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REPORT
OF
THE COLABA FIRE COMMITTEE.

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Bombay, July 14th, 1914.

To

THE SECRETARY TO GOVERNMENT,
General Department,
Bombay.

Sir,

We, the members of the Committee appointed by G. R., G. D., No. 2326, dated 13th April 1914, to enquire into the causes of the recent fires on the Cotton Green, have the honour to submit the following report to Government.

2. Including a preliminary meeting held on the 29th April, the Committee met on twelve occasions for the purpose of recording evidence, and examined 26 witnesses, including Mr. A. J. Turner, Head of the Chemical Department of the Victoria Jubilee Technical Institute, whose evidence forms one of the appendices to our report.

3. In appointing our Committee Government desired that we should—

(a) enquire into the cause of the outbreaks of fire on the Cotton Green at Colába, and

(b) consider and recommend what preventive and protective measures should be adopted to guard against such outbreaks in future.

We will proceed to deal in order with these two main heads of enquiry.

4. As regards (a), we may remark in the first place that an extraordinary variety of theories and suggestions have been put forward in the press and elsewhere to account for the origin of these disastrous fires in baled cotton, which may be briefly summarised under the following heads:—

- (i) The wrath of God.
- (ii) The maledictions of an evicted *Sádkhu*.
- (iii) Wireless telegraphy.
- (iv) Atmospheric electricity.
- (v) The violet rays of the solar *spectrum*.
- (vi) Grease from cart-wheels, attaching by mischance to the outside of bales.
- (vii) The watering of cotton at presses up-country.
- (viii) The germination of cotton-seeds, left in the cotton owing to bad ginning.
- (ix) The heating of the hoops which bind the bales and the friction of one against another.
- (x) The use of sea-water to extinguish fires.
- (xi) A sinister conjunction of planets.

The Committee are of opinion that there is no direct evidence of any kind to support any of these suggestions and that they must be rejected, as for the most part fanciful and in one or two cases preposterous.

5. The enquiry resolves itself into the main question whether these fires are due to natural causes, or in other words to spontaneous combustion, or whether they are due to unnatural causes, including incendiarism. Now as regards spontaneous combustion, the Committee have the oral evidence of witnesses recorded before them, evidence drawn from various shipping-companies as to the prevalence of fires among baled cotton in ships' holds, and the expert

evidence of Dr. Harold Mann, Captain Higham, and Mr. A. J. Turner, who conducted separately a number of experiments and whose opinions appear as appendices to this report.

Dealing with the oral evidence of witnesses examined by the Committee, it must be admitted that for the most part the evidence for spontaneous combustion is peculiarly unconvincing, and would appear to be based, not so much upon technical or other proof, as upon a perhaps natural desire not to cast aspersions upon the Bombay cotton trade in general or upon any or all of the various classes of persons engaged in it. Some witnesses too may have felt compelled to favour spontaneous combustion, in the absence of such direct evidence of incendiaryism as would justify and demand a criminal prosecution. Out of the twenty-five witnesses, excluding Mr. Turner, 9 recorded their belief that the fires are due to spontaneous combustion or natural causes; 13 were in favour of unnatural causes, including incendiaryism; while three gentlemen were inspired by so much caution that they were unable to give an opinion at all on this point. So far, therefore, as the oral evidence goes, there is a small balance of opinion in favour of unnatural causes or incendiaryism. It must, however, be pointed out that the witnesses who favour the belief in unnatural causes or incendiaryism are for the most part men with long experience of the cotton trade and the business of insuring cotton, and men whose mercantile standing precludes the suggestion that they might be capable of submitting a hasty and ill-formed opinion.

Turning to the evidence of the shipping companies, the Committee enquired of the following firms how many fires in baled cotton they had had during the last ten years in the holds of their ships or of ships chartered by them. Messrs. Graham & Co. report no fires during that period; Messrs. Killick, Nixon & Co. report no fires in baled cotton during that period; the Austrian-Lloyd S. N. Co. report no fires during the last six years, statistics for the previous four years apparently not being available; the Italian Marittima S. N. Co. report one fire only in baled cotton during the decennial period; the Nippon Yusen Kaisha S. N. Co. report that, so far as their records go, they have only experienced one fire in their ships; while the P. & O. S. N. Co. state that there was a fire on board one of their ships at anchor in Shanghai in 1911; a second fire on board the S.S. *Banca* in the Bombay Docks in 1912; a third fire while unloading cotton at Kobe in 1913; a fourth fire on the S.S. *Banca* in the Bombay Docks in 1913 in cotton loaded for Japan; and a fifth fire in the same year on the S.S. *Assaye*, when that vessel was close to Singapore. Excluding the fires on the last-named company's vessels, which took place in practically every case when the vessel was in the docks or at her moorings, the number of fires in baled cotton aboard ships has been negligible, whereas if baled cotton were liable to spontaneous combustion it is certainly within the bounds of probability that many more fires would have occurred in the holds of ships and that shipping companies would have adopted far more stringent precautions than at present exist, and might in some cases have refused to load baled cotton at all.

The Committee would also point to the fact that extremely few fires have occurred in baled cotton in the mills of Bombay. They have not called for direct statistical evidence on this point; but it is within the knowledge of the majority of the Committee that, although fires have not been infrequent among loose cotton in the blow-rooms and other parts of mills, fires have been rare among baled cotton stacked in the local mill-godowns. Assuming for the sake of argument that baled cotton is liable to spontaneous combustion, it is impossible to reconcile the series of disastrous fires at the Colába Cotton Green with the almost complete absence of fires in mill-godowns among bales of cotton of the same classes and varieties, subjected to practically the same atmospheric conditions.

The falsity of the theory of spontaneous combustion in pressed cotton-bales becomes more apparent and more pronounced when we peruse the reports of Dr. Mann, Captain Higham and Mr. Turner, which are printed as appendices to our finding. While deeming it unnecessary to reiterate or review the details of the careful experiments carried out by these gentlemen, the Committee

would call the special attention of Government to their separate conclusions: as taken in conjunction with the arguments already set forth, they appear to establish once for all the impossibility of ascribing the Colába fires to spontaneous combustion in pressed cotton.

Dr. Mann writes as follows:—“The results of the large number of experiments carried out and which have been designed to try and reproduce the conditions in which cotton could conceivably take fire are entirely negative. There is no reason to suppose that in default of outside agency, whether human or other, cotton under the conditions of storage in Bombay will take fire, and this conclusion applies to cotton as stored in godowns or on the Cotton Green, and to the cotton of the last crop as to that of previous year.”

Captain Higham remarks:—“That in the vast majority of cases where objects, either cotton bales or other, are found burning a human origin to that fire may be confidently postulated. A spontaneous origin for a fire is exceptional; and therefore in the fires now under consideration the onus of proof lies on the spontaneous theory: and that no experimental or other evidence has been adduced before the Committee which would tend to substantiate this theory as a satisfactory explanation of the fires that have occurred.”

Mr. Turner likewise writes at the close of his report:—“At the present moment I do not feel that there is any ground whatever for attributing these fires to spontaneous combustion due to natural causes.”

The conclusions at which these gentlemen have separately arrived find ample corroboration in the proceedings of a Board of Trade Enquiry into the loss of the steamer “City of Montreal” which was burnt at sea on the 11th August 1887. During the course of that enquiry Dr. Dupré, Chemical Adviser to the Explosives Department of the Home Office, was summoned to give evidence and stated that he had given his attention to cotton and its properties, and also to the subject of spontaneous combustion. This subject came before him repeatedly in all manner of shapes. He had had some samples of cotton supplied to him by the Board of Trade for the purpose of making experiments. He had made elaborate experiments upon that cotton. He did not believe that such cotton was liable to spontaneous combustion, unless it were mixed with extraneous matter. There were two species of cotton, Indian and American, given to him. He found that the American cotton was decidedly the purer. It had far less of the seeds of cotton in it. The Indian cotton was full of the husks of the seed. He made an analysis of the cotton, and he found that the American contained 7·28 per cent. of moisture, and the Indian 7·24. The American cotton contained 0·7 per cent. of oily matter, and the Indian 1·04. The American had 1 per cent. resinous matter, and the Indian 1·7. In the American there was 1·56 per cent. of albuminous matter, and in the Indian 1·9; mineral ash 1·46 in the American and 5·7 in the Indian, and the rest was cotton fibre and husk. *The conclusion he drew from the analysis was that neither the American nor Indian cotton would be liable to what was called spontaneous combustion.* The only material present that might create suspicion was the oily matter, but this was so minute and so diffused over the whole mass that even if the oil was actually oxidised it would not raise the temperature to anything like that which was necessary for spontaneous combustion. In addition to this he had kept the cotton for four or five days at varying temperatures, from the ordinary temperature to one in which the cotton began to char, about 250 Fahrenheit. It then began like paper or wood to be browned outside slightly. Although he had a thermometer inside the cotton and one outside, he never could trace any difference in the temperature between the inner and the outer, clearly showing that there was no action going on inside the cotton. Burning heat was generally considered 1,000 Fahrenheit. He made these experiments with both wet and dry cotton with the same result. These experiments quite confirmed his conclusion that unless the cotton was placed in contact at the surface with burning material it would not be likely to take fire. There was nothing in the cotton itself to ignite it spontaneously. With regard to oiled cotton, there was little doubt that there had been instances of spontaneous

combustion. But the oil must be in the cotton to some considerable extent. A very little oil would not do. It must be protected by loose cotton around it, and have a fair access of air, and there should be a moderately high temperature to start with. If these conditions were combined the oil would begin to oxidise, but if any of the conditions were absent it would not do. *The conclusion he drew from this was that no oiled cotton in a bale would be liable to spontaneous combustion, or anywhere where it was closely packed.* Even if a piece of oiled cotton were placed on the outer part of a bale, if the bale was fairly closely packed, it would not be liable to spontaneous ignition. Having heard the evidence in this inquiry, he did not think it was possible that spontaneous combustion could have been set up in the bales of cotton. He next tried an experiment with a view to find out how long cotton might smoulder without bursting actually into flames. He lighted a piece of wool, blew it out, put it into a tin box and in the centre of about 4 lbs. of cotton. The top of the box was covered over loosely. In two experiments he found that the ignited cotton smouldered for four days and on opening the box and distributing it, it burst into flames. A considerable portion of it had become partly charred. Sometimes cotton went out after two days. He had no doubt that the cotton might smoulder much longer under certain conditions. Another point was that there was comparatively speaking very little smell during the smouldering. This was easily accounted for, because cotton was a very good respirator and it absorbed the smoke and the smell, and the whole mass must be saturated before it began to smell outside. They could go with a cotton respirator into the thickest smoke for a time. The American matches in a bale of cotton might ignite by friction. A light falling between bales of cotton might set fire to one without there being flame where there was no great quantity of air, but when the air got at it, it would burst into a flame. He thought it just possible that a spark might be emitted by the bursting of a band, but not very probable. The bands might burst a thousand times without a spark. In the lamps used in stowing cargo fine soot often accumulated in the upper part of the funnel, and small sparks might come from that without being observed. There was great danger from sparks from tobacco pipes, and the people who smoked were very careless with regard to sparks and matches.

6. In view of the evidence detailed in the preceding paragraphs, the Committee are of opinion that the theory of spontaneous combustion is the primary cause of the series of fires at the Colaba Cotton Green must be definitely rejected, and that the reason must be sought for in other directions.

7. Excluding the advocates of the rejected theory of spontaneous combustion, the witnesses who appeared before the Committee may be divided into three main classes, *viz.*, those who suppose the fires to be accidental, those who ascribe them to what may be termed unconscious incendiarism, and those who ascribe them to conscious or mischievous incendiarism.

The first-named class, who regard the fires as due to accident, pin their faith to the theory of what may be termed "the wandering spark," and incline to the belief that subsequent to a large fire a number of sparks are carried by the wind to other stacks of bales at varying distances, where they lie hid and set the cotton smouldering, until it eventually bursts into flame. There is a certain body of opinion which regards the gunny coverings of the bales as decidedly inflammable, and the plausibility of the spark theory may be said to gain some weight from that opinion. On the other hand, while not disposed to deny absolutely that a small number of the lesser fires which were discovered and extinguished may have been due to the carriage of sparks from the huge conflagrations of the 23rd March and 2nd April, the Committee are not disposed to consider the theory—for it is little more than theory—as entitled to much weight. Assuming for the sake of argument that gunnies are highly inflammable and that wandering sparks are capable of almost human powers of mischief, the theory fails entirely to account for the huge fires such as those which took place in the slated godown and in the Argyle Road godown (Mandvi) on the 18th May. In fact the Committee

hold that the theory of "the wandering spark" is inadequate to account for a series of fires—some of them very large ones—which have disfigured, we might almost say disgraced, the Cotton Green, between the 12th February and the 26th May 1914.

Turning to the subject of "unconscious incendiarism," opinions have been freely expressed that careless tobacco-smoking, in particular the smoking of *bidis*, is a probable cause of the fires on the Cotton Green. It has been pointed out that in spite of strict orders to the contrary, cartmen, coolies and others engaged on the Green do occasionally smoke, and that *bidi* ends and cigarette ends, carelessly thrown down upon the cotton-covered soil, may cause fire, which smouldering unseen sets fire to stacks. The weakness of the theory seems to us to lie in the fact that, when all is said, *bidi* smoking is not excessive; that if the theory were true, Bombay would have witnessed *annually* a similar series of outbreaks, which is not the case; and, lastly, that the theory gives no reasonable explanation of the fact that in many cases the fires of 1914 have commenced in an extraordinary position inside the stack, about 4 feet from the ground and within reach of a man's hand. Here again therefore the Committee find it impossible to accept the theory of careless tobacco-smoking or unconscious incendiarism as fully explanatory of the long series of fires at the Green in 1914.

8. It now remains to discuss the third theory of "conscious incendiarism" or criminality as the cause of these outbreaks. Here the Committee, in the absence of the actual arrest of an incendiary* or of definite suspicion against any individual or class of individuals, find themselves upon rather delicate ground. But they are emboldened to discuss the probabilities of criminality by the fact that several witnesses of standing and experience have expressed the belief that these cotton fires are caused fraudulently by persons, as yet unknown, who make or seek to acquire direct or indirect profit for themselves from the wholesale destruction of cotton-stocks.

Now in proceeding to discuss this theory the Committee wish it to be clearly understood that in the existing absence of any definite clue as to how and through what agency these fires have taken place, they do not wish to cast suspicion or aspersion upon any person or class of persons in particular. All that they feel called upon to do is to show in what way a person or a body of persons might, if actuated by corrupt motives, find it profitable to set fire to the baled cotton at Colaba.

Before enumerating such classes, the Committee consider it desirable to record a brief introductory note on the cotton trade of this season, which will help to explain the suggestions made later on as to the manner in which certain classes might profit by these fires.

The season of 1913-1914 opened with a high level of prices for both American and Indian cotton. Until the season had well advanced the belief widely prevailed that there would be a shortage in the total yield of American cotton as compared with the expected requirements of trade. Consequently American cotton gradually rose in price, taking values of Indian cotton in its trail, until towards the end of September 1913, when spot middling American in Liverpool was quoted at nearly 8d. per lb., while in Bombay fine machine-ginned Akola-Khámgaon had risen to Rs. 320 per *khandi* of 784 lbs. net. Subsequently opinions began to gain ground that the American crop would after all be larger in yield than had been expected, while about the same time it became known that the American crop was a partial failure as regards quality. Although this latter fact should have to a very large extent, if not wholly, neutralized the bearish effect on prices of the increased estimates of the total American yield, values began to decline steadily; and this, in the circumstances just mentioned, must be attributed to the enthusiastic reports, then current about the growing Indian crop. It was realized that in spite of a probable shortage of good American cotton there would be such an abundance of Indian cotton that the world's total supply would actually be in excess of the total

* Since the final meeting of the Committee three boys were arrested by the police for setting fire to cotton. The Committee are satisfied that this was an isolated case of school-boy mischief and has no connection with the previous series of fires.

requirements for the year of the world's cotton trade. Thus the decline in values continued steadily with very few reactions until about the middle of March 1914, and it may safely be laid down that, while under normal conditions the course of prices of Indian cotton is governed by the course of American cotton values, the downward course of prices this season was due to the extraordinary abundance of Indian cotton. About the middle of March American cotton values commenced to move upward, but the values of Indian cotton still continued their downward course till about the middle of May, as will be apparent from the chart referred to in the next paragraph.

We have appended to our report a chart which shows the movement of values of spot middling Americans in Liverpool (prices given in pence and decimals per one English lb. net) and of fine Akola-Khámgaon machine-ginned, fair staple, in Bombay (prices given in rupees per Bombay candy of 784 lbs. English net), from the 24th September 1913 (highest point) to the end of May 1914. This chart shows that while for middling Americans the difference between the highest point on the 24th September 1913, and the lowest point on the 23rd December 1913 and 9th January 1914, was 103 points (1'03d.) or 13 per cent., the difference between the highest (24th September 1913) and the lowest point (1st May 1914) for Khamgaon-Akola reached Rs. 116, or 36 per cent., the rates of other descriptions of cotton being in proportion. Thus, as compared with American cotton, Indian cotton was much cheaper than in previous seasons. The relative position of American and Indian cotton, in respect of cheapness, was also due in great measure to the stringency of the Indian money markets and to the shaken credit of Indian dealers, consequent upon the deplorable financial fiasco in Western India at the close of 1913, which rendered it very difficult, and in many cases impossible, for dealers to finance large holdings. The salient reason, however, was the record cotton crop grown in India, which obliged dealers to accept relatively low rates in order to facilitate the disposal of the enormous quantities of cotton which kept pouring into Bombay from up-country districts.

In spite, however, of the tempting rates at which cotton was offered, the supplies were in excess of the immediate requirements of buyers, and the result was a huge accumulation of stocks both in Bombay and up-country districts. The Committee desire to draw particular attention to the annexed chart, which contains a statement of estimated stocks in Bombay on various dates during the last decade, and to point out that stocks on the 15th May 1914 and 1906—in which year Bombay witnessed a similar epidemic of fires—were practically identical in quantity.

Another point to bear in mind is that there is barely sufficient godown accommodation in Colaba and elsewhere to warehouse even normal stocks, and in consequence the rents of godowns have risen enormously during the last few years. It is reported for example that a cotton godown in Mandvi, which a few years ago fetched about Rs. 300 per mensem, was readily let for Rs. 1,300 per mensem in May 1914. With abnormally large stocks such as have characterized the season under report, the difficulty of warehousing becomes extremely acute; and large quantities of cotton, for which accommodation was not forthcoming in Colaba, are now stored in godowns in other parts of the city, in particular in Mandvi. Dealers however dislike storing their cotton at a distance from Colaba; for buyers find it inconvenient to sample cotton lying so far from the centre of the cotton trade and give preference to stocks lying nearer at hand. In consequence cotton stored at a distance is difficult to sell.

With these preliminary remarks, the Committee desire to point out that the classes who might conceivably profit by cotton-fires in a season of the character of that now under review, are:—

- (a) The cotton-merchants at large.
- (b) Individual cotton-dealers in Bombay or the mofussil.
- (c) The mukádams.
- (d) The buyers of salvaged cotton.
- (e) Labourers and cartmen.

In respect of (a) the cotton-merchants at large, it has been already shown above that prices took a downward course, in consequence primarily of the abundance of the Indian cotton crop. It is estimated roughly that more than 100,000 bales of cotton have been affected by the fires at Colaba and Mandvi, and that at least half this quantity of bales have completely disappeared, the balance consisting of salvage which can be used, and is actually being partly used, by our local mills. Had the stocks of cotton not been so huge, the sudden disappearance of so large a quantity would most certainly have affected the course of prices. Actually, owing to the enormous size of the stocks, this has not been the case; but on the other hand it must be remembered that, thanks largely to the military patrol, the majority of fires have been discovered in good time and in most cases only a few bales have been affected. Had the majority of the outbreaks assumed larger proportions and a larger number of bales been destroyed completely, the effect upon prices would have been far more appreciable. Even if such fires had not resulted in an advance of price, they would in all probability have prevented a further decline. In such a case, the benefit, accruing from wholesale conflagration, would have rested with the general body of merchants whose cotton had not been burnt; for they would have gained the advantage of a rise in the value of their cotton and possibly of lower godown rents. Very probably also, even if no material advantage accrued to them in the manner just mentioned, they would have staved off the serious disadvantage of a further decline in prices; and here the merchants whose cotton had been destroyed by fire would have profited equally with them; for the Insurance Companies settle claims for loss on the basis of the market rate of the day of the fire. It is obvious that in certain circumstances it might be more profitable for a merchant to fire his cotton and get paid for it the full rate obtaining on the day of the fire than risk a further drop in values, the extent of which he cannot foresee.

In reference to (b) individual cotton-dealers, it may be postulated that the majority of dealers, whose business it is to purchase cotton in the mofussil and send it to Bombay for sale through their agents, who are usually termed *mukādams* and *jathawallas*, are not possessed of sufficient means of their own to finance their business without extraneous aid. Consequently they take advances from their Bombay agents on cotton lying in stock with the latter. The extent of the advance depends upon the arrangements existing between the dealer and his agent. Thus some agents pay 60 per cent., others 70 per cent. or 80 per cent. or 90 per cent., and some even 100 per cent. of the market value of the cotton on the date when the advance is actually paid. The difference between the advance given and the market value of the cotton on any day is known in the trade as "The Margin". If on a falling market the margins are nearing exhaustion, the Agents call upon the dealers to replenish them. If the margins are not replenished, the Agents have the right to sell the cotton involved at the best price they can obtain. But cotton, thus rendered subject to a forced sale, usually fetches a low price, a price in fact which may be considerably lower than the official market quotations. It will readily be understood from the above facts that profit may accrue to a dealer whose cotton is destroyed by fire, in the following manner:—

- (a) He escapes the necessity of replenishing the margins.
- (b) He avoids the possible loss incurred in a forced sale; because the Insurance Companies pay on the basis of the official market quotations on the day of the fire.
- (c) He escapes a possible further decline in the market value of his cotton.
- (d) He turns in a few hours into ready cash goods which, owing to absence of demand, were for the time being unsaleable.
- (e) He may be paid by the Insurance Company a higher value than was represented by the actual quality or quantity of the goods destroyed.

In regard to possibility (e) above, we must digress for a moment, in order to emphasize the fact that, according to evidence laid before the Committee,

some Insurance Companies are prone to some laxity in the settlement of the claims made against them. Briefly stated, some Insurance Companies regard the speedy settlement of fire-losses as of greater advantage to their business than a minute and searching enquiry into the justice of the claims made against them; and they depend in most cases on the report of a Surveyor, who, though he may be personally quite honest, is fully aware that the Insurance Company which employs him prefers to lose a certain amount of hard cash in over-payment rather than acquire a reputation for enquiring too minutely into the *bona fides* of any particular claim. In consequence the Surveyor is inclined to depend, when assessing weights, quality and number of bales, largely upon railway receipts, merchants' books, and individual demands, which, though in most cases they may be regarded as unimpeachable, are by no means always accurate; and evidence is not wanting to show that in consequence of the laxity which prevails in estimating fire-losses in cotton, cotton merchants might be paid larger amounts than was warranted either by the quality or quantity of their stock. The same undercurrent of laxity leads to the Insurance Companies being charged an excessive amount, in some cases, for the handling and transport of the damaged bales from the scene of the fire to the auction-ground. The police, for example, received information that in one case the Surveyor, acting on behalf of the Insurance Company, paid a rate of Rs. 2 per bale for carting, whereas another company paid only 5 annas per bale, the usual rate being from 4 to 6 annas. Speaking generally, and judging by the evidence available, the Committee are of opinion that Insurance Companies require to tighten up their enquiries into all claims against them for loss by fire in baled cotton, and that the present method of preparing loss-statements and assessing damages is occasionally very slipshod and renders the object of a fraudulent cotton-owner far more easy of attainment than it otherwise would be or indeed ought to be.

We now turn to the subject of (c) Mukádams and Jathawallas. As explained above, they advance money to dealers on the cotton belonging to the latter. The number of Mukádams and Jathawallas has increased largely during the last ten years, and in order to attract clients great competition has arisen and most favourable terms have been offered to dealers by the competing agents. On the one hand, rates for charges and commission have been gradually reduced: on the other hand, the terms on which advances are granted have been made much easier. Even during the season under review, with its constant decline in prices, no material alteration is reported to have taken place in the nature and amount of the advances. The easier the terms, the larger naturally is the risk. The larger the advances, the smaller the margins in hand, and the weaker the market, the more frequent the necessity for a call to replenish the margins. If a dealer fails to replenish margins, the usual protection open to the Mukádám is to sell the goods as best he can and appropriate the sale proceeds against the advances made by him. It follows from this that a Mukádám might profit by fires in practically the same manner as a dealer, and the remarks under (a), (b), (c), (d) and (e) above apply equally in this case.

We may also point out that when advancing money against a railway receipt a Mukádám has no other guarantee than the standing of his client, that the cotton covered by that railway receipt is actually of the quality described by the client. To some extent the railway station of despatch is a safeguard, but one and the same station often, indeed in most cases, produces cotton widely differing in value. Cotton may be superfine or fine or fully good, or of even lower quality, and it is within the bounds of possibility that a Mukádám, who has advanced money on the basis of superfine, may discover on the arrival of the cotton in Bombay, that it is only "fine" or "fully good". In the market he could realize only the price of "fine" or "fully good", while the Insurance Company, trusting to its Surveyor and the railway receipt, might pay losses on a "superfine" basis. These cases are, the Committee are glad to believe, on the whole infrequent.

Lastly, a fire in baled cotton might serve to conceal fraud on the part of a corrupt Mukádám, who had sold certain goods without authority and appropriated the proceeds. In the present condition and circumstances of the Cotton Green the unauthorized removal of stock from a "Jatha" would be by

no means a difficult matter. Fraud and criminal breach of trust by the employes of firms are offences of fairly common occurrence in the city, as can be proved by the records of various police stations; and there is no reason why the generally respectable class of Mukadams engaged in the cotton trade should not number amongst them from time to time certain individuals who, with little capital behind them, spend their lives in rank speculation, designed to ensure a meteoric rise to affluence, which not infrequently obliges them to act, if not fraudulently at any rate unscrupulously, and sometimes also may lead to their sudden flight and subsequent arrest and incarceration.

In regard to (d) the buyers of salvage, the Committee would point out that salvage is usually the subject of a forced sale and auctions are usually held within a few days of the fire. The salvage is knocked down to the highest bidder; but it is generally understood that the bidders, who deal in salvage, have formed a ring to keep prices low. The view, which finds general acceptance in mercantile circles, is that the profits on purchase of salvage are usually handsome. It is obvious that without fires there can be no salvage; but the Committee are not prepared to assume that the profits on salvage constitute generally the cause of successive fires, albeit they are of opinion that Insurance Companies by stricter attention to the possibilities of recouping losses on salvage might in many cases minimise an appreciable portion of their outgoings on fires.

Lastly we must mention (e) the labourers and cartmen. It is a well-known fact that when a fire occurs at the Cotton Green, much higher wages than usual are paid for the removal of bales to safety. Cases have been known where Rs. 2 per bale was paid, while the ordinary daily wage of a cooly in Colaba is approximately Re. 1 to Rs. 1-8. The same remarks apply to the cartmen, who have been known to obtain Rs. 2 per bale after a fire, while in ordinary circumstances the rate is 6 annas per bale. The Committee, however, are not prepared to say that either the coolies or cartmen at Colaba are directly responsible for the fires which have occurred there.

9. We have now discussed all the possible causes of the fires, which have taken place at the Cotton Green, and in view of the non-discovery of any person or persons actually setting fire to bales, we can only say that the most probable cause underlying the fires was the condition of the market during this season, as explained in preceding paragraphs. Assuming such to be the case, those who meditated incendiarism would have found very little difficulty in carrying out their object, owing to the extraordinary congestion of bales on the Cotton Green, the complete unsuitability of the Green itself from the standpoint of effective watch and ward, the constant daily inroad to all parts of the Green of all sorts and conditions of men, whom it is nobody's business to stop or to question, the inefficiency and inadequacy of the ordinary staff which the Merchants and Insurance Companies employ to watch their stocks, and lastly the laxity which sometimes prevails after a fire in the actual investigation of the quality, quantity, etc., of cotton destroyed or rendered unmerchantable. The Committee wish it to be clearly understood that they do not allege fraud against any individual firm or person, and particularly is this so, considering that the firms of cotton merchants, which have suffered most, have a standing and reputation which absolutely precludes any suspicion that they could be parties to such fraudulent incendiarism. But the Committee are disposed to believe that the circumstances of 1913-14 are in many ways similar to those of 1905-06, and that there has been an organised, attempt by certain persons, endued with less scruple, less morality, and probably less capital than the chief sufferers, to re-adjust unfavourable conditions arising from an abnormal Indian crop and a constantly falling market, and by driving large stocks out of existence to recover losses which had already accrued or which were practically certain to accrue in the immediate future. The existence of gambling and speculation in cotton by certain classes of those who regularly frequent the Cotton Green has been admitted by some witnesses before the Committee; and indeed it is not easy to see why the chief trade of the City should be free from a parasitic form of business which is

followed in respect of other commodities such as silver, opium, etc. All that the Committee can say is that if the culprit or culprits are ever discovered, it is quite possible that the underlying motive of firing the cotton-stacks at Colaba may prove to be one or more of those suggested in the preceding paragraphs of this report. Further it is practically certain that had it not been for the presence at the height of the fire-period of the special military patrol, the objects, suggested by us, would have been attained, inasmuch as the majority of the fires, which that patrol discovered and rendered ineffective, would have attained large proportions and done immense damage to stocks.

10. We now proceed to the second half of the task allotted to us by Government, namely, recommendations as to the preventive and protective measures which should be adopted to obviate the recurrence of a similar series of conflagrations in future. The first point to which we would draw attention is the patent unsuitability of the present Colaba Cotton Green. Here is an area, upon which is concentrated enormous wealth in the shape of baled cotton, but which from its position, configuration, and internal arrangement is wholly incapable of being properly guarded and supervised. As was recently stated in the Press, the Colaba Cotton Green is a costly and dangerous anachronism. The same remark was made about the Fort walls in 1860, and in spite of vested interests and a certain amount of interested opposition, those old walls, gates and battlements had to disappear. The position of the Colaba Cotton Green in the present year is much the same as that of the Fort walls. A glance at prints and photographs taken in 1850 to 1860, and a perusal of the history of the growth and expansion of this portion of the Island of Bombay must inevitably lead to the conviction that, however suitable this site may have been for the stacking and warehousing of cotton bales sixty years ago, it is at the present moment a dangerous nuisance, and to none does it offer greater danger than the owners of the cotton and the persons who dwell in the buildings which have sprung up in its immediate neighbourhood. Nowhere else in the world, perhaps, would one find solid wealth of the nature of this baled cotton flung down pell-mell in an ill-drained area, surrounded by dwelling houses and cut by a busy main thoroughfare. It is in our view absolutely essential that the baled cotton, which forms so valuable an asset of this City, should be stacked and warehoused in an area well-removed from dwellings and from main and busy thoroughfares. We understand that the Chamber of Commerce has itself appointed a Committee to look into this question, and that they have been able to arrange with the Port Trustees for an area of land at Tank Bandar, capable of accommodating a full normal crop without congestion, and that this arrangement will remain in force until the Sewri Reclamation is ready to receive the whole trade. We are quite convinced that this is a move in the right direction, and that the sooner this area is made available for the stacking of cotton bales the better will it be for everyone concerned. Further it is desirable to stack cotton in a place which can, if necessary, be completely closed to the general public at night, and we believe that this could be arranged at Tank Bandar.

The extraordinary congestion on the Colaba Cotton Green during the season under review has been a source of serious danger and has absolutely prevented anything in the nature of effective watch and ward. Bales stacked one upon another to an enormous height, passages and alleys and side roads blocked with cotton, small colonies of persons of the lower classes squatting among the stacked wealth—these are some of the salient features of the Colaba Green. No absolutely effective watch and ward system could be devised for these conditions without an enormous staff, which is not available and the cost of which would be almost prohibitive. This has not been a normal season, it is true; but even in a normal season it is a matter of great difficulty to guard the present Cotton Green effectively, and from its position on the fringes of a main thoroughfare it is practically impossible to prevent the ingress into all parts of the area of all manner of reputable and disreputable persons. The Police are well aware that the Cotton Green by night serves as a popular resort, and during the day any man can enter the area, with little chance of being asked what his business is and with every chance of escaping observation, if he is on mischief bent.

Then also the area is badly drained, with the result that when a fire does occur and volumes of water are poured through the hoses, a very large number of unaffected bales are rendered unmerchantable owing to water-damage. The Committee are of opinion that wherever cotton may be stacked in the future, arrangements should be made so that the least possible amount of damage may be done by water to the bottom tiers of the various stacks. Slightly sloping ground; platforms for each stack, raised some inches above the ground, and regular surface drainage, seem to the Committee to be three of the chief desiderata, and when once a new area of sufficient size to accommodate all the cotton of a normal year has been set apart, we suggest that if possible the height of stacks should be limited to 5 tiers of bales.

But here we must strike a note of warning. The normal crop of the future will not be the normal crop of past years. We have it on the authority of Dr. Mann that Bombay must be prepared during the next decade for a rise of fully 50 per cent., both in the acreage under cotton cultivation and in the yield per acre. The abnormal crop of the season we have been discussing will probably, if seasons are favourable, be in a very few years no more than a normal crop; and it is therefore essential that the temporary area which it is proposed to set apart at Tank Bandar, as well as the ultimate home of the cotton trade at Sewri, should be of an area sufficient to accommodate properly (*i. e.*, in stacks of not excessive height, with suitable lanes, alleys or paths between them) a very much larger quantity of cotton than has up to date been regarded as the normal outturn of the cotton-growing districts of India. We feel confident that if arrangements of this kind are made, with prescience and understanding, the first and foremost persons to pass a benediction on the scheme will be the Insurance Agencies of Bombay, to whom the Colaba Cotton Green has become "Anathema".

Before passing to the subject of the watch and ward of the Cotton Green, we would say a brief word regarding the cotton-godowns which disfigure this ill-omened area. They are even more anachronistic than the Green upon which they stand. Ill-built to begin with, they contain the flimsiest partitions which do not reach up to the roof, and in many cases their doors do not fit together and cannot be tightly closed. Since the fire in the famous "slated godown", the owners have commenced to repair and rebuild it; and we have it on the authority of an official who has personally inspected the resuscitated building, that it would be nothing short of a scandal, were the Municipal authorities to pass it. All we can therefore say on this subject is that the majority of the present godowns are highly unsuitable and inadequate, and that if godowns for the storage of bales are hereafter erected on the Sewri Reclamation they should be built substantially, according to plans approved in the first instance by persons who understand the risks and realize the requirements of trade.

The next point that occurs for discussion concerns the staff engaged for the watching of the jathas and godowns. At present this staff consists of three different classes of people, namely (*a*) Ramoshis, supplied by the Commissioner of Police, (*b*) private watchmen engaged by the firms who own cotton and (*c*) members of the Salvage Corps, which is maintained by the Insurance Companies. As a class, the Ramoshis are thoroughly unsatisfactory, and indeed would not exist at all, if the regular Police Force was augmented up to a strength adequate to carry out its duties effectively. But as matters stand, the numerical strength of the Constabulary obliges the Police Commissioner to supply, and private citizens or firms to pay for, an agency which occupies in some respects much the same position to the City of Bombay that the old watch did to the City of London before the passing of Peel's Bill.

The private watchmen employed by various firms are very little better. Many of them are Pathans, who are numbered among the regular criminal classes of the Bombay Presidency; and although here and there they may do good work and may, by the very fact of their origin strike a certain amount of awe into the minds of the inferior Indian public, they are nevertheless capable of quite as much guile, chicanery and criminal misbehaviour as any class in this steadily-advancing Presidency.

Thirdly there is the Salvage Corps, whose primary duty is not to guard jathas and prevent fires. The Committee is of opinion that if the cotton trade of this City is to be centred for some years yet at Colaba, the Insurance Companies and the Cotton firms concerned would do well to jettison wholesale their Ramoshis and Pathan and Panjabi watchmen, and establish in their place, by mutual agreement and payment, a reorganized Salvage Corps, numerically larger and efficiently controlled and supervised. The same suggestions apply in some degree, if the centre of the trade is carried to Tank Bandar or Sewri. Once an area is provided, in which a really satisfactory arrangement of stacks, jathas, or godowns can be devised and enforced, there would be no difficulty in framing a very complete system of beats and guard-posts, to be carried out by a single agency of carefully recruited men, under decent and trustworthy supervision; and such a system would probably cost both the Insurance Companies and the Cotton-Traders less in the end than the present system of large monthly payments to an inferior agency coupled with wholesale distribution of rupees to special agencies, like the British regiment at Colaba, whenever a crisis occurs and panic supervenes. But no matter what agency is employed for watch and ward of these huge interests, the greatest source of safety will lie in having the cotton stacked and warehoused on modern and satisfactory lines in an area which is not liable to be visited and perambulated at any hour of the day or night by casual visitants, who may or may not have any interest in the cotton-trade.

Another obvious safeguard against heavy losses by fire is a ready and copious supply of water at the Green. We are of opinion that, considering the general deficiency of water-supply from which Bombay at present suffers, the Municipal authorities have responded to the very best of their ability to the extraordinary demands made upon them by the Colaba Cotton Green. At the same time we suggest that if, simultaneously with the completion of the duplication of the Tansa Main, a constant supply and more hydrants are provided for the Green, no matter whether it be at Colaba or Tank Bandar or Sewri, not only will a further material safeguard against fire have been provided, but a certain misgiving, which at present affects the mind of the trade, will have been set at rest.

We have already touched upon the question of the laxity in safeguarding their interests after a fire has occurred, which would appear to characterize some Insurance Companies. In this country the system of "give and take" is apt on occasions to be carried to excess, and a distinct opinion prevails among persons who have had experience of this form of business that Insurance Companies would do well to satisfy themselves more fully as to the facts of loss, after a fire has occurred, rather than to pay up blindly in the hope of recovering a fair proportion of their losses by increased business in subsequent seasons and of acquiring a reputation for being "good losers". We hold that it is advisable to constitute by legislation an agency, consisting of either a single individual or a tribunal, for holding immediate enquiries into all fires, which cause loss or injury, occurring within the City of Bombay, such agency to be vested with legal power to call for evidence both oral and documentary. The value of such a procedure lies in the fact that it ensures an immediate enquiry under law, the taking of statements on oath, and the power of calling for documentary or other evidence, which in present circumstances is not always feasible or lawful.

11. To sum up therefore, our suggestions for preventive and precautionary action are briefly as follows:—

- (i) The removal of the Cotton Green from Colaba to some more spacious, better arranged, better drained and more remote site.
- (ii) The restriction of the height of cotton stacks, with proper alleys, lanes or roads between the various stacks and jathas.
- (iii) The storage of cotton in godowns which are properly built.
- (iv) The organization and maintenance by the cotton merchants and Insurance Companies jointly of a better staff for guarding the Green.

(v) The provision of an adequate number of hydrants and full pressure of water throughout the 24 hours.

(vi) Efforts by Insurance Companies to safeguard as closely as possible their own interests after a fire has occurred.

(vii) The institution of a tribunal or court of enquiry of the nature referred to in the preceding paragraph.

12. Lastly, we beg to bring to the notice of Government that several of those who gave evidence before the Committee, desired to have their statements taken *in camera*, and are most anxious that their views should not be made public. In these circumstances we beg that Government will treat the printed copies of the evidence, which accompany this report, as confidential documents and will not publish them with this report. Mr. H. B. Clayton, the Municipal Commissioner, and Mr. M. Leslie, have been unable to sign the report, as they left for Europe before the report had left the press ; but it is believed that their views coincide with those expressed by us. Dr. Harold Mann has signed the report subject to a minute of reservation, the inclusion of which in this report is in the opinion of the remainder of the Committee unnecessary, and which is therefore being submitted separately to Government.

We have the honour to be,

Sir,

Your most obedient servants,

S. M. EDWARDES.

A. H. A. SIMCOX.

D. E. WACHA.

H. R. GREAVES.

HAROLD H. MANN.

PURUSHOTTAMDAS THAKURDAS.

J. MULLER.

B. HIGHAM.

NAROTTAM MORARJI GOKULDAS.

APPENDIX A.

Report on Observations and Experiments in connection with the Cotton Fires in Bombay, March-May 1914.

The cotton fires can have only one of three origins. They must be caused by foul play, or they must have originated from spontaneous combustion, or they must have originated from outside influences as yet unknown. The third deals with unknown possible outside causes of which we have heard so many theories during the past few weeks: I have some experiments in hand with regard to these, but so far there seems no evidence in favour of any of them. If there is any chance of the second origin above suggested being true, it is obviously necessary to ascertain what are the conditions, if any, in which cotton as stored in Bombay would undergo such a rise in temperature as would possibly lead to ignition.

Now the stored cotton in Bombay consists of (1) cotton, (2) cotton seeds, (3) broken cotton seeds, (4) produce from cotton seeds such as cotton seed oil, husk, 'meats' of cotton seed, (5) a varying quantity of original or added water. Under normal conditions I cannot find any other materials present. It is kept in hardpressed* bales, covered with gunny bag, and held together by iron bands. The special conditions are a very high temperature particularly when stored in the sun on the Cotton Green where the majority of the fires have occurred, accompanied by a much moister atmosphere than is found up-country. We have, therefore, to consider whether each of these influences can produce any rise in temperature—and, if so, what.

The actual temperature in and on the cotton in the Cotton Green and in godowns is shown by the following observations:—

A. Cotton Green—

(1) May 5th, 1914. 1 to 2 p. m.

Temperature in sun on top of cotton stack—133° F.

Temperature under iron bands on top of stack—146° F.

Temperature between bales on top of stack, where sun was penetrating—115° F.

Temperature between two bales near top of stack, in shade—99° F.

Temperature between two bales, three rows from the top—92° F.

Temperature between two bales, two and three rows from bottom (1) 93.5° F., (2) 91.5° F., (3) 92° F.

It was evident that the temperature at the hottest time of the day inside a stack, leaving out of consideration the top layers exposed to the sun, was between 92 and 95° F. The temperature on the top layers are of little importance in the present inquiry, as fires have never broken out there.

(2) May 5th, 1914. 4 p. m.

Temperature two and three rows from the bottom (1) 92° F., (2) 93.5° F.

This is the point at which fires usually break out.

(3) May 5th, 1914. 1 to 2 p. m. (Temperature inside bales.)

Temperature inside cotton bales 6 inches from the surface—93 to 97° F.

Temperature inside cotton bales 2 inches from the surface—95° F.

Temperature inside cotton bales 12 inches deep in broken bale in the open—93.5° F.

Temperature inside cotton bales on top of stack in full sun (2 inches deep)—104° F.

(4) May 5th, 1914. 1 to 2 p. m. (Temperature in loose cotton *bohras*.)

Temperature under top bale in loose cotton *bohras* (from top)—83° F.

Temperature 4 inches top bale—104° F.

Temperature 6 inches inside top bale (from top)—99° F.

B. Godowns. Various dates in May 1914.

Temperatures at middle of day (1 to 2 p. m.)—90 to 95° F.

C. Mill Godowns. Bombay, May 6th, 1914.

Temperatures at 3.30 p. m. in ordinary mill godown between stacks—86 to 92° F.

Temperatures in godown rarely opened in cotton long stacked (4 p. m.) between stacks—88 to 90° F.

* One fire, and only one, has occurred in unpressed, or half-pressed cotton *bohras*.

In connection with these temperature determinations, which are typical results, from a very large number of readings taken, I sought for local heating everywhere both on the stacks in the open, and in godowns—and never found a single case. In summary, the figures show:—

- (1) that the temperature of the cotton in the sun may rise to 135°F. or so, and under the iron bands to 145°F.;
- (2) that the temperature inside the stacks differs very little in different parts and runs from 92 to 95°F. at the hottest time of the day;
- (3) that the temperature in godowns in Bombay is slightly below that in the stacks in the open and varies from 88 to 95°F.;
- (4) that the temperature inside the bales does not differ appreciably from those on the outside;
- (5) that no evidence of local heating apart from ignition has been obtained from many observations on the cotton in the stacks and in godowns.

In order to ascertain whether there was any real difference in temperature between the temperature of godowns and cotton stacks upcountry where fully pressed bales are stored and where few fires occur, I was invited by Mr. Narottamdas to visit the Sholapur Mill, and did so on May 9th. The following are the figures obtained (12 noon to 1 p. m.):—

- (1) Cotton bales stacked two weeks in open, temperature between bales, second layer from ground —94°F.
(Temperature outside in shade at same time —104°F.)
- (2) Cotton bales stacked in godown for five months.
Temperature between bales, two bales from ground —92°F.
Temperature inside bale —94°F.
- (3) Cotton bales stacked in godown for two months.
Temperature between bales, two bales from ground —92°F.
Temperature between bales, three bales from ground —93°F.

Other readings were taken, but these are sufficient to show that the conditions as to temperature are very close to those in Bombay, and that no reasoning based on differences in temperature can be used to account for the difference in the fires which occur.

There is, on the other hand, a very large difference in humidity in the two places, indicated by the tabulated statements of humidity which are attached.

In conclusion, so far as I can see, the conditions of storage in Bombay and upcountry are for all practical purposes identical, except for the larger amount of moisture in the atmosphere in Bombay.

This being the case, the problem before us is to ascertain whether cotton containing nothing more than specified in a previous paragraph, can possibly fire or can even sustain a considerable rise of temperature, the outside temperature being not higher than 105°F., and the moisture varying in any way you please.

I may say that it quickly became evident that the pressing of the bales had nothing to do with the matter. The fires, where investigation was possible, always broke out on the outside of a bale where there was loose cotton, and worked inwards from such a point. This being the case, I have conducted a large series of tests in which I have ascertained whether with perfect aeration, and with and without moisture, I could get any rise of temperature with varying mixtures of the constituents previously indicated as occurring in normal cotton bales.

Before detailing the experiments made, it will be well to indicate the composition of the cotton immediately round the place of fire in a large number of cases where fires have occurred and have been rapidly put out. The samples were supplied by the Bombay Salvage Corps.

	Burning cotton from P. Chrystal, the fire on 10th of April 1914.	Clean cotton from P. Chrystal, fire on 10th April 1914.	Surface burnt cotton from Messrs. Prier de Soane & Co. Apollo reclamation on 14th April 1914.	Clean Bengal cotton from Messrs. Prier de Soane, fire on 14th April 1914.	Cotton from Indian Cotton Co. fire on two bales on 15th April 1914.	Cotton from Messrs. Prier de Soane 51 bales, fire on 15th April 1914.	Cotton from G. G. Kalseha Vict Bunder, fire on 16th April 1914.	Cotton burnt from G. G. Kalseha Vict Bunder, fire on 16th April 1914.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Lint	88.00	88.88	89.62	85.32	92.41	93.83	92.37	85.70
Whole seed	Nil	Nil	Nil	3.97	Nil	Nil	1.40	2.85
Crushed seed	4.00	3.71	0.95	1.35	1.66	0.68	2.10	4.28
Other Rubbish	8.00	7.41	9.48	9.96	5.93	5.49	4.13	7.17
<i>Total</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>
Oil	0.82	1.13	0.71	0.83	0.78	0.46	0.88	0.22
Acidity of oil milli-grams of KOH per gram of fat.	8.10	3.59	4.70	5.5	4.70	6.90	4.40	17.90

	Cotton from Messrs. Prier de Soane & Co. 5 bales, fire on 16th April 1914.	Cotton from Indian Cotton Co. bale 1, fire on 16th April 1914.	Cotton from Indian Cotton Co. bales 17, fire on 17th April 1914.	Cotton from slated godown A, clean cotton.	Cotton from slated godown A, burnt cotton.	Cotton from slated godown A, clean cotton.	Cotton from slated godown A, burnt cotton.	Cotton from Arthur Bunder 1 bale, on 19th April 1914.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Lint	96.74	91.89	91.24	93.16	97.98	93.08	94.11	87.50
Whole seed	Nil	Nil	Nil	1.89	Nil	1.07	Nil	Nil
Crushed seed	2.82	1.31	1.46	0.39	0.22	0.53	1.37	Nil
Other Rubbish	0.44	7.30	7.30	5.56	3.40	5.32	4.52	12.50
<i>Total</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>	<i>100.00</i>
Oil	0.61	0.41	0.69	0.46	0.26	0.37	0.39	0.49
Acidity of oil milli-grams of KOH per gram of fat.	6.80	17.60	9.90	6.00	10.60	9.60	7.95	9.30

These analyses taken from near the portions actually burnt in bales which were near the origin of the various fires, indicate a very great variation in the character of the cotton. It is not cotton which contains much whole seed, as many of the samples contain no seed at all. It is not cotton which contains much crushed seed as, although several of the samples contained an excessive amount, yet in a number of the cases there was very little indeed, and some of these cases, like that on Arthur Bunder on April 19th, and that from the Indian Cotton Company on April 16th, were cases where the sample was really taken without doubt from the place where the bale caught fire.

At one time I was inclined to think that the firing might possibly be attributed to the presence of a large quantity of oil, but the quantity is very small really, and varies very much indeed, and especially is it very small where the certainty that I have had the actual cotton from the place where the fire has taken place is most complete.

Lastly it was suggested that the oil, being spread on the surface of the cotton fibre rapidly becomes rancid, and so more liable to lead to fire. The acidity test indicates how far this has taken place, and while it proves that the oil has become rancid and under these conditions, it shows that there is no connection between any particular degree of acidity and the firing.

I may say at the same time that all these samples, and many others have been tested for foreign substances. Nitrates (which would have been found if nitric acid had been used) have always been absent. Phosphates (which would have been found if phosphorus had been used) have never been found in larger quantity than is present in ordinary cotton.

And generally, I may say that in my tests there has been no sign of the doctoring of the cotton. It was with the object of detecting such doctoring that the examination of clean cotton from near the point of the fire, as well as that immediately in contact with the fire was made, and in no case was anything found.

I am aware that Mr. Turner found signs of *possible* doctoring of one bale in connection with the Slated Godown fire on April 16th, and this I own was suspicious. It stands alone however, no case at all similar to it has occurred in any of my samples.

As there was no evidence from the cotton received from burnt cotton bales, the next point was (as I have already stated) to try to reconstruct, from the materials normally present in cotton bales in Bombay, any condition where a local rise of temperature could possibly occur. For this purpose, the following materials have been taken and placed with perfect aeration, but without wind, with moisture, and without moisture, at various temperatures.

- (1) Crushed cotton seed.
- (2) Meats from cotton seed.
- (3) Husks of cotton seed, broken and ground.
- (4) Cotton mixed with crushed cotton seed.
- (5) Cotton mixed with the meats from cotton seed.
- (6) Cotton mixed with the husks of cotton seed.
- (7) Cotton with shredded gunny bag.
- (8) Cotton with ten per cent. rancid cotton seed oil.
- (9) Cotton as it occurs in the cotton bales in Bombay repeatedly moistened and dried.
- (10) Cotton as it occurs in Bombay, mixed with ten per cent. rancid cotton seed oil, and repeatedly wetted and dried.

Each of these was kept for three hours at a temperature of 120° F., 150° F., 180° F., and 212° F., and in the cases of Nos. 1, 2, 3, 8, 9 and 10, for twenty hours also, and constant observation made as to any rise of temperature, even to the extent of two or three degrees.

In no case was any rise of temperature observed, and we may take it, I think, that no mixture of any of these materials which could conceivably occur in cotton bales, or in any local part of cotton bales, would be likely to cause a local rise of temperature of any more than a small amount.

In only one set of cases was any rise of temperature observed and then it never exceeded 9 degrees F. This was when very dry cotton—whether containing oil, or other impurities or no—was placed suddenly in a moist atmosphere. This always led, at the temperature usual in cotton godowns, 96° F., to a rise of temperature.

If all the fires occurred in cotton immediately or soon after its arrival in Bombay from up-country, it is conceivable that this might have something to do with them, but as fires occur indiscriminately in bales which have been in Bombay for months, and in new ones, there can be nothing in the fact which affects our present enquiry.

Watering of cotton only leads, in my experiments, to a rise of temperature in the presence of cotton seed, or in the presence of rotting of the cotton and the materials present with it. As many of the samples in which the fires occurred do *not* contain cotton seed; and as there is no rotting of the cotton where the fires took place on the surface of the bales, this cannot be connected with the production of the fires.

The results of the large number of experiments carried out, and which have been designed to try and reproduce the conditions in which cotton could conceivably take fire, are entirely negative.

There is no reason to suppose that in default of outside agency, whether human or other, cotton, under the conditions of storage in Bombay will take fire, and this conclusion applies to cotton as stored in Godowns or on the Cotton Green, and to the cotton of the last crop as to that of previous years.

H. H. MANN, D.Sc.,
Principal, Agricultural College.

Humidity at Bombay and at Sholapur, 8 a. m., 1914.

Date.					Humidity.	
					Bombay.	Sholapur.
15th	March	1914	...	...	62	10
16th	"	"	...	...	76	15
17th	"	"	...	...	78	18
18th	"	"	...	...	84	24
19th	"	"	...	...	70	55
20th	"	"	...	...	72	17
21st	"	"	...	...	76	16
22nd	"	"	...	...	81	28
23rd	"	"	...	...	81	33
24th	"	"	...	...	80	27
25th	"	"	...	...	82	21
26th	"	"	...	...	64	30
27th	"	"	...	...	79	35
28th	"	"	...	...	84	27
29th	"	"	...	...	85	25
30th	"	"	...	...	82	51
31st	"	"	...	...	86	27
1st	April	1914	...	...	83	23
2nd	"	"	...	...	82	25
3rd	"	"	...	...	79	45
4th	"	"	...	...	80	86
5th	"	"	...	...	80	33
6th	"	"	...	...	80	35
7th	"	"	...	...	69	50
8th	"	"	...	...	73	53
9th	"	"	...	...	82	48
10th	"	"	...	...	71	44
11th	"	"	...	...	71	49
12th	"	"	...	...	71	58
13th	"	"	...	...	80	55
14th	"	"	...	...	77	30
15th	"	"	...	...	73	45
16th	"	"	...	...	74	29
17th	"	"	...	...	76	19
18th	"	"	...	...	78	28
19th	"	"	...	...	78	33
20th	"	"	...	...	76	33
21st	"	"	...	...	81	43
22nd	"	"	...	...	85	57
23rd	"	"	...	...	79	47
24th	"	"	...	...	81	34
25th	"	"	...	...	79	31
26th	"	"	...	...	79	31
27th	"	"	...	...	80	37
28th	"	"	...	...	82	42
29th	"	"	...	...	81	27
30th	"	"	...	...	79	29
1st	May	1914	...	...	79	43
2nd	"	"	...	...	78	41
3rd	"	"	...	...	78	38
4th	"	"	...	...	78	48
5th	"	"	...	...	74	00
6th	"	"	...	...	74	50
7th	"	"	...	...	74	50
8th	"	"	...	...	72	69
9th	"	"	...	...	70	55
10th	"	"	...	...	74	57
11th	"	"	...	...	73	58
12th	"	"	...	...	72	50
13th	"	"	...	...	72	43
14th	"	"	...	...	79	29
15th	"	"	...	...	83	14
16th	"	"	...	...	79	30
17th	"	"	...	...	79	47
18th	"	"	...	...	73	38
19th	"	"	...	...	74	37
20th	"	"	...	...	74	41
21st	"	"	...	...	73	29
22nd	"	"	...	...	79	24
23rd	"	"	...	...	81	20

APPENDIX B.

Report upon certain Experiments performed in connection with Cotton Fires with conclusions deduced therefrom and from the evidence given before the Colaba Fire Committee.

The only condition under which cotton is definitely known to be liable to spontaneous combustion is that it shall be impregnated with a vegetable oil. Fires in neglected heaps of oily cotton waste are of fairly frequent occurrence. The liability to spontaneous combustion depends upon the kind of oil and in particular upon its capacity for absorbing oxygen as is indicated by its possessing "drying" properties.

Of the common oils linseed is the most dangerous in this respect, cotton-seed is fairly high up in the scale and coconut oil is low down, the liabilities, as estimated by their chemical unsaturation to iodine, being roughly in the proportion of 19 : 12 : 1. Though it is theoretically possible, I know of no actual experiments in which cotton impregnated with cotton-seed oil in any proportion has actually become ignited when exposed merely to the air either in the direct sun or in the shade. I am conducting experiments to endeavour to show this phenomenon. I first impregnated about 2½ lbs. of cotton with its own weight of cotton-seed oil and exposed it loosely heaped in the sun. No sensible rise of temperature has been noticed in 24 days and the experiment is still in progress. Samples of the cotton have been taken every day and the oil extracted and analysed. The oil is being gradually oxidised as shown by a gradually increasing acidity and a gradually diminishing iodine absorption value, but from the nature of the experiment, the heat of oxidation is dissipated owing to draughts of air passing amongst the loosely packed cotton. Had this been avoided by tighter pressing, the result would probably have been different. I next had some metal boxes made with perforated zinc sides into which cotton with known proportions of oil could be introduced and tightly pressed down by hand. The bottom and the lid of the boxes were made of tin-plate, the latter perforated with holes through which thermometers were thrust to register any rise of temperature. A trial was first made with equal weights of cotton and linseed oil and the box was kept out of the direct sunlight. No rise of temperature was registered by the end of a week. The box was then placed in direct sunlight and at the end of 5 hours a rise of 9 degrees Centigrade occurred. This condition of increased temperature was maintained practically unchanged during the night but on re-exposure to sunlight the following day the temperature rapidly rose and after a further 5 hours of exposure the temperature in the centre of the mass had reached 175° C. and the cotton in contact with the side of the box on the windward side was noticed to be smouldering. To avoid damaging the box, the cotton was removed and it at once burst into flame and was entirely consumed. On first removing the lid it was noticed that except where it was actually on fire, the cotton directly in contact with the side of the box was white in colour, but inside this it was brown and commencing to char. The marginal cotton had apparently been cooled by air currents. The experiment has been repeated using cotton impregnated with a quarter of its weight of linseed oil. No rise of temperature was noticed after thirteen days exposure in sunlight. The box was then brought inside, the monsoon having set in. No rise of temperature has occurred since. The experiments with linseed were intended first to demonstrate that spontaneous combustion could be produced at all in the experimental box and secondly to attempt to ascertain the optimum proportion of oil. They will be repeated with cotton-seed-oil.

It seems possible that broken seeds accidentally present in cotton might on the application of high pressures exude cotton-seed-oil into the surrounding cotton fibres and thus produce conditions favourable to spontaneous combustion. Such potentially dangerous centres might occasionally be found on the free surfaces, of a bale, but in the greater proportion of cases they would occur in its interior. It was important to know therefore whether combustion occurring primarily inside a pressed cotton bale would find sufficient oxygen entrapped in the compressed fibres to be propagated and so eventually reach the surface. Experiments were therefore made in collaboration with Mr. Turner of the Victoria Technical Institute to elucidate this question. Three pressed bales were opened up, fuses introduced and the bales re-pressed. The fuses consisted respectively of (1) thin iron wire; (2) similar wire surrounded by a drachm or so of sporting powder; (3) the same wire imbedded in phosphorus, in the three bales. The fuses were connected with thick copper wires leading to the outside of the bales. An electric current was then passed into the wires of such a strength as to make the thin wires in each bale white hot and eventually to fuse them; in this way igniting the cotton from within, with or without the assistance of a charge of inflammable powder or phosphorus. The passing of the current resulted in the production of a noticeable smell of burning cotton except in the case of the bale containing phosphorus. The odour was appreciable a dozen or more feet from the bale and was about equally intense twelve hours later but thereafter became less marked until at last it was only noticeable actually on the surface of the bale. The bales were opened up on the tenth day when the following effects were noticed.

(1) The plain wire fuse.

A fusiform area of carbonisation was found round the wires about five inches in diameter at its widest point extending with gradually decreasing radius along the copper leads. There was no appreciable heat remaining in the charred area showing that the combustion had ceased for some time.

(2) *The powder fuse.*

The area of carbonisation was less in this case, but obvious combustion of the cotton had occurred.

(3) *The phosphorus fuse.*

The phosphorus had been partly converted into the red or inert variety and no combustion of the surrounding cotton had occurred. It may be added that soon after it had been opened up this bale caught fire. Whether this was due to some unchanged phosphorus left in the bale or to sparks from a piece of cotton which was burning nearby where another experiment was in progress, cannot be definitely stated. The whole bale was consumed to ash in about twelve hours. This is of interest as showing the time taken by a burst bale to be completely consumed by fire.

The experiments appear to show that if a focus of combustion were to occur within five inches of the side of a bale it would in all probability extend to the surface, and if within three inches it may be taken, I think, that it would almost certainly do so.

It is not however possible to state definitely that spontaneous combustion could arise in a focus of oily cotton under the conditions existing in a fully pressed bale. Moreover were this at all a common occurrence, bales would frequently be found showing an area of burnt cotton in the interior which had not reached the surface but had been extinguished exactly as was demonstrated in the fuse experiments above. Inquiry of millowners has entirely failed to substantiate this possibility, but Major Dickinson, Chemical Analyser to Government, now on leave, has since written informing me that he once observed this phenomenon some years ago in a bale in the King Edward Mill at Mazagan. A small area of ash not connected with the surface has also been described by Mr. Turner in his evidence; but this was in a bale which had also been burned from the outside. It had thus the advantage of a higher initial temperature, due to the neighbouring fire, than would normally ever occur in a cotton bale. It must therefore be conceded that spontaneous combustion may occur inside a pressed cotton bale in certain conditions.

A cogent objection to such an origin for the present series of fires is given by an investigation of the numerous small fires which have occurred involving one bale only. In all these cases the fire has originated superficially in the loose cotton projecting at the corner of a bale between the hoops and this moreover in the lower tiers of the stacks where the initial heat is lower than at the top where the bales are directly heated by the sun's rays. This loose cotton, even if impregnated with oil, must be in a condition approximating to that of the first experiment described above, where no heating effect was obtained owing to loss of heat to surrounding air currents.

Some of the witnesses have spoken of great heat generated in moist cotton. This heat has not yet been reproduced artificially but I am making experiments in this direction.

Several witnesses have spoken of the difficulty of igniting a bale by means of matches and one witness even stated that with a candle a bale could not be ignited in five minutes. This has certainly not been my experience and I have managed to get such an extensive conflagration in a bale as would certainly have resulted in its complete reduction to ashes, merely by placing a lighted cigarette in contact with the loose cotton at the corner of the bale. A direct draught from an open window was blowing on to the ignited area at the time.

In this and other experiments it has appeared to me that when a fire is started in loose cotton at the margin of a pressed bale it proceeds to smoulder without flame, persistently but quietly, eating into the bale and spreading over the surface. If however it reaches a loose flap of the gunny covering the bale the latter is often inflamed and thereafter the spread of the fire is enormously increased. I have confirmed this impression in many cases by evidence procured from the witnesses before the Committee. It appears to me that this inflammability of gunny was a serious contributing agent to the spread of fires in stacked cotton bales. The analysis of a sample of gunny cloth sent to me by the Insurance Association revealed the fact that it contained about 6 per cent. of substances soluble in ether which appeared to be of resinous nature. I set up three samples of the gunny, one in which this resinous substance had been removed by treatment with ether, one similarly treated and impregnated with a fire-proofing solution containing borax, boric acid and sal ammoniac, and the third a check consisting of untreated gunny. These samples were then ignited in the flame of a bunsen burner. The resin-free gunny burnt less readily than the untreated sample, and it was impossible to ignite the fire-proofed gunny at all: it merely glowed as long as it was kept in the flame and was immediately extinguished when it was removed from the flame. As the fire-proofing agents used were quite cheap it appears to me that a fireproof covering to cotton bales would be a financial possibility and would result in a great diminution of the rapidity and extent of the spread of fires originating in stacked bales.

Experiments to ascertain the presence of any inflammable substance introduced with felonious intent have been uniformly unsuccessful. I have not had the leisure to examine samples of cotton from every outbreak of fire but those examined showed no evidence of the presence of phosphorus, nitrates or chlorates. This was really only to be expected, seeing that had any

of these substances been utilised they would have been the centre of the ensuing fire and no trace of their presence would be left in most instances. Mr. Turner had produced evidence pointing to the use of chlorate of potash and sulphuric acid in one case. Major Carter also produced evidence less conclusive but pointing in the same direction. Another possible method of igniting a cotton bale was demonstrated to me, namely, of igniting a handful of loose cotton and then covering up the smouldering point with more cotton. Such a handful of cotton with a focus of combustion in the centre can be held in the palm of the hand for many minutes, and no odour is appreciable from it. I placed such a bale of cotton in a glass vessel in my laboratory and it was two hours afterwards before it burst into flame. Had it been pushed between two bales or tacked into a loose corner of a bale, maybe under cover of the pretence of taking a sample, the bale would in a large proportion of cases have been ignited an hour or so later.

After the extensive fire which occurred at the Apollo Godown in June a reddish earthy substance was noticed on the surface of and between the partially consumed cotton bales. As this substance was present in very large quantities it was thought that the cotton which was in this godown might have been artificially weighted with earthy matter up-country before baling and that the fire might have been intentionally caused with a view to concealing this proceeding. Had this actually been the case it would follow that samples of this cotton which had escaped the conflagration would have given abnormally high percentages of ash. I took six samples of unburnt cotton from bales either themselves presenting a coating of this earthy substance or in the near neighbourhood of accumulations of it. The ash of these samples varied between 1.30 per cent. and 3.18 per cent. and averaged 2.28 per cent. of the dried cotton. The ash of Indian Cotton may be as much as 4 per cent. or more, anything above 1 per cent. being taken for practical purposes as being mechanically attached sand, dust, etc. It is clear then that the samples taken were in no wise exceptional in this regard. I further compared the earthy substance with the actual ash of the samples I had taken and found that the former contained 77.4 per cent. of substances soluble in hydrochloric acid and the latter 79.1 per cent. This near agreement of these figures suggests that the earthy substance observed was merely the ash of that portion of the cotton which had been totally consumed by the fire. It would be exceedingly improbable that any added earth would have so large a proportion of soluble substances. The Fire Brigade authorities look upon this particular fire as being the fiercest blaze of the whole series and this may account for the fact that the presence of this earth had not been a noticeable feature of the other fires. I certainly saw none in the debris of the Frere Road fire, which I particularly examined in this regard after seeing the appearances noted above at the Apollo Godown.

The result of my experiments and my conclusions from the evidence adduced before the committee may be epitomised thus:—

(1) That spontaneous combustion does occur in oily cotton exposed to the sun in Bombay when linsed oil in certain proportion is used. It may occur similarly with cotton-seed oil.

(2) Combustion originating in the interior of a pressed bale may spread to the exterior.

(3) No evidence has been adduced of fire occurring in the interior of a bale in any of the fires now under consideration.

(4) On the contrary, the fire appears to arise most frequently in the loose cotton at the corner of a bale: where the theory of a spontaneous origin is unlikely owing to the loss of heat by conduction and convection which would inevitably occur in this situation.

(5) That in the vast majority of cases where objects, either cotton bales or other, are found burning a human origin to that fire may be confidently postulated; a spontaneous origin for a fire is exceptional; that therefore in the fires now under consideration the onus of proof lies on the spontaneous theory: and that no experimental or other evidence has been adduced before the committee which would tend to substantiate this theory as a satisfactory explanation of the fires that have occurred.

(6) That gunny is unnecessarily inflammable and that the rapidity of spread of fire could be reduced by the use of a less inflammable covering to the bale.

(7) That the present series of fires could have been produced by human origin.

B. HIGHAM, CAPTAIN, I. M. S.,
Officiating Chemical Analyser to Government.

APPENDIX. C.

VICTORIA JUBILEE TECHNICAL INSTITUTE:
Bombay, 29th May 1914.

Report on Cotton Samples.

1. Report on samples taken from burnt portion of bale in salvage, April 11th, 1914.

This burnt portion showed several curious features. The outer crust was very hard and had every appearance of having been charred and fused.

It had a distinctly saline taste. The Chief Officer of the Fire Brigade, the police and the salvage authorities were absolutely certain that no salt water had been used to extinguish the fire.

The inner portion of the bale and other parts of the exterior did not show this fused appearance.

The ash from cotton normally shows about 10 per cent. of potassium chloride and 10.13 per cent. of sulphate. This sample showed 11.2 per cent. chloride and 16.4 per cent. of sulphate.

This result seems to indicate that chlorate of potash was put on the gunny bag probably as solution and allowed to dry. I suggest that at some later period vitriol was put on the bale which caused the whole mass to ignite.

No other burnt bale that I have examined showed either the same abnormality in physical appearance or gave any unusual ratio between the chlorides and sulphates.

2. On the same day I examined some of the damaged bales from the same fires which were stored in the fire station at Colaba. In one of them I found at a distance of about 2 inches from the end and from the two faces a portion burnt to a white ash. The cotton on the outside was only charred. This completely burnt ash was probably the ash from a cotton-seed or some foreign matter, which had fired spontaneously owing to the great heat in the vicinity, but I do not think that the foreign matter would have fired under the normal conditions of temperature obtaining in Bombay; in fact I feel sure that it would not have so done.

In no other case have I been able to discover any similar ash.

3. A bale from the Alexandra Dock (which was to have been shipped per S. S. *Mantua* was forwarded to me by the police. This was very carefully handpicked and one or two curious features were noted:—

(a) A batch of 50 lbs. was run through the various opening and cleaning machines and the amount of impurity consisting of whole and broken seeds, sand, leaves, grass, bits of string, etc., carefully determined. They totalled upto 9 per cent. This is well within the average, but in small samples the seed was considerably in excess of this amount, in fact in one case the amount of seed was 60 per cent. Some of these seeds had been out in the gin and if the cotton were damped fermentation would inevitably set in with considerable rise of temperature. (See notes below).

(b) A piece of grass was found abutting on the burnt surface. It burnt as if it had been dipped in nitre or chlorate of potash, but as some vegetation contains the former, it is impossible to say definitely that the grass had been "doctored." Still as it was the only piece showing this peculiarity, I think it worthy of note.

Notes to (a).—The whole and broken seeds from the cotton cleaning machines in the blow room of a mill are thrown out into the compound and I have noted a very considerable temperature in the heap. The smell of putrefaction is very noticeable and at a depth of a few feet from the surface the seed is often in a state of combustion. Cotton from one of the fires was, at the end of March or early in April, stacked wet near the basin to the north of Grant's Buildings and on April 11th there was this characteristic smell of putrefaction and also a moderate excess of temperature over that of the outside air. These observations go to prove that water on cotton containing seeds, etc., may set up dangerous conditions, but as already stated there is no evidence that any of the fires have arisen from this cause.

4. Experiments have been carried out to determine whether if a fire were started in the centre of a bale, the fire would find its way to the outside. The results showed that the cotton burnt giving about a five-inch cube of badly burned and charred cotton and then that the products of combustion extinguished the fire.

5. I am carrying on further experiments and will report the results in due course.

6. At the present moment I do not feel that there is any ground whatever for attributing these fires to spontaneous combustion due to natural causes.

A. F. TURNER, B.Sc., F.I.C.,
Head of the Chemical Department.



Black figures in row-- Rate for fine Akola Khampoon mgd. per Bombay Candy of 78.4 lbs. engl. net.
 Red figures in row-- Rate for Spot Midding American in Liverpool per 1 lb. engl. net.
 0.02 d. per lb. = R.I. per Bombay Candy.

Estimated Stocks in Bombay on: (in thousands of bales.) Vertical

	1 December.	15 December.	30 December.	15 January.	30 January.	15 February.	28 February.	15 March.	31 March.	15 April.	30 April.	15 May.	31 May.
1904-05	215	305	332	325	382	513	599	732	767	678	723	804	869
1905-06	401	499	584	685	794	857	955	952	953	994	1035	1015	960
1906-07	234	307	398	430	475	487	623	600	646	642	660	663	770
1907-08	285	322	427	462	511	575	636	657	639	641	638	616	613
1908-09	64	94	149	216	295	no figure available.	345	448	481	405	416	387	366
1909-10	120	443	552	569	574	572	706	770	761	727	697	700	684
1910-11	118	179	232	341	357	337	369	404	436	480	504	526	497
1911-12	300	313	358	471	591	543	587	631	672	650	658	627	714
1912-13	190	234	405	469	505	531	702	731	660	642	717	755	749
1913-14	457	553	663	658	770	788	879	979	1061	1096	1117	1015	924

The red lines denote the number of fires for which an alarm was given to the fire brigade. There were, however, a good many small fires which were put out without the help of the fire brigade and for which no alarm had been given. These small fires, which were not reported would, however, not alter the appearance of the Chart.