

WASC 2030

Report on Explosion
at F. Joyce & Co.
22.12.1893
Gf. vD Majendie

146888
AWB
EXPLOSION OF CAP COMPOSITION IN MIXING SHED OF MESSRS.
JOYCE & CO'S FACTORY.

No. CVII.



REPORT

TO

THE RIGHT HONOURABLE THE SECRETARY OF STATE FOR THE
HOME DEPARTMENT

ON THE

CIRCUMSTANCES ATTENDING AN EXPLOSION

WHICH OCCURRED AT THE

AMMUNITION FACTORY OF MESSRS. F. JOYCE & CO. (LIMITED), AT
WALTHAM ABBEY,

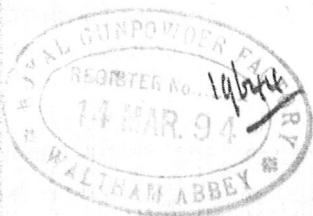
On the 22nd December 1893;

BY

COLONEL V. D. MAJENDIE, C.B.,

HER MAJESTY'S CHIEF INSPECTOR OF EXPLOSIVES.

Presented to both Houses of Parliament by Command of Her Majesty.



LONDON:

PRINTED FOR HER MAJESTY'S STATIONERY OFFICE,
BY EYRE AND SPOTTISWOODE,

PRINTERS TO THE QUEEN'S MOST EXCELLENT MAJESTY.

And to be purchased, either directly or through any Bookseller, from
EYRE AND SPOTTISWOODE, EAST HARDING STREET, FLEET STREET, E.C., and
32, ABINGDON STREET, WESTMINSTER, S.W.; or

JOHN MENZIES & Co., 12, HANOVER STREET, EDINBURGH, and
90, WEST NILE STREET, GLASGOW; or

HODGES, FIGGIS, & Co., LIMITED, 101, GRAFTON STREET, DUBLIN.

REPORT

TO

THE RIGHT HONOURABLE THE SECRETARY OF STATE FOR THE
HOME DEPARTMENT

ON

the Circumstances attending an Explosion which occurred at the
Ammunition Factory of Messrs. F. Joyce & Co. (Limited), at
Waltham Abbey, on the 22nd December 1893;

BY

COLONEL V. D. MAJENDIE, C.B.,

HER MAJESTY'S CHIEF INSPECTOR OF EXPLOSIVES.

Home Office, 30th December 1893.

I HAVE the honour to report that in obedience to your Order, dated 28th December 1893 (Home Office, No. 59/53282), made under the 66th section of the Explosives Act, 1875, I have held an Inquiry into the circumstances attending an explosion (No. 105/1893), which occurred on the 22nd December 1893, at an ammunition factory at Waltham Abbey, occupied by Messrs. Frederick Joyce & Co. (Limited), by which 3 men were killed and three others sustained injury (in one case slight).

The factory in which the accident occurred, although long established, was not one in which a Continuing Certificate could be properly claimed at the passing of the Explosives Act, 1875,* and accordingly the then occupiers, Messrs. R. G. Joyce and Joyce (of Waltham Abbey, Essex, and 57, Upper Thames Street, London), took a License to legalise the factory shortly after the Act came into operation, viz., License No. 3, dated 19th June 1876.

Subsequently, on 2nd September 1889, the license was transferred to a limited company, trading as Messrs. Frederick Joyce & Co. (Limited), of the above address, and by this company the factory continues to be worked.

The factory (which occupies about 5½ acres of ground, and contains several sheds and buildings), is situated a little way outside the town of Waltham, in Essex, and comprises a number of buildings for the carrying on prominently of the operation of making percussion and safety cartridges (empty and filled). The license also authorises the manufacture of fulminate of mercury, but practically, with the exception of drying fulminate of mercury, this manufacture is not carried on.†

Among the buildings of the factory was an isolated wooden shed (No. 45), which is licensed for the operation of mixing percussion cap composition. As this operation is recognised as being, under certain conditions, an extremely delicate and risky one, I took the precaution to narrowly limit the amount of explosives to be present therein, and the number of persons. The license only allows 5 lbs. of explosive, i.e., explosive of the 5th (fulminate) class, and one person.

It was in this shed that the accident now under notice occurred.

Before proceeding to describe the circumstances of the accident, so far as I have been able to gather them, it is necessary to say something of the shed, and of the nature of the work carried on therein.

Description of factory in which accident occurred.

Shed in which accident occurred.

* The license held by Messrs. Joyce was an annual one, which expired on 12th March 1876, and sect. 52 of the Explosives Act, 1875, provides that "where the license of a factory or magazine for any explosive other than gunpowder will expire within 12 months after the commencement of this Act, the occupier of such factory or magazine shall not require a continuing certificate under this Act, but until such license expires shall be entitled to use such factory or magazine in like manner as if this Act had not passed, without prejudice nevertheless to any application by him for a license under the Act for such factory or magazine." † Indeed, no buildings are assigned in the schedule to the license to any process of such manufacture except the one building which is appropriated to drying fulminate of mercury.

ingredients in separate paper parcels (or in the case of the fulminate of mercury in a little closed gutta percha vessel) to the mixing shed (No. 45), where he would first grind the chlorate and ground glass together, with a wooden pestle in a wooden bowl (on the bench to left of door), and then turn this mixture out on to a sheet of paper, and convey it to the mixing table, where the fulminate of mercury and the sulphide of antimony would be added, the whole of the ingredients being dry, and the charge about 15½ ozs. (or say roughly 1 lb.).*

The mixing was effected by the operator raising and lowering the corners of the paper on which the ingredients rested, so as to bring them together, and then the crude mixture was placed in a wire bottomed 40 mesh sieve, which was rocked gently from side to side until the whole had passed through into the paper below. In some instances the mixture had to be sifted more than once.

With some compositions a brush was used to assist the passage of the composition through the sieve. But the manager assures that the brush was never, to his knowledge, employed with the sort of composition that Burton was engaged upon at the time of the accident.

After the composition was mixed, it was placed in a gutta percha bottle, which bottle was temporarily deposited in a neighbouring shed (No. 50) until a second mixing was ready, which was likewise taken to No. 50, and placed in the partly filled bottle, which in its turn was at once conveyed to the magazine, whence it could be drawn as required by the men engaged in filling the percussion caps.† There is no reason to believe that this practice was departed from in the present instance, except in one important particular, viz., the non-removal of a mixed charge, to which unfortunate omission, as will presently appear, the fact that anyone except Burton sustained injury must undoubtedly be ascribed.‡

The accident occurred at about 10 minutes before 12 on the morning of Friday, 22nd of December 1893.

Mr. Courtman was at the time standing in the yard, near the entrance gate of the factory, which was then in full work. He heard an explosion, "not over loud, like a gun as to sharpness, but louder," and for the moment he thought it came from the cap charging sheds, to which he ran rapidly, but seeing they were all right, and seeing straight ahead a faint smoke proceeding from the direction of the mixing shed, he ran across the field and made for that shed, which as he approached it he saw was very much damaged. When he had got within about six feet of the exploded shed, he could see Burton lying among the débris, with his feet apparently outside the position of what was once the doorway, and his body lay, so to speak, across the doorway, his head being to the right. He was lying on his back, and apparently trying to rise. At the same moment Mr. Courtman saw the heads of two men appear through the bushes at the back, and at that moment there was a second explosion, much louder than the other, and the effect of it was to throw Mr. Courtman down and scatter the remains of the shattered shed in various directions; some of the débris here scattered over Mr. Courtman, and he sustained some slight injury. Mr. Courtman says that the two heads that he had seen disappeared, and he ran forward when he had recovered himself and tried to raise Burton, who was living, and who made some remark about his injuries. Mr. Courtman saw at once that the poor fellow was very severely injured; his right arm was blown off below the elbow,§ and appeared to be broken above; the left hand was

Circumstances in connexion with accident.

* The amounts differed slightly with different compositions, but in no case exceeded 22 ozs.

† There does not appear to have been any formal order to this effect; and so far as the conditions of the license were concerned, the mixer would not have been committing any transgression in allowing the mixing to remain a short time in the shed while he proceeded to mix another batch, so long as the total amount allowed to be in the shed (5 lbs.) was not exceeded. But it was an understood thing that the mixings, as completed, were to be removed, and undoubtedly such an arrangement tended greatly to diminish risk, and would also be more consistent with the spirit—if not with the letter—of general rule No. 12 (Order in Council, No. 2), which enjoins that "every ingredient in course of manufacture into explosive, which either by itself is possessed of explosive properties, or which, when mixed with any other ingredient or article also present in any working building, is capable of forming an explosive mixture or an explosive compound, shall be removed with all due diligence from such working building so soon as the process connected with those ingredients which is carried on in such building is completed, and all finished explosive shall, with all due diligence, either be removed to a factory magazine, or sent away immediately from the factory." Of course, the disposition of a mixing in No. 50 (which was not a "Factory Magazine") was not *strictly* a compliance with this rule, but it was, perhaps, arguable that the "mixing" was not complete until a bottleful had been prepared. At any rate, the practice was not one which appeared to us to call for any interference on our part.

‡ It is also not improbable that Burton's injuries were sensibly aggravated by the second explosion, which was the result of his omission to remove the mixing.

§ Burton's right hand, minus the thumb, was afterwards found among the debris, and the thumb, blown off at the second joint, was found about 6 feet outside the mixing house door.

much injured; his face, and especially his forehead, was a good deal cut, and his hair was slightly singed; he also complained of great pain in his back. Mr. Courtman was unable to raise him unassisted, but at this moment the injured man's son came along, and together they carried him to the laboratory, where he remained until the doctor shortly afterwards attended to him, and whence he was subsequently removed by their direction to the Cheshunt Cottage Hospital, where he expired that evening.

Unfortunately, as has been stated, Burton was not the only man who sustained injury of a serious character. The noise of the first explosion naturally attracted attention, and three persons (Charles Hubbard and Thomas Laurence, and a lad, Charles Bird), ran immediately from the boiler house to render assistance. Doubtless the two heads which Mr. Courtman saw among the trees at the side of the mixing house were the heads of two of these men, who had thus got up to the house (but were outside it) when the second and more formidable explosion occurred. They all sustained more or less severe injury, from the effects of which one (the lad Bird) subsequently died. It will be seen that their fate was narrowly escaped by Mr. Courtman, who, fortunately, was just far enough from the house (barely six feet) at the time of the second explosion, to escape material injury. In another second or less he would have been within the zone of dangerous effect.

Beyond the injury to the building itself, and to the four men, the explosion did no harm. Not a single window even was broken, although one of the neighbouring buildings was distant only about 13 yards.

Débris of sorts was scattered about over a mean radius of about eight yards; some of the lighter fragments (assisted evidently by the wind) had travelled about 13 yards. The shed itself is an absolute ruin (*see photograph*)*, and a careful examination of the débris, which Mr. Courtman very properly caused to be left absolutely undisturbed until after my visit, threw some valuable and instructive light, if not on the originating cause of the explosions, at any rate upon the order and manner in which they had occurred.

Thus, it is abundantly clear, from the position of the screen, from the splintering into small fragments of the mixing table, from a crater formed in the floor just in front of the screen, and therefore under the mixing table, from the disappearance, more or less complete, of the sieve, and from the small fragments of felt and cloth and glazed paper from the table which we picked up, that an explosion had occurred on the table; it was also clear from another and larger crater to the right of the door that another explosion had occurred at this point; and the fact that we recovered from this crater fragments of one of the gutta percha bottles used for containing a completed mixing, conclusively established that the contents of such a bottle had gone off here. In short, the *locale* of each of the two explosions was perfectly established.

Order in
which the
two ex-
plosions
occurred.

Then comes the question as to the order in which these explosions occurred. To my mind this question can be quite confidently answered. The first explosion happened on the mixing table; the second in the bottle near the door. This sequence appears to be established by one or two circumstances.

1st. The nature of the injuries sustained by Burton. His right arm below the elbow was destroyed, and the thumb of the right hand was blown off, showing that his hand must at the time of the explosion have been close to the charge, and this it is easier to believe would have happened when he was in the act of mixing than while he was handling a bottle; indeed, the loss of the thumb would appear strongly to indicate that he was holding sieve at the time.

2nd. If he had been handling a bottle, and not mixing, at the moment of the first explosion, it is certain that his body would have sustained more serious injury, whereas if he was behind the screen his body and breast would have been (as in fact they were) largely protected.

3rd. That he was at and behind the screen seem to follow from the fact that we found one of his felt over-shoes on the soft stool behind the screen, and the other close beside it.

4th. His cap, which we discovered among the débris, had the whole of the fore part of it more or less blown away, the hinder part being uninjured, a result which is consistent (as were all his injuries) with his being at and behind the screen when the first explosion occurred, and which, taking his injuries as a whole, seems scarcely consistent with his having been elsewhere when the explosion occurred.

5th. Again, the fact that among the débris were found small fragments of the sieve blown to pieces, portions of the table, the felt cloth which covered the table, with a

* It has not been thought necessary to reproduce the photograph.

hole blown out of the centre, all contributes to support the view that the explosion originated at the mixing table, while Burton was actually engaged in mixing.

6th. The crater to right of the door (where the bottle exploded) is of a more formidable character than the crater under the mixing table, and although this difference may have been in part due to, it is not in my judgment to be entirely accounted for by, the fact that the charge in the case of the table was a couple of feet or so from the ground, whereas in the other case the bottle must apparently have rested on the floor. Rather is it to be inferred that whereas the charge which was on the table was unconfined, and more or less spread out, the charge in the bottle was concentrated and confined, and accordingly it would follow that the bottled charge would produce the more marked effects and the louder report; and all the testimony agrees as to this, that the second explosion was much the louder and more considerable.†

In short, I think we need have no hesitation in saying that what happened was this: the charge which Burton was mixing on the table (he being behind the screen) exploded first; and a mixed charge in a bottle standing on the floor exploded after an interval of about half a minute.‡

I have yet to consider what caused these two explosions.

As to the first, or originating explosion, viz., the explosion of the charge in process of being mixed on the table, I am afraid we shall never be able to arrive at any satisfactory conclusion. It is quite probable that even if Burton were himself alive he would be unable to tell us what caused it. As we said when treating in our Annual Report of the fatal accident on this site in 1878:§ “In dealing with a highly sensitive detonating composition, very minute causes may lead to serious results, and even the accidental slipping of a tool from the operator’s hands, or a momentary in-cautious handling of the same, may determine an explosion. More than one accident has occurred at the Royal Arsenal, Woolwich, from the mere scraping up of cap composition on a highly polished metal plate with a wooden scraper.”|| All our experience during the 15 years which have elapsed since those words were written has tended to confirm their correctness, and to show what very slight disturbing causes may establish an explosion of a sensitive composition. The detonating composition on which there is no reasonable doubt Burton was engaged is of a specially sensitive character, its sensitiveness being purposely raised to a high point (for the purpose of securing certainty of ignition in the cap) by the admixture of ground glass, which plays the part of grit in rendering the explosive ready to explode on the application of a very slight degree of friction or percussion.¶ But even apart from this, and even apart from the possible accidental presence of other foreign matters or gritty particles, a composition which contains fulminate of mercury in a high proportion, chlorate of potash, and sulphide of antimony, cannot fail to be highly sensitive.

As to cause of the explosions.

Under these circumstances, it really seems unprofitable to examine more recondite causes, or to go outside those which are supplied by the mere handling and normal mixing of the composition. At the same time, I have not neglected to make inquiries in other directions. The result of these inquiries leaves me in no doubt that Burton was a steady, well-behaved, competent man; that he was sober, and apparently in a healthy mental condition that morning; that he was not hurried in any way, either owing to the near approach of the Christmas holidays or from other cause;*** he does not seem to have been rendered specially nervous by the very serious disaster which had occurred nine days previously at the Government Gunpowder Factory near at hand; he had, in reply to Mr. Courtman’s exhortation (after the explosion at the

* That the explosion did not originate with the fulminate of mercury is proved by the fact that the only two gutta percha caps which had contained dry fulminate were found uninjured.

† It is also not impossible that the amount in the bottle may have been rather larger than that on the table. The bottles when full contain two pounds, which would be about double what would be mixed at one time (see p. 5); but we have no means of knowing that the bottle was full. It may have contained a single mixing corresponding in amount to that on the table. In that case the amount in the bottle would correspond exactly with that on the table, viz., 15½ ounces each.

‡ I have arrived at a fairly confident estimate of the interval between the two explosions, by getting Mr. Courtman to run from the point at which he heard the first explosion to that where he was when the second occurred, and timing him. He took just 29 seconds.

§ See ante, p. 4.

|| Annual Report of Her Majesty’s Inspectors of Explosives for 1878, pp. 28, 29.

¶ A similar effect is produced in what are known as “throw-down crackers” by introducing gritty particles into the fulminate of silver of which they are composed.

*** Burton was paid by “time” and not by the piece, so that he personally had no pecuniary end to serve in hurrying his work.

Government Factory) to be specially careful, replied quite quietly and composedly that he always took the greatest care, and could do no more: his shed at the inspection of Her Majesty's Inspectors has generally been found to be very well kept, and clean;* there is ample evidence that he was wearing at the time the regulation clothing provided under the rules; and I see no reason to suspect that there was any violation on his part of the special rule forbidding any workperson to wear pockets in any danger building; we may safely conclude from the position in which we found his felt boots, that he was wearing them at the time of the accident. In short, so far as I can see, we may properly reject all exceptional extraneous causes, and entirely relieve Burton of any suspicion that the cause of the original accident was due to any violation on his part of the regulations, or of that careful and even delicate treatment of the composition which no regulation can define.

Blame attaching in connexion with the second explosion.

There is, however, one direction in which it is impossible for me to report with confidence that no blame attaches to Burton. There is no doubt that at the time of the accident a bottle of mixed composition was present in the shed over and above the amount which Burton was engaged in mixing. The presence of this bottle in the shed was contrary to practice, and contrary also to an understood (though not formulated or expressed) regulation of the factory, the practice and understood rule being, that the bottles containing a mixing, should be at once deposited in No. 50, *en route* for the magazine. If I were in a position to say positively that the bottle was full (2 lbs.), the blame would be even greater; but I am not able to do this, and it is possible that the bottle only contained one mixing (say 1 lb.), but according to the manager it was contrary to practice and rule that even one mixing should remain in the shed.

The evidence all points to the second explosion, which was that of the mixed composition in the bottle, being very markedly louder and more violent than the other. But this in itself is not absolutely conclusive as to the amount in the bottle being greater than the amount which was being mixed, for in the first place the bottled composition was completely mixed; it was in a mass, instead of being spread out; it was under confinement, which the charge in process of mixing was not.

It may be asked, why did this second lot go off at all, at an interval of about half a minute after the first explosion. I have no sort of doubt that it was in consequence of the falling on it of a quantity of the débris projected by the first explosion. A beam, a piece of slate, the principals of the roof, or other body projected into the air, may have fallen on to the bottle and exploded its contents. At any rate, it is easy to see from an examination of the remains of the exploded building that the escape from explosion of a bottle of highly sensitive detonating composition standing in the midst of the wreckage would have been little short of miraculous.

I have next to consider whether any blame attaches in connexion with this accident.

General question of blame.

Blame in connexion with presence of bottle of mixed composition.

I have already dealt with the question of whether Burton was to blame for having a bottle containing mixed composition in the shed; and have shown, although I have come to this conclusion with regret, that undoubtedly, whether the bottle was full or contained only a single mixing, not only was he to blame, but that to his omission to remove the mixed composition the injuries to the three men who rushed to Burton's rescue at the time of the first explosion are directly attributable.

Non-adoption by company of mechanical system suggested by Her Majesty's Inspectors.

The method of mixing actually in use, and in the course of which the originating explosion occurred, was not only open to grave objection, but had been over and over again objected to by us. The fact is that there is a method of mixing highly sensitive compositions in use at the Royal Laboratory, Woolwich Arsenal, and (by our advice) at some of the private factories, which, although it does not wholly get rid of the risk of an explosion, possesses the conspicuous merit of removing the operator from the sphere of the more serious effects of such an explosion. This system was adopted at Woolwich about six or seven years ago by the then superintendent, Colonel Barlow, who had seen it in use in one of the Government laboratories in France. It is known as the "jelly-bag" system, and will be hereafter more particularly described.

About the time of the first introduction of the system to this country, viz., 1887, we sent out a circular† to the various manufacturers of detonating compositions for caps and detonators, in which we said:

* At my inspection of 16th December 1892 I complained of the calico spread over the floor-felt being a little dirty, or rather, perhaps, I should say dingey, as the result of the cloths not being washed quite often enough.

† Burton appears to have made no statement before his death which could be regarded as throwing any light on the cause of the accident.

‡ Circular letter of 25th February 1887.

"So far as we can judge, this apparatus, which is inexpensive and simple, appears to offer considerable advantages as regards safety to the operator, as compared with the methods usually employed.

"In the event of your wishing to send a representative to see it, the Superintendent, Royal Laboratory, has kindly consented to allow any such representative of the trade to inspect the apparatus on producing this letter as a voucher."

Among the firms to which this letter was sent were Messrs. Joyce. Whether those gentlemen did or did not avail themselves of the suggestion that they should visit Woolwich and see the machine I am not quite certain. I believe they did (from a remark in the notes of my inspection of 6th April 1887). But it is quite certain that they never adopted this method of mixing.

We have repeatedly directed their attention to the advantages to be derived from this system without effect. Thus, I find in my inspection notes on this factory, the following remarks:—

Inspection of 6th April 1887.—"They have a screen now, and they mix on the old system. They have seen the new at Woolwich. Mr. Bailey '(the then manager)' thinks it good; but he is disposed to prefer wet process. I said I thought they would do well to substitute the one or the other."

Inspection of 26th June 1889 (p. 13).—"They have a screen here, and they mix on the old system (? Why don't they adopt the new French system). Mr. Bailey said last time he preferred wet. It would be well to adopt one or the other."

Inspection of 18th February 1890 (p. 8).—"They mix with a brush and sieve, and with a screen (I have before suggested the Woolwich or rather the French system; and I repeated suggestion)."

Inspection of 28th September 1891 (p. 8).—"They mix with a brush and sieve, and with a screen . . . (we have frequently suggested Woolwich mixing. No need to press it further)."

Inspection of 16th December 1892 (p. 14).—"They mix with a brush and sieve and a screen. (We have repeatedly recommended the jelly bag system, but hitherto without effect. So it is no use going on repeating it. The risk and responsibility are theirs.)"

I also at my inspection of 28th August 1886, expressed a strongly unfavourable view of their particular methods of mixing, as the following quotation from my notes will show.

"I don't like the sieve system of mixing, and it brings the man's hand over the stuff, though the screen protects his body, but not his face, which also would be rather over it. Said so to Mr. Hanbury."

It is difficult to see how we could have gone much further than we did to procure the condemnation of the existing system, and the adoption of the safer jelly bag method, for the case was one in which it is very doubtful if we should have been justified in bringing section 56 into play,* seeing that Messrs. Joyce's system was one which had been long in vogue here and elsewhere, and that, although attended as we think with considerably more risk to the operator than the jelly bag system, it had not given rise to any very large number of accidents,† and, further, that only one man was engaged, and he, as it was understood, was not anxious for a change.

Indeed, the present manager of the factory (Mr. Courtman) bases his non-adoption of the jelly bag system on Burton's distinct unwillingness to employ it. Mr. Courtman made the following statement to me on this subject: "I had a conversation with him" (Burton) "about three years ago, in which I intimated that it would probably be safer if the work was done by a machine (I had in view the sort of machine they use at Woolwich), and his reply was to the effect that he would rather do it by hand, as he had had experience of machines at the gunpowder factory, and felt safer doing it by

* "If in any matter (which is not provided for by any express provision of this Act) an inspector find any factory, magazine, or store for an explosive, or any part thereof, or anything or practice therein, or connected therewith to be unnecessarily dangerous or defective, so as in his opinion to tend to endanger the public safety or the bodily safety of any person, such inspector may require the occupier of such factory, magazine, or store to remedy the same." (Section 56.)

† Since the Act came into operation we have had cognisance of only six accidents in mixing, and of these two were with the jelly bag (without personal injury), two were in the process of wet mixing, and two others in the dry mixing as practised on this occasion, viz.: one at the same factory on 14th October 1878, when Mr. Joyce was killed (see Annual Report 1878, p. 63), and one at Grenfell and Accles on 22nd July 1892, when one man was injured (Annual Report 1892, p. 80). There were also accidents in mixing before this Act came into force.

"hand. I explained to him the machine in general terms, and that the operator would be at a distance. He positively refused to work a machine, and said if it was adopted he would not work it." The subject was not renewed.

What were Burton's reasons for opposing himself to the adoption of the jelly bag system I do not know, but it is fair to him to remark that we have found the same disinclination to adopt this system elsewhere, and it has sometimes proved difficult, and even impossible, to overcome it except by substituting a new operator. I can quite understand the disinclination of the manager at Messrs. Joyce's to proceed to this extremity, though in view of the unfortunate event now under notice it is greatly to be regretted that he allowed himself to be swayed by Burton's objections, resting, so far as he knew, on no solid grounds.

I may add that Mr. Courtman has intimated to me that he will not think of resuming the old system, but will adopt the jelly bag system forthwith. And I shall feel it my duty to put such pressure on any manufacturers as have not already adopted the jelly bag system as will, I hope, lead to its universal adoption.

Description of system of mechanical mixing.

The system is as follows:—The ingredients are mixed in a conical silk bag, which is suspended from an india-rubber ring inside a semicircular wrought iron screen. A cord is attached to the bottom of the bag, and, passing up through the top, is fastened to the end of a lever which is pivotted at the top of the screen. The operator is entirely protected by the screen and effects the mixing by working the lever up and down. To assist the mixing india-rubber washers are strung on the cord. The details of the arrangement are shown in the accompanying drawing.

Accidents, without personal injury, with mechanical system of mixing.

That it possesses the merits of safety ascribed to it is indicated by the fact that so far as we know two explosions only have occurred with it in this country, and both of them unattended with personal injury of any description.

The cases are as follows:—

(1.) *At Messrs. Kynoch's Factory at Witton, near Birmingham, on 19th August 1891 (Accident 79/1891).*—Our Annual Report gives the following particulars of this:—

"The one case, 1879, was an accident at Messrs. Kynoch's factory during the operation of mixing the cap composition in one of the 'jelly bag' mixing arrangements which are used in the Royal Laboratory, Woolwich (the idea having been borrowed from France), and which are now (very prudently) adopted in some cases by private manufacturers. This is the first accident, so far as we are aware, that has ever occurred with this system of mixing, a fact which speaks well for its safety; while the further circumstance, that although about seven ounces of fulminate exploded the operator was entirely uninjured, testifies to the efficiency of the arrangements for limiting the effects of an accident should one unfortunately occur."

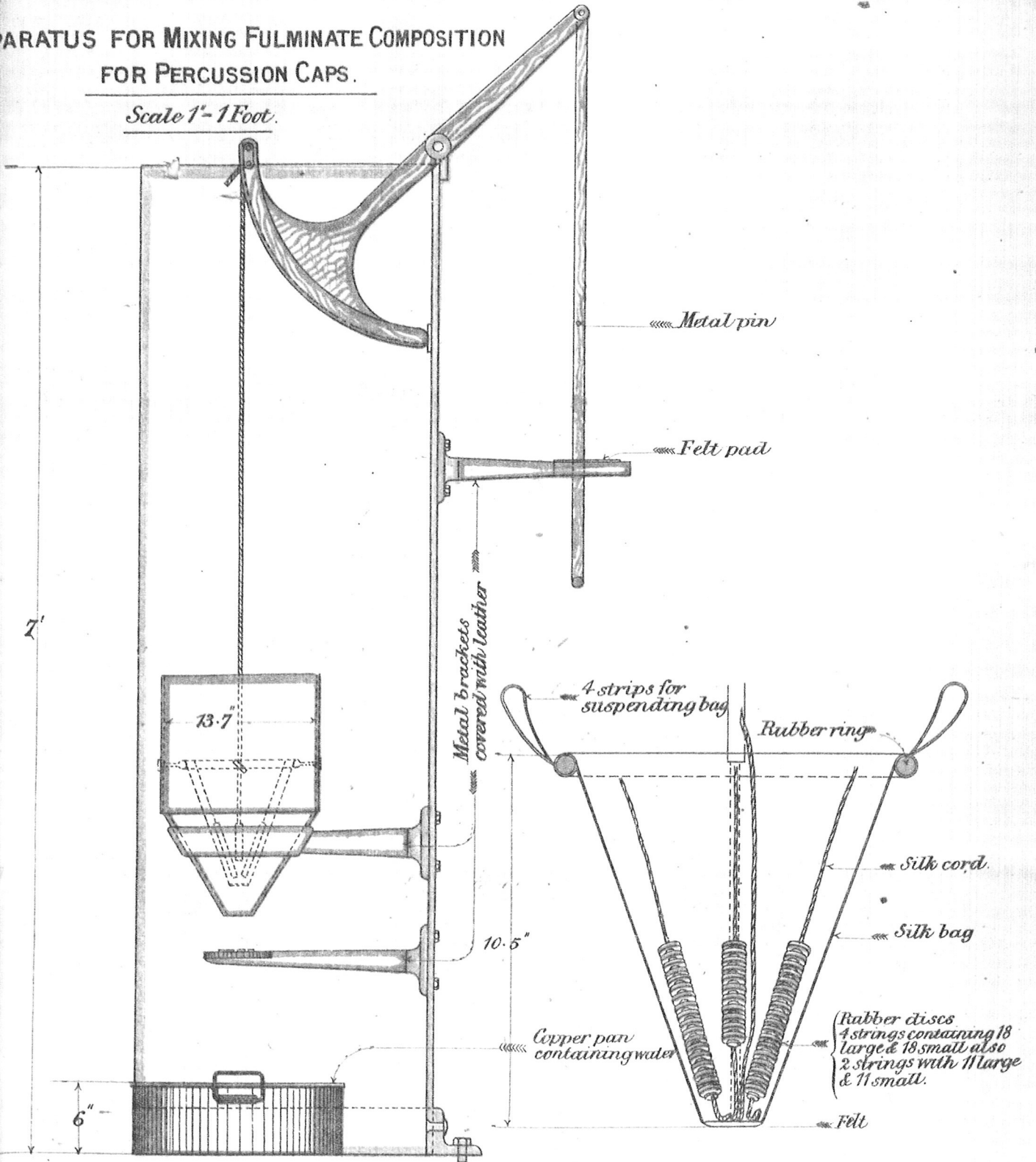
(2.) *At the Royal Laboratory, Woolwich, on the 5th July.*—In this case we wrote as follows:—

"An explosion occurred at the Royal Laboratory on the 5th July during the mixing of some detonating composition, which usefully illustrates the value of the precautionary measures which have been adopted for limiting and localising the effects of an accident of this sort, and the suitability of the machine which has been introduced for the purpose. The machine was of what is known as the 'jelly-bag' type (adapted originally from a system used in France) in which the mixing was effected (behind a screen) by means of a string attached to the pointed lower end of a bag resembling a 'jelly bag,' in which the ingredients of the composition which it is intended to mix are placed. By raising and lowering the string the composition is kept in movement and turned over and over, the operation being assisted in some cases by small discs of india-rubber on the strings under the bag, and in other cases by little india-rubber balls in the bag. This class of apparatus has been in use in the Royal Laboratory for several years, and the same, or a similar arrangement, has now very prudently been adopted in some of the private factories, as for example, at Nobel's Explosives Factory at Polmont, and at Messrs. Kynoch and Co.'s Factory near Witton, and at the latter place an explosion (No. 79/1891) occurred in one of their machines in 1891, which, like the one now under notice, was chiefly interesting as showing the effectiveness of the arrangement for preventing personal (or serious structural) injury in the event of an accident."*

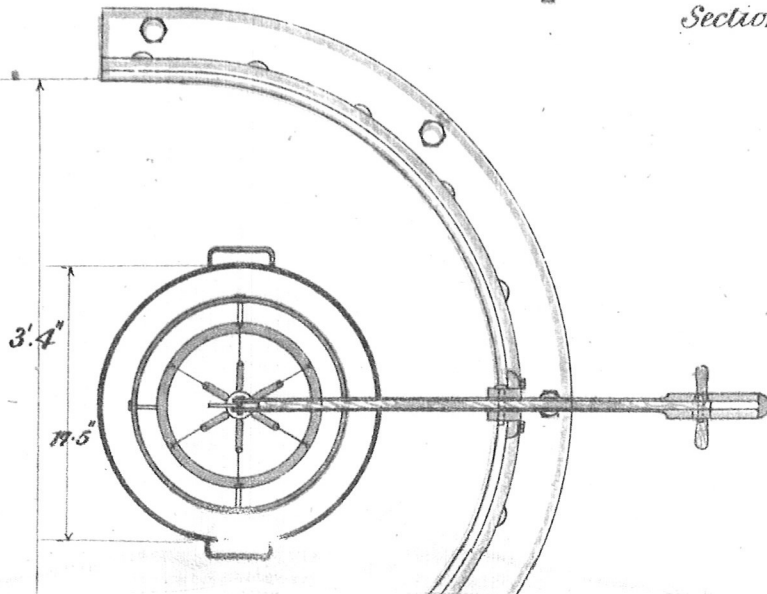
As these, so far as we are aware, are the only two accidents which have occurred with this apparatus, and as in both cases the effectiveness of this arrangement for limiting the effects was amply demonstrated, we trust that in time the use of such a machine for

APPARATUS FOR MIXING FULMINATE COMPOSITION FOR PERCUSSION CAPS.

Scale 1" = 1 Foot.



Sectional Elevation of Bag.
Scale 3" = 1 Foot.



W. Lambie

mixing detonating composition, instead of the old-fashioned and extremely dangerous method of mixing by hand, will ere long become general.

(3.) But the arrangement by which a bottle containing a quantity of completed composition may be left standing on the floor while more composition is being mixed is obviously not a good one; and I think that in future it would be desirable—

Minor suggestions for safer carrying on of business.

1st, that the bottles to be employed should contain no more than one mixing (*i.e.*, from 15 ozs. to 22 ozs., as the case may be); and

2nd, that if it be impracticable to convey away each mixing as it is completed, that such mixing should be deposited in a shelter cupboard external to the building, and by preference detached therefrom.

The manager has intimated to me that he will be prepared to adopt these suggestions, and the necessary alterations will be made on the license accordingly.

I have, &c.
(Signed) V. D. MAJENDIE, Colonel,
H.M. Chief Inspector of Explosives.

P.S.—While this Report has been in progress I have also attended (on 2nd January, 1894) the Inquest held at Cheshunt by Mr. Sworder, coroner for Hertfordshire, on the body of Burton.

The verdict arrived at was: That deceased died of injuries received from two accidental explosions at the mixing house of Messrs. Joyce's factory; and the jury think that the Home Secretary should make the adoption of the machinery recommended by Colonel Majendie compulsory.

I also attended (on 24th January, 1894) the Inquest held at the Elim Hall, Tottenham, by Mr. A. Hodgkinson, deputy coroner for East Middlesex, on the body of Bird.

The verdict arrived at was: That deceased died from shock and injuries received from an explosion at Messrs. Joyce & Co.'s (Ltd.) Ammunition Factories, Waltham Abbey, from accidental causes.

V. D. M.