient number of cartridges for your own use. Cartridges are not so dangerous.

A MEMBER: If you can have explosive powder in cartridges, what is the use of your protecting powder? Besides, our cartridges are all in cases, and no fire can get at them.

MR. SAUNDERS: Very good. If they are there and are safe there is an end of that. It just confirms what I said, that cartridges are much safer than loose powder. Still you must remember that I am entering upon a point of the subject which I distinctly stated I could not undertake to do. I do not think, if you came here with the expectation of hearing how all this is to be manipulated in action, that you would have asked a non-military man to occupy the position I occupy this evening. I came here in the hope of hearing some explanation and information from military men. I can only say that Mr. Gale's process can be very readily applied, and the powder very readily restored. It is for military men to say how they will use the process. The President asked just now if some further experiments can be made. If agreeable, I will show you Lord Bury's test.

[Mr. SAUNDERS then exhibited some experiments to show the impossibility of exploding gunpowder protected by Mr. Gale's process.]

Captain SELWYN: I should be glad to have an answer to the question, as to whether he has by any mechanical test ascertained that there is none of the protecting powder left with any portion which he may have sifted—in the ordinary way it would be sifted in, not taking particular care to sift it—that under no circumstances is there a portion of the protected powder left? Because it is a most difficult thing, if we take any two substances and mix them intimately together, to mechanically separate them again.

MR. SAUNDERS: This morning I took a pound of Curtis and Harvey's gunpowder. Immediately I received it I applied to it as good a test as you can apply in a rough way. I dropped it on this glass, and the result was that a great deal of dust was left on the glass. That I believe is as good a test as you can have as to the quantity of dust which is left on the powder. Now, after I did that, I separated some powder which had been mixed, and dropped that on the glass, and I found that the quantity of dust left was very much less from the sifted powder than it was from Curtis and Harvey's powder which had not been mixed, simply because it had been recently sifted, and it is my impression that powder should always be sifted almost immediately before use. I believe this is a test which gunpowder-makers generally use, and which they consider very satisfactory. I cannot by this light discover that any dust has been left on this glass after dropping upon it powder that has been mixed and separated.

THE CHAIRMAN: Whatever the merits may be of the invention which Mr. Gale has put before the public, I am sure we are indebted to Mr. Saunders for the lecture which he has addressed to us. I am sure I may thank him on behalf of all who are here present. I would now ask Dr. Millar kindly to give us the information which he has proposed to do.

A NEW METALLIC CARTRIDGE FOR MILITARY PURPOSES.

By DR. J. MILLAR, F.G.S., F.L.S.

Soon after the Government had last summer made known their intention to arm the soldier with a breech-loading rifle, I became much in-