

Tuesday, 15th May, 1928.

NOTES of EVIDENCE

Baken before

THE COMMITTEE APPOINTED BY THE MINISTER OF HEALTH

"To enquire into the possible dangers to health resulting from the use of motor spirit containing lead tetra-ethyl or similar lead-containing compounds, and to report what precautions, if any, are desirable for the protection of the public or of individuals in connection with the use and handling of such motor spirit."

Present:-

Sir Frederick Willis, K.B.E., C.B. (Chairman)
Dr J. C. Bridge, F.R.C.S.
Professor A. C. Chapman, F.R.S.
Professor W. E. Dixon, M.D., F.R.S.
Major W. R. Galwey, O.B.E., M.C., M.B.
Dr C. H. Lander, D. Sc.
Sir Charles J. Martin, C.M.G., D.Sc., F.R.S., F.R.C.P.
Mr D. R. Pye
Sir Robert Robertson
Sir William Wilcoxon, K.C.I.E., C.B., M.D., F.R.C.S.

Mr S. F. S. Hearder, (Secretary)

(Transcript from the Shorthand Notes of GEORGE MOORE
38, Parliament Street, Westminster, S.W.1.
Telephone:- Victoria 18

Dr M. COPLANDS called and examined.

CHAIRMAN: You are an M.D. of London, I understand? --- Yes.

Q You have studied medicine and the details of medicine? --- Yes.

Q You have done a good deal of research work? --- Yes.

Q You have published a work in the Journal of Toxicology, and you have been associated with Sir Richard Graham, a Fellow of The Royal Society, on this same subject? --- Not exactly the same subject but on toxins.

Q We are very much obliged to you for furnishing this Memorandum you have sent in to us: we shall keep it on our records, and we propose to put some questions to you arising out of your work. In the main, of course, what we want to know from you is precisely what experiments you yourself have made, your observations and what results you have obtained, and what deductions, if any, you have drawn from the experiments. I notice, for instance, that you paid a visit to the United States in the summer of 1927, and you took the opportunity of consulting various people in America in regard to the use of ethyl petrol. You then refer us to the report of The Bureau of Mines in regard to the experiments which they have carried out, and you refer us to various American reports. On that I may say that the Committee have been furnished with practically all these reports that you have mentioned; still, we are much obliged to you for giving us the references. I gather that you do not in your paper refer to the Surgeon-General's report. Were you aware of that report? --- Oh yes.

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Q For instance, I notice that Professor Edsall of Harvard signed a preliminary report with a Mr Drinker, and they give rather a different view as to the danger of ethyl petrol from that which was subsequently arrived at by the Government Committee in America; and Professor Edsall of Harvard was a member of this Committee subsequently;

I do not know whether you are aware of that? --- This report was published in 1925.

Q Yes. --- I rather think that the Surgeon-General's report saw the light of day somewhere about January 1926.

Q That is right; and the work was done, I think, between --- May 1925 and the end of 1925. The written report was published in 1926. --- I think the Surgeon-General in his report asked for an appropriation from Congress in order to carry on experiments.

Q That is quite true; but they did issue a report in 1926. I notice that you refer to certain discrepancies between the full report of The Bureau of Mines which was published in 1927 and the draft preliminary report which they made in 1924? --- Yes.

Q The full report in 1927 of course embraces a great deal more than what had been done in 1924? --- A good deal of that work refers to matters outside our scope here.

Q You are quite right. This Committee is concerned to enquire into the question of whether there is any danger from the use of commercial ethyl petrol. I notice that you refer to the possible danger in traffic blocks of a large number of cars using ethyl petrol? --- Yes.

Q Have you yourself made any experiments to ascertain these facts? --- I have taken them from Professor Henderson's work in New York; but I think I was quoting from the reports.

Q That is what I gathered. You yourself have not done any experiments of that kind? --- No.

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- Q Have you yourself made any experiments to ascertain these facts? --- I have taken them from Professor Henderson's work in New York; but I think I was quoting from the reports.
- Q That is what I gathered. You yourself have not done any experiments of that kind? --- No.

Q You also refer to the possible pollution of wells and water supplies? --- Yes.

Q But you have made no examination of water supplies and wells in order to see whether they are polluted?

--- The experiments were conducted in such a way that one would necessarily infer that it was possible to pollute these places.

Q I suppose you would agree generally with this; we all know the danger of lead poisoning, and that a certain amount of lead is necessary to produce lead poisoning. But if you have an infinitesimal amount of lead in a river, that is not dangerous. If you have a large amount of lead in a river, of course it would be dangerous. It is a question of amount? --- And time, sir.

Q And time? --- And of course the amount involves the question of sex and age.

Q Yes. What experiments have you yourself done. First of all I think you have had an examination made of the lead contents in the excreta of certain men who had worked in^a garage?

--- There were two men who were kept under independent medical observation by their own doctors and also by a specialist representing a London teaching hospital, where they are expected to do that work, with the results that I have stated. There were only two mechanics employed at this place, otherwise more men would have been examined, but it was not possible to examine more than two men. It was necessary to obtain their consent, and there was a special circumstance

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water supplies. --- Yes.

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Q And time? --- And of course the amount involves the question of sex and age.

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--- There were two men who were kept under independent medical observation by their own doctors and also by a specialist representing a London teaching hospital, where they are expected to do that work, with the results that I have stated. There were only two mechanics employed at this place, otherwise more men would have been examined, but it was not possible to examine more than two men. It was necessary to obtain their consent, and there was a special circumstance, that this thing had started by being asked to give an opinion about one car. I began by having the engines tested. I then advised that these men should be medically taken care of, and a fortnight or three weeks elapsed before the consent was obtained and the men examined.

Dr Coplans.

- Q You did not examine these men before your experiment started?
--- No; they were not examined at all as far as I know.
- Q You do not know whether if you had examined them a month before this work started you would have found the same amount of lead? --- It is quite possible.
- Q You do not know? --- I do not know at all. But I understand that it is possible that these men do handle lead occasionally. But they do not handle it in this form; they handle it in the ordinary form -- that may be in mass.
- Q And you only examined the bowel content of one of these men?
--- All these men were examined before I examined them.
- Q But you did not get a proper person to examine the bowel content of men working in garages who were not suffering from tetra-ethyl, for comparison? -- No, I did not. After all this is a very small fact.
- Q I am not saying whether you should or should not have done so? In this connection it was not done.
- Q Then you make a general statement: "spectroscopic examination with photographic record was employed on every occasion for the purpose of detection of the presence of lead". Is that a quantitative test? --- Within certain limits it is both quantitative and qualitative.
- Q You do not ^{depend} ~~base~~ entirely on the spectroscopic examination?
--- I did not examine at all. I simply examined the reports of the doctors who examined them.
- Q Did those people who did examine them depend entirely on spectroscopic examination? --- I am not prepared to say.
- Q You do not know whether they got the lead out and weighed it?
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- Q Did those people who did examine them depend entirely on spectroscopic examination? --- I am not prepared to say.
- Q You do not know whether they got the lead out and weighed it? --- I do not know. I should think not, because such a point was made that there was such a minute quantity.
- Q There were some other people who made these tests and you utilised the results, for what they were worth? --- Yes.
- Q Then another experiment you made was to examine some pieces of

the overalls of these men? --- Yes.

Q Did you for comparative purposes examine pieces of the overalls of other men working in other garages? --- No.

Q So there again you yourself have not got the basis of comparison? --- These facts simply confirm the presence of lead.

Q Quite. Then you make the statement that the laundry to which garments so stained are sent should ordinarily be notified of the risks of handling such material, more particularly by laundresses. Why do you say that?

--- I think that laundresses handling garments of workers in lead should be notified of it by reason of the particular susceptibility of women -- handling lead.

Q Do you happen to know whether laundries are notified when the overalls of lead workers are sent to them? --- I do not know, but I know that in the North of England when they obtain garments from the lead workers the people are warned that they come from lead workers.

Q What sort of lead workers? --- They may be white lead -- ordinary lead. There are quite a number of instances. That kind of rule applies to all laundries being notified.

Q Do you seriously suggest that these particular overalls that we are concerned with are so laden with lead that it is dangerous to send them to the laundry? --- I do.

Q You seriously make that statement? --- I think so. People habitually handling a garment like that I think ought to be warned.

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Q Then you made an experiment about the evaporation of lead with a view to seeing whether any of it was absorbed? --- Not so much that as to seeing the possibility of removing it.

Q You put a certain amount of ethyl petrol on the skin? --- On my own skin, and I tried to rub it off with a linen swab soaked in kerosene.

Dr Coplans.

Q Then you estimated the amount of lead in this linen swab?

--- Yes.

Q Then by calculation you show that what was not removed by the linen swab was absorbed by the skin? --- No. All I say is that it was not removed.

Q You say the skin of the arm had absorbed .54 milligrams?

--- The skin had absorbed it.

Q You do not say it was merely not removed but you say the skin had absorbed it. That is on page 2. You do not say it was absorbed but that it was not removed? --- Yes.

Q Are you acquainted with this experiment that was carried out by Dr Kehoe? --- The only experiments that I know of are these experiments quoted in the green book -- if I may call it the green book. It is confirmed by the facts in regard to the guinea pigs -- it is on page 380. There is a table.

Q Are you acquainted with an experiment by Dr Kehoe.

He kept a monkey for three years and on the skin of the monkey 720 ^{application} ~~lbs~~ of lead was placed during the three years.

Two cubic centimetres of ethyl petrol -- after that this particular monkey was killed and only a trace of lead was found in the monkey -- no more than was found in a control animal? --- That may be so. It may be that the monkey

in did not absorb it. On the other hand a very large number of experiments in which the material was only absorbed by the skin it was found in the foetus recovered from the animal.

That was confirmed by Flinn. He painted the skin of some goats, and not only was the material absorbed but the

pregnant animal aborted and the lead was found in the foetus.

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Dr Copland.

- Q In regard to the somewhat alarming statement that the water supplies of Great Britain might be endangered if this material were allowed. Have you made any calculation as to the amount that would be necessary to make that possible? --- I do not see the remarks to which you refer.
- Q "The danger of pollution of underground water supplied as might arise when oil from the engine sump of a car in which ethyl petrol has been used as motor fuel is poured on the ground in proximity to a shallow well"? --- Yes. There is also a specific statement in regard to underground water supplies particularly shallow wells, where there may be circumstances where there would be danger.
- Q Then you give us a copy of a letter from Dr Flinn which reached you in March of this year, about lead poisoning in general, but not about ethyl petrol? --- That is showing the effect of a very small dose.
- Q I think you did a certain amount of work for the Daily Mail? --- Yes.
- Q A series of articles was published in the Daily Mail on your work? --- That is so. That was on material furnished by the Research Association of British Motor Manufacturers, and assisted by the Committee on Scientific and Industrial Research.
- Q Do you consider as a scientific man that the amount of work that you yourself have done on this subject justified the somewhat alarmist articles that you have published? --- I think I say in this report that whatever I found was exactly what was found in America. There is no difference in the findings
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as might arise when oil from the engine sump of a car in
which ethyl petrol has been used as motor fuel is poured
on the ground in proximity to a shallow well"? --- Yes.
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that you yourself have done on this subject justified the
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I say in this report that whatever I found was exactly what
was found in America. There is no difference in the findings
from what have been already found in the United States. In tha
I have associated myself with a very large number of people
in America who consider that the universal use -- the
unlimited use of ethyl petrol carries with it a number of
dangers.

Q That does not quite answer my question, which was whether you

Dr Coplans.

consider that the amount of work that you have done and the results that you obtained yourself justify the somewhat alarmist articles. You yourself have done very little?

--- Well, I say that what I have done, as far as I have gone, is exactly in accord with the results that have been produced by the Americans: as appears in this green book. Granting that what they say is true.

Q You agree that these articles emphasise what a very serious thing lead poisoning is, and rather by implication suggest that if the use of ethyl petrol were allowed in this country those bad results would follow? --- I think I have said "if a large number of cars use it." I mean it is almost the direct cause of a large number of cars using this material. A few cars of course would amount to nothing at all. If a large number of cars were placed in a particular spot the danger would be increased. I do not think I could have said it more emphatically.

Q Do you think it was right to issue those articles after the Government had decided to set up a Committee to enquire whether the use of this material was dangerous or not?
--- As to that I would like to explain: on January 16th I was undertaking with the Daily Mail to act in association with the Research Association in a certain number of matters, and to provide a written opinion on the materials collected by them. That was in January, long before any question came up or anything at all was proposed by the Government. As a matter of fact at that time the Government were opposed, I understand, to any Government enquiry.

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Q Oh, I do not doubt that. At any rate you say that when your contract with the Daily Mail was made there was no decision to have an enquiry? --- That is so.

Q And before those articles were issued it had been decided to have an enquiry? --- At the time the Government decided to have

an enquiry the work was practically all done and it was beyond my power. I was under a legal obligation to hand the material over to the Daily Mail.

Q You were not responsible for the publishing of the articles?
--- Not the slightest.

Q I do not know what interest the Daily Mail has in it, but if they were really anxious to get quite to the bottom of this in a scientific way one would have thought that some of this American work -- the Government report, for instance which was in rather an opposite direction to your articles, would have been mentioned by them. But that is not mentioned at all, is it? --- Oh, the American Government Report. I do not quite accept that. The American Report appeared in 1926 and asked for an appropriation from Congress to continue the work.

Q But after a very exhaustive investigation the Government Committee did say that they were unable to find any definite cases of lead poisoning in which they found the fuel had been used for from two to three years, and accordingly in the view of that Government Committee in America there was no good ground for prohibiting the use of ethyl residue as a motor fuel. That was not stated in the Daily Mail articles. I mean our British public would perhaps have been more comfortable if they had been told that? --- I think that Report is more recent. I think the result of what was done was published in the Medical Officer. As a matter of fact I published the whole of that article in the Medical Officer. I will give the Committee the dates when I actually published in the Medical Journals before the Daily Mail

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Q Of course there is danger in garages from carbon monoxide?

--- That is one danger; but that may be taken away by ordinary means, but the danger with lead remains.

The Surgeon-General did not decide the matter there and then: he asked to be allowed to continue the research, and the United States Government have not given him the appropriation that was asked for.

Q But there is a certain amount of work that is being done?

--- Yes.

Q It is a question of what value is to be attached to it?

--- Quite so; but your opening remark was that I did not publish the Surgeon-General's report. I say that I did publish it in the Medical Journal.

Q I only say that in The Daily Mail articles, which reach a very large public, you did not refer to the investigations that had been made by the American Government. --- If I had done so, it would have been the same thing as had already been done before: in regard to the necessity for further observation.

Q Quite. Are you acquainted with this report which came out on March 30th 1928: this report of the American Government?

--- No, I have not seen that. I had pretty well completed my report before that report was published.

Q I was only going to draw your attention to the fact that they had made elaborate examination of the atmosphere in very many crowded places - in pretty crowded American cities. The important thing I want to emphasise is this: that you did not do work so as to control your results, that is to say,

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The amount of money that has been spent on this is perhaps not one-thousandth of what has been spent by the interested parties in America, and it is not possible for an individual like myself, receiving money which is not enough to pay for the initial charges of a laboratory. I am bound to say that because you are asking for an impossible thing.

Q I am not asking you to do anything; I only want to see what you did do. I am not in any sense saying what you ought to have done. --- This is the sort of work that I suggest ought to be carried out by the Committee.

Q You think you gave The Daily Mail very good value for the money they paid you? --- I think I can certainly say that.

Sir CHARLES MARTIN: Dr Coplans, I do not wish to intrude upon your private matters, but did you go to the United States on purpose to study this hazard of ethyl-petrol? --- No.

Q That was purely incidental? --- That was purely incidental: I was there on certain matters in connection with myself, and this matter was very much in the air at the time.

Q That is what I thought. Would you turn to your introduction on page 1? There is a sentence there to begin with which I am quite incapable of comprehending, as to why you wrote it. You say: "The opportunity was afforded me of appreciating some of the main factors which have obfuscated the issue as to whether the sale or use of leaded petrol should be permitted as a motor fuel." Could you tell the Committee why you wrote that sentence? --- Yes, sir. In New York City, where the sale is not permitted, the evidence is that there were very few people who had lead in their systems in a normal

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parties in America, and it is not possible for an individual like myself, receiving money which is not enough to pay for the initial charges of a laboratory. I am bound to say that because you are asking for an impossible thing.

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SIR CHARLES MARTIN: Dr Coplans, I do not wish to intrude upon your private matters, but did you go to the United States on purpose to study this hazard of ethyl-petrol? --- No.

Q That was purely incidental? --- That was purely incidental: I was there on certain matters in connection with myself, and this matter was very much in the air at the time.

Q That is what I thought. Would you turn to your introduction on page 1? There is a sentence there to begin with which I am quite incapable of comprehending, as to why you wrote it. You say: "The opportunity was afforded me of appreciating some of the main factors which have obfuscated the issue as to whether the sale or use of leaded petrol should be permitted as a motor fuel." Could you tell the Committee why you wrote that sentence? --- Yes, sir. In New York City, where the sale is not permitted, the evidence is that there were very few people who had lead in their systems in a normal way. It has been said that outside New York a very large number of people have lead in their systems; and that was the point, as to how many people normally have lead in their systems. In New York it was said that not more than three as to or four per cent had it, whereas people representing those who carry on work outside New York, it was said that in

certain cases 100 per cent of the people have it in their systems. Of course, with a background like that, it is impossible to say whether the wholesale distribution of petrol has brought on this universal distribution of lead or not.

Q You think that obfuscated the issue as to whether leaded petrol should be permitted as a motor fuel? --- That was the point.

Q You think you could not decide the question then at all in those circumstances, or only in regard to New York? --- The New York people say that only 3 per cent of the people have lead in their systems; and the New York people say: "You have lead outside New York because you are using leaded petrol".

Q You mean to say that you could not decide this point as to whether leaded petrol was a public danger or not unless you did it in New York? --- I think so.

Q That is really your opinion? --- I think so, yes.

CHAIRMAN: Might we ask you whether cars going into New York have got to empty out? --- I think it has been very fully stated by Mr Francis Powell in The Times of April 11th:

A great point was made of the fact that the New York municipal authorities do not turn out the petrol coming from the cars going into New York. I do not know why they ^{do not} turn out the petrol; it is nothing to do with me.

Q No, no: I am only asking you whether it is the fact that they do not turn out the petrol from the cars? --- No, they do not. I have underlined here the passage from the letter

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Q No, no: I am only asking you whether it is the fact that they do not turn out the petrol from the cars? --- No, they do not. I have underlined here the passage from the letter in The Times: "In the City of New York its sale is forbidden, but not its use, and thousands of cars using it daily pass through the Holland tunnel to and from Jersey City without conditions or hindrance. The reason for the New York City prohibition is not well founded and will undoubtedly be

removed." That is the opinion of Mr Francis Powell, chairman of The Anglo-American Oil Company. I respectfully suggest that if Mr Francis Powell reads the report of Dr Flynn of The Columbia University, he will see that he has carried out certain experiments in regard to ethyl petrol, and it will be an answer to his question.

Sir CHARLES MARTIN: You are evidently of the opinion that the discharge into the atmosphere of exhaust gases from cars using ethyl petrol may be a serious public danger in crowded areas. That is at the bottom of page 9 of your memorandum. That is your view? --- I think so.

Q That is what you say; that is your belief, is not it? --- That is so.

Q Supposing we were to take for illustration a block in Piccadilly, and supposing I had to remain there amongst the cars for an hour and they were all using ethyl petrol, do you think that I should run a serious risk of being poisoned with lead? --- Do you say in one hour?

Q Yes, in one hour. --- I should say certainly not. I should not put it as one hour, but I think if your duty kept you there, on point duty, we will say, it would be a different matter. Piccadilly, of course, is getting very wide now -- you might choose a narrow street. You have chosen one of the widest streets in Great Britain.

Q I just chose Piccadilly because I encounter more blocks in Piccadilly than anywhere. --- I think you also get blocks in very small narrow streets outside Piccadilly.

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Q But do you think that if I were there for an hour I should be in any danger of getting lead poisoning? --- I think the whole risk is an industrial risk. I think it means being a long time under exposure, and it is particularly intensified in the case of women and young children. I do not think your illustration helps you very much.

Q That is rather a nasty thing to say? --- Well, I should not describe it as a good illustration of it at all. You asked me to take your case, did not you?

Q Yes. Do you think then that it is a public danger to the police force. Nobody else remains for an hour in a block where there are these cars continuously, although of course the policemen do that? --- Well, I do not know. There may be people selling things. There might be people remaining about for certain reasons. But take the case of shops close by: in a narrow street where there are blocks: lots of shopkeepers are there, and people on the pavement -- anybody. Why just one person? I suppose a policeman in particular on point duty would get a certain amount of it.

Q You think they would not suffer, first of all, from carbon monoxide poisoning? --- I think the actual discharge of the gas and the disturbance of the air would be sufficient. The tendency of ethyl-protol is to settle more than the carbon monoxide and it remains nearer the ground.

Q But as you keep a certain distance from the ground would not you be more likely to get away from it? --- I say in the case of small people who are nearer the ground you would get more of it, and they are the particular people

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Q But as you keep a certain distance from the ground would not you be more likely to get away from it? --- I say in the case of small people who are nearer the ground you would get more of it, and they are the particular people I refer to. As a matter of fact you will just get the lead at the breathing level.

Q And so you will in the case of the carbon monoxide? --- The carbon monoxide will be disturbed by the ordinary passage of the car. Might I suggest that in order to obtain a perfectly scientific four-square answer, the only way to do

this is by testing it on a very large scale: carried out quite apart from private people -- by a Committee of this sort, whose province it is, to start with. You are asking me to settle questions which can only be settled in that way.

- Q Then your opinion comes down to a mere guess? --- I do not think so: but if you ask me, what about the relationship between the rise and fall of lead and carbon monoxide, if you want a scientific answer you must be prepared to go to the extent of getting a scientific answer. If you ask me as an ordinary person I say Yes, lead is a heavy stuff: it tends to descend, whereas carbon monoxide gas tends to rise.
- Q You have absolutely not the haziest idea how much lead there would be in such circumstances? --- We know how much carbon monoxide there would be, from Professor Henderson's work.
- Q I am perfectly familiar with Professor Henderson's work? --- Therefore we might surmise the amount of lead that is in circulation.
- Q Supposing I came to the conclusion that if I breathed for an hour -- given your maximum lead output of 90 milligrams per cubic metre -----? --- That is a light proportion.
- Q Well, call it 100 milligrams. Take the maximum possible. Of course I would not be breathing pure exhaust gas. Supposing we diluted it in 100: you would agree that that is a very small dilution in the air: 1 in 100? --- In order to bring our figures down to the American figures I calculated 1 in 5,000.

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Q I am asking you some questions and I should be very glad if you would try and follow. I have given 100 milligrams of lead per cubic metre as a maximum: then I give 6 per cent of carbon monoxide -- which is a very moderate estimate that would give us 60 metres of carbon monoxide. We must

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assume that you have diluted it -- it does not very much matter, but you admit that dilution by 100 is a very diluted exhaust gas. That has never been found in a garage?

--- Four parts in 10,000.

Q It is going to be a good deal more than four parts in 10,000: it is going to be 6 parts in 10,000 -- .6 per cent?

--- Yes.

Q If I breathe that for an hour, if it has 100 milligrams of lead, I would breathe half a milligram of lead, but I should breathe 300 cc. of C.O. You will admit that as substantially

correct? --- Yes, I will accept that. / That is 300 cc. of C.O. would have saturated my blood and I would have to be taken away in an ambulance? --- Quite so. You would not stay there that time.

Q No, but I must stay there for an hour to get the half milligram of lead? --- Quite so.

Q But would half a milligram of lead matter to me? --- Not the slightest.

Q Would 300 cc of C.O.? --- That would poison you.

Q Then may I not suggest that you have somewhat exaggerated -- possibly with the best intentions of protecting the public health -- the danger that of necessity arises in confined areas. I say exaggerated, that is all? --- Well, how far is it justifiable to exaggerate a risk to public health?

Q I am asking you questions? --- That is the whole practice of public health, to exaggerate the risk: to say "Do not do things because of the risk".

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Q Then I may take it that you admit that you have exaggerated the risk? --- I totally deny that, sir. I may have over-estimated the result of what is commonly used, but at the same time it is justifiable to over-estimate risks and exaggerate: that is part of the practice of public health now all over the world. We do not tell people the

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danger in scientific terms: we say "Do not do this, or it will punish you for it doing it". With regard to the 6 parts in 10,000, do you mind speaking of 4 parts in 10,000, and then reconsidering your figure in the light of 4 parts in 10,000, because to my mind you have created a hypothetical case, and I am ^{not} prepared to answer a hypothetical case.

- Q Will you take 4 parts in 10,000 of carbon monoxide. That would be on the limit of carbon monoxide? --- I am not at all sure, sir. You will have a witness following who will be prepared to speak to you with authority on the analyses of gases in garages. I understand that 4 parts in 10,000 is not at all unusual in a garage.
- Q I ^{do not} admit that? --- Then would you mind, in place of the half milligram, reducing it to four-sixths: two-thirds of a half, that is a third of a milligram?
- Q Yes? --- So in place of your half milligram you admit that there is a third of a milligram of lead?
- Q Would a third of a milligram hurt you? --- No, not at all; but that is not the point: lead is a cumulative poison, and the constant breathing in of a third of a milligram per hour is undoubtedly, in the light of industrial experience a very wrong thing to permit.
- Q Supposing you were to take the conclusions of Dr Legge --- an expert on lead poisoning, you will admit? --- I ask that all these things should be interpreted in the light of his experience.

- Q Very well. I think he said that the limit for a miner, for ^{plumbism} in the light of lead tests was two milligrams for eight

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Q Very well. I think he said that the limit for a miner, for ^{plumbism} in the light of lead tests, was two milligrams for eight hours a day? --- I thought he said 10 hours a day; still, it does not matter. A total of two milligrams a day.

Q Yes? --- One third of a milligram would last me six hours. This takes me three hours to get a milligram. Is it reasonable to suppose that anybody is going to stop in a

traffic block for six hours every day of their life.

--- I do not know. You were talking about a garage.

Q No, I was talking about a traffic block; I have not said anything about garages. --- I thought you were talking about the ventilation of a garage. I said that an expert would tell you what the air was in a garage: four parts in ten thousand.

Q But I was referring to a remark of yours on page 10 of your memorandum, and I asked you whether you did not think you had exaggerated it? --- May I be allowed to look?

CHAIRMAN: "In traffic blocks, with the racing of engines that occurs immediately following a period of idling and storage of lead in the exhaust system - so resulting in dense discharge of richly leaded exhaust - the conditions of atmosphere may well become highly dangerous in the immediate neighbourhood where the settling heavy lead dust will go on accumulating." That is on page 10. --- I see. -----

The reason that takes place is this: Following the idling of an engine you suddenly get a racing and get a discharge of richly leaded exhaust.

Sir CHARLES MARTIN: They would not be racing all the time; most of the time they would be idling in the block? --- Yes; but you have that repeated. I imagined that that block is taking place for five minutes; in fact it is going on all day long, and every five minutes you are going to have a risk of a number of engines with a discharge of clouds richly laden with lead: that is the condition that I have in my mind

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Q You have explained to the Chairman that you were not able to examine ^{other} mechanics who had been engaged with cars that used ethyl petrol - in your experiments; and also that you had not had an opportunity, or it did not occur to you, to examine their excreta beforehand? --- I had not the opportunity.

Q Anyhow, it was not done? --- I had not the opportunity.

Q As a scientific man do you feel justified in drawing any conclusion whatever from the fact that one of those mechanics had got a trace of lead in his feces at the end of that time? --- I think it justified having such a man under observation.

Q I asked you whether you considered it justifiable to draw any conclusions. --- How should one draw a conclusion from one case, or two cases?

CHAIRMAN: Your answer is No? --- That is so.

SIR CHARLES MARTIN: Do you think it would be absurd to draw any conclusions? --- I think so.

Q On the other hand, I gathered that you attached considerable importance to that, from some accounts of yours that I saw in The Daily Mail. Was I mistaken, and you do not attach any importance to that? --- I attach no undue importance to it. I say I consider it justified.

Q I mean, talking to this Committee? --- No, I am not talking to a Committee, I am talking to a public meeting.

CHAIRMAN: You are talking to a Committee. --- Yes, but this is public evidence, therefore I am not entitled to say what happened. What I said was that it is as well that these men should be kept under medical observation: I say that was justifiable. There is a risk.

CHAIRMAN: Let us get it quite clear. Although the public is here we are expecting you to answer to the best of your ability.

--- Yes, I hope I am. But what I mean is this: this examination is rather hinging round the fact that I reported things in The Daily Mail. As a matter of fact I prefer to be examined on this memorandum which I have submitted to the Committee.

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Sir CHARLES MARTIN: I quite agree with you. That is why I mentioned the memorandum. --- I think when I communicated this memorandum I said that I should like to be cross-examined or to answer questions on the memorandum, not on what appeared in The Daily Mail, although the Daily Mail articles ^{do} not in any

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shape or form vary from this memorandum.

- Q As to the experiments that you did yourself - putting \$5.00, was it, of ethyl petrol on your arm - what particular method did you use for estimating lead under those circumstances? --- I have tabled a list of methods used.
- Q But I have not seen them. --- After all, I am asked to present 26 copies of these, and it is at my own expense: five or six copies are quite sufficient.
- Q Did you use the spectroscope method? --- No, this is a direct determination.
- Q You are responsible for that? --- Yes, I am responsible for that.
- Q You have said how you did it? --- Yes.
- Q That we shall see. I could not make out from your answers to the Chairman whether you were aware of the Enquiry into the possible hazard of this material that was undertaken by the United States Public Health Service between June 1925 and January 1926. This is it? (Indicating publication).
You know this? --- In that particular form I do not know it. I know the publication of the Report of ^{Chemical} ~~Mechanical~~ Engineering and to that I refer in the articles that I have already published in The Medical Officer and The British Medical Journal. I was aware of that, but the date you refer to, June 1925 to January 1926 is not in accord with the period that I know: the period of investigation that I know is from May down to six or seven months following.
- Q There was only one Enquiry by the United States Public Health Service, and they made their report in January 1926.

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Q There was only one Enquiry by the United States Public Health Service, and they made their report in January 1926.

--- That has specific reference to the lead in garage workers, I take it: ethyl-petrol users.

Q You have not seen it? --- It may be referring to the same thing because we are told that there are other reports. Here is an alleged Government report. (Indicating green book).

That was published in 1927. Then here is another report.

Q But surely it is sufficient to identify it by the United States Public Health Service. The other book you refer to is The Bureau of Mines. --- That is the Surgeon-General's report that I know.

Q You were aware of this publication? --- I am aware of it. May I look at it?

Q Certainly. (Handing book). --- I have not seen it in this cover; I have seen it reported in The Journal of Chemical Industry.

Q This was referred to in the Proceedings of The American Medical Association on more than one occasion, and was undertaken at public request. --- I have not seen this full report. I have seen a copy of its findings published in The Journal of Chemical Industry, and with general reservations, but I have not seen this. (Indicating).

Q As it is the most authoritative account by entirely unbiased people, and an account of work done by some of the most capable scientific people in the service of the United States Government, it is unfortunate that you did not read the whole report before expressing yourself on the hazards of ethyl petrol ~~control~~; do not you think so? --- I do not think so, s

Q You do not think it matters? --- I do not think it matters considerably. What I said was that the results found here were exactly the same as the American, and should be interpreted in the light of our peculiarly English experience of industrial leads. I specifically say in this report that there is no difference between the findings I have obtained and those that have been obtained in America. There is no

difference. I want to emphasize that; but I do think there is

that I know.

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and those that have been obtained in America. There is no
difference, I want to emphasise that; but I do think there is
a difference in our industrial conditions: in the circumstances
of our housing and population and our roads: we have no
Lincoln Highway here.

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- Q How long have they been using ethyl petrol in America, do you know? --- I think Dr Edgar is here and will probably tell you better than I can.
- Q Do you know? --- I think since 1923. Of course it has been held up pending the investigation.
- Q It was held up which this investigation (referring to book) was going on? --- Yes; and I think as far as New York is concerned it is not sold at all.
- Q Still there has been three years continual use? --- It depends on the conditions. If you ask me how many firms have been using this continuously from the beginning the answer would be found in something Dr Kehoe sent me. That is, that you only find one large industrial organisation actually in Dayton which is using it continuously.
- Q For five years? --- There has been an intermission of a year. Five years, from 1923 to 1928 barring intermissions.
- Q It has been used on an enormous scale has not it? --- According to the letter I have got from Dr Kehoe he can only state one industrial organisation that has used it for five years or rather during a period of five years when it was permitted to be used.

CHAIRMAN: I think that particular firm in Dayton, took to using it during the period when most people had given it up --- That I do not know.

Q That is a question for the Committee? --- I do not know at

Sir CHARLES MARTIN: But do you think there are 100 or 1,000 or 100,000 garage employees who are constantly exposed to the risk of ethyl petrol in America now? --- Yes, I suppose that would be so.

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Sir CHARLES MARTIN: But do you think there are 100 or 1,000 or 100,000 garage employees who are constantly exposed to the risk of ethyl petrol in America now? --- Yes, I suppose that would be so.

Q On a very large scale? --- Yes. On the other hand I know of garages where they will not have it.

Q Do you know of any single substantiated case of lead poisoning in America, apart from the persons employed in the mixing and manufacture of tetra-ethyl lead itself? --- Have you seen this publication? (Producing yellow book).

Q No, I have not? --- This was published on March 20th this year. This is published by the American Labour Office.

Dr BRIDGE: That is a publication by Alice Hamilton? --- Yes.

I have marked this paragraph in red (indicating).

CHAIRMAN: Does that answer Sir Charles Martin's question?

Sir CHARLES MARTIN: I asked, did you know of any substantiated case of lead poisoning in America? --- May I refer to the evidence that I have furnished. I may be allowed to do that

CHAIRMAN: Please do not talk like that? --- Well, you would not allow me to look at my books just now.

Q Because you would not answer the question? --- I want to refer to a paper now.

Sir CHARLES MARTIN: You have put this in as the best you can do in answer to my question: the passage you have underlined in red? --- That is one part.

Q This is the passage from Alice Hamilton's publication?

--- Yes. That paper has been duly examined and passed by a Committee. I had another paper, an abstract from the American Medical Association, published in February of last year, in which they cited the circumstances that the Standard Oil Company had agreed to pay out of court as damages last year (February 1927) 350,000 dollars damages, for people who had been injured in connection with ethyl gas -- as the expression is: ethyl gas. I do not know what they mean by it, but I understood when I was in America last year that gasoline -- gas -- is employed colloquially to describe what we call petrol in this country -- spirit.

Q Are you quoting something? --- I am quoting the American Medical Association published in the Times.

Q Is that an editorial? --- It is a small item of news.

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Q Are you quoting something? --- I am quoting the American Medical Association published in the Times.

Q Is that an editorial? --- It is a small item of news: 350,000 dollars were paid as damages out of Court. I had the paper this morning in my hand. Not only that but there are other cases settled out of Court, in which there were a million dollars damages claimed -- suits which have been settled out of Court.

Dr Coplans.

Q Was this for accidents that have happened in the manufacture
--- I only quoted them in connection with ethyl gas.

I thought at first that they must be referring to those
? old ^{Bayway accidents} ~~Byways~~ Acts. But apparently it was not so: the word
gas was specifically used: otherwise I would not have taken
notice of it, because it would probably be a manufacturing
disaster.

Sir CHARLES MARTIN: But you are here to give us all the
information you can? --- Yes.

PROF. DIXON: I read that also, and I think that those damages
were paid for accidents in the manufacture of the ethyl
petrol? --- It was not the manufacture of petrol.

PROF. DIXON: Of lead ethyl.

CHAIRMAN: That is the essential difference.

THE WITNESS: May I read the paper now. It is the Journal of
the American Medical Association, Saturday, February 25th
1927: "Medical News: New Jersey: Tetra-ethyl gas:
350,000 dollars damages. The Standard Oil Company of New
Jersey agreed on January 25th to award out of Court damages
to the amount of 350,000 dollars to six victims of poisoning
from tetra-ethyl gas who had brought suits for damages", et
"and there are said to be other suits" (etc, reading further
to the words) "nearly one million dollars. The Grand
Jury investigation did not find ground for criminal
prosecution". That is the document I was trying to find.

Sir CHARLES MARTIN: Do not you think that that refers to
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Sir CHARLES MARTIN: Do not you think that that refers to manufacture? --- And may I quote what appears here in the other Journal, and I think it is rather important (referring to yellow document).

CHAIRMAN: Before we leave that, as far as I can see it was due to the lead ethyl itself? --- It says "gas", otherwise I would not have taken any notice of it: I would not have brought it here.

Sir CHARLES MARTIN: But it speaks about 30 other ^{men} ~~films~~ and refers to a Refinery in New Jersey? --- Yes.

Q Being at the refinery it must be the manufacture of tetra-ethyl? --- I am not at all sure that I ought to say where this other action occurred, but they are referring to several things, and they specifically say that there are suits lodged for damages owing to tetra-ethyl gas.

Q But you do not know whether that means tetra-ethyl petrol? --- Whether that occurred in the ethylising I do not know.

Q The Committee can ascertain that? --- But I would like to read this, if you do not mind.

Q Please do so? --- "It is impossible to say just how many cases of acute poisoning occurred between the Autumn of 1923 and the early Spring of 1925, because a good deal of secrecy was maintained. The cases, including the mild ones, are supposed to have reached over 100".

Q Again I ask, is there any evidence that those arose owing to tetra-ethyl petrol? --- I do not know.

Q I rather think that it refers to the manufacture? --- At any rate the only point of that is the secrecy.

Q You do not know what it refers to? --- I cannot do more than quote this, but I was struck personally by the fact that secrecy was maintained: and that comes from the people who are investigating it on the spot.

Dr BRIDGE: It was about 1925 when the accident occurred? --- There were a number of accidents.

Q That was when they were giving up the manufacture? --- I thought the thing was in common use in 1923. If the material was in common use in 1923, then the accidents

ethyl? --- I am not at all sure that I ought to say where this other action occurred, but they are referring to several things, and they specifically say that there are suits lodged for damages owing to tetra-ethyl gas.

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--- There were a number of accidents.

Q That was when they were giving up the manufacture? --- I thought the thing was in common use in 1923. If the material was in common use in 1923, then the accidents have occurred since the material has come into common use -- two years afterwards.

SIR CHARLES MARTIN: Thank you. I have no more questions to ask.

Mr PYE: I should like to refer to your experiments on crank case oil because I think they are of some considerable interest. On page 7 of your introduction you say this: "In examining the used crank case oil and sludge taken from the engine sump of a car, and also the chain and sprocket washings of a motor bicycle using ethyl petrol as motor fuel, I determined the presence of volatile lead, as indeed might be expected."

Then on page 10 of your third memorandum in the table referring to crank case oil, there is a section which refers to the Report on Mechanics A. & B. There is a table which gives the total lead present in the crank case oil and lead volatile. That is estimated as lead tetra-ethyl. The total lead present is .07 per cent, and the volatile lead is .078. I think if it can be proved that there is lead present as lead tetra-ethyl in the crank case oil in increasing concentration, that is a very important point; but I should like to know whether you are quite certain that the lead which you found and which you state was volatile lead is in the form of lead tetra-ethyl. — I see the point, sir. First of all, it is volatile. You will see from the addenda I put in as to the methods employed.

Q I have not seen that; but perhaps you can tell us how that lead was measured? — Would you care to see this?

Q But could you tell us shortly how the lead present was measured and how you identify it as being present in the volatile form? — You will see if you refer to it. Used oils -----

Q Could you not just tell us shortly? I understand you did this experiment yourself and took a sample of crank case oil

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used crank case oil and sludge taken from the engine sump of a car, and also the chain and sprocket washings of a motor bicycle using ethyl petrol as motor fuel, I determined the presence of volatile lead, as indeed might be expected."

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Q Could you not just tell us shortly? I understand you did this experiment yourself and took a sample of crank case oil and analysed it and determined the amounts. --- The temperature of volatilisation was 220 to 230 Centigrade. I would rather you read this.

- Q I should like the Committee to understand how this lead petrol was estimated? --- It was estimated in this way: the total lead estimated and the estimation of non-volatile lead.
- Q quite so. --- And the method of difference- the results are different. If the non-volatile lead is less, the difference is the volatile portion. As to whether it is lead ethyl or some derivative of lead tetra-ethyl- that is to say lead tri-ethyl and carbonate, or something; I do not know.

Mr CHAPMAN: Do you mean volatile at 220 temperature? --- At that temperature, yes: at the temperature of 220 to 230 I saw it was volatile in the material we were using. There was not sufficient to determine whether it was lead tetra-ethyl or lead ^{tetra}tri-ethyl, because in other experiments the lead petrol is not so volatile, or does not volatilise so rapidly.

Mr PYE: You are quite certain that the lead present was in the form of lead ethyl? --- Yes; it is volatile lead at that temperature.

Q Did you test any samples of used crank case oil which had been taken from an engine which had not been using ethyl petrol - by way of control? --- No.

Q You did not take any control? --- No.

Q Would you agree that it is likely, or possible, let us say, that all used crank case oil would contain traces of lead? --- I should think so.

Q You agree that that is so? --- Yes. For instance, the kerosene oils that are used contain ~~ma~~ traces of lead --- ordinary kerosene oil.

Q So that the effect of increasing the danger through the use

total lead estimated and the estimation of non-volatile lead.

Q quite so. --- And the method of difference- the results are different. If the non-volatile lead is less, the difference is the volatile portion. As to whether it is lead ethyl or some derivative of lead tetra-ethyl- that is to say lead tri-ethyl and carbonate, or something; I do not know.

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Q You did not take any control? --- No.

Q Would you agree that it is likely, or possible, let us say, that all used crank case oil would contain traces of lead? --- I should think so.

Q You agree that that is so? --- Yes. For instance, the kerosene oils that are used contain ~~as~~ traces of lead --- ordinary kerosene oil.

Q So that the effect of increasing the danger through the use of ethyl petrol does rather depend on being quite certain that the lead which you find as present in the used crank case oil was present in a form which could be absorbed through the skin? --- I do not think so. If you say: Am I sure that it was tetra tri-ethyl and not the other, I would not say that,

because I have no right to assume that it changes to lead tetra-ethyl.

- Q Have you ever tried the effect of the decomposition of lead? --- Yes. I have had a bottle containing about 10 cc. of lead petrol, and about 8 per cent becomes tri-ethyl carbonate, when exposed to the air.

There are a considerable number of experiments that I have not recorded in the memorandum submitted - quite a large number; particularly on food; but I did not think it was right to publish these.

In regard to the particular experiment you have just asked me about, there is one here. The material was put in an open glass bottle and the residue amounted to about eight per cent of a white powder. I imagine that that is a material which is tri-ethyl carbonate, and obviously it was not volatile, because if it had been volatile, it would not have been there. Then I have a sample which I have had for three years in a corked bottle. What is left behind is a yellowish white powder, showing that lead tetra-ethyl can get away quite easily if you give it time, and you get left behind a white powder which, according to work that was done in 1876, is just as dangerous as lead tetra-ethyl.

- Q The point I want to bring out is this: that you did not actually isolate from the crank case oil the lead in the form of lead tetra-ethyl? --- No.

- Q Nor as lead tri-ethyl? --- No -- by the method of differences.

PROFESSOR DIXON: You do not suggest that these two mechanisms

tetra-ethyl.

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Q Nor as lead tri-ethyl? --- No --by the method of differences.

PROFESSOR DIXON: You do not suggest that these two mechanics whom you examined showed any signs of lead poisoning? --- Not the slightest.

Q All these findings were really only physiological?

--- It was merely a record of a medical examination, nothing more.

- Q Do you know the amount of lead that a doctor might prescribe? --- Well, I have been puzzled for some months to find out.
- Q What is the official amount? --- I have heard that in dysentery they would give 100 milligrams so many times a day. I think, according to the green book, 800 milligrams can be given eight times a day and nothing happens; but if you distribute that over three or four months, two or three times a day, you would no longer have a patient.
- Q You think it is a question of absorption? --- It is a question of slowness.
- Q If you took a quick test, you might not get much absorption? --- quite.
- Q Would you agree that there is given in the British Pharmacopeia as a dose of lead acetate about 300 milligrams? --- Well, sir, you know.
- Q Something of that kind is given. --- You will agree that it is impossible to say what is a dose in these cases.
- Q I suggested the British Pharmacopeia because they generally give the minimum dose, so to speak, which cannot under any conditions produce evil effects. --- Well, the toxicologists say it is almost impossible to say what the limit is at which lead can be given in a single dose. Is not that so?

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Sir WM WILLCOX: That is quite right.

PROFESSOR DIXON: There are other sources of lead poisoning besides ethyl lead? --- Oh yes.

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Is not that so?

Sir WM WILLCOX: That is quite right.

PROFESSOR DIXON: There are other sources of lead poisoning besides ethyl lead? --- Oh yes.

Q Is your point rather - if I can get it - that it is the accumulated effect of poisoning from all sources which is detrimental? --- That is so.

Dr Coplans

Q Supposing that paint were made with zinc, and they used only alum and so on, so that all these lead hazards were diminished down to the ethyl petrol, then the danger of using ethyl petrol must be completely negligible?

--- I would not admit that - not quite like that.

Q That is most extraordinary. What is the principal difference between carbonic oxide poisoning and lead poisoning? --- I understand the haematologists say this ---

Q I did not mean the symptoms; but supposing you are poisoned with one or other, what is the principal difference?

--- Carbonmonoxide poisoning is acute, and leadpoisoning is a slow insidious thing and might come on five years later.

Q Quite. --- They are not of the same order, or thought even.

Q Do you think if you took a milligram of lead every day you might get poisoned in five years, according to someone who is quoted as an authority? / One milligram a day is certain to produce poisoning in a month, not in five years? --- An yes,

Q ----- but it is merely on somebody else's authority.

--- I quite agree.

Q You have made no experiments on that? --- None at all. I ask that the experiments should be taken on industrial knowledge.

Q The American report of January 1926 says that the drivers of cars using ethyl petrol showed no signs of poisoning - none of them showed any signs of poisoning after two years.

--- I should think the driver of a car is the least likely to be injured.

Q quite so; I accept that. I have three points I want to put

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Q Quite so; I accept that. I have three points I want to put to you, and the second point is this: The employees in garages handling and repairing automobiles may show evidence of leaded absorption in the stools. That you would agree to? --- Yes.

- Q The men from your garage showed it? --- Yes.
- Q But did it not occur almost equally in all garages, whether they used ethyl or not, where the same conditions obtained? --- Do not they say: "in slighter amounts?"
- Q Yes, they do; but the analyses show a negligible difference in the case of ethyl. --- They show slightly more in the case of ethyl garages.
- Q Then the third point is this: in the regions in which the ethyl petrol was used to a great extent as motor fuel, for between two and three years, there has never been a case of recognised lead poisoning? --- Of course there is a reservation there: they might refuse to recognise it.
- Q Yes, but accepting that those people are reasonably honest? --- Well, sir, I do not know. The reason I say that is this: I understand from Dr Thomas Oliver - who is also reasonably honest - that the only way of finding out that people are being poisoned by lead is in regard to the women: there is an unusual number of cases of miscarriage - of absolute abortion: although none of the men showed it, Dr Oliver pointed out that it was the women who gave the first sign, not the men; and that is what - with deference - we ought to bear in mind. It is not a question of honesty.

Dr Coplans.

Q You have not any facts that you can give us about this abortion, have you? --- Apart from Oliver's published works?

Q But you are speaking of ethyl petrol? --- Yes, There is Dr Flinn who carried out the work.

Q But did Dr Flinn use ethyl petrol? --- Yes.

Q Or lead ethyl -- in those experiments to which you are referring? --- He did a number: not only with lead ethyl concentrated, but also with a thousand to one mixture. I think he took really 1300 to one -- some use both: but we will say it was 1,000 to one. He gave it specific work to do, and his work bears on this 1,000 to one mixture, of which he gives details. These are the questions that he is asked, and he shows there that in regard to animals on which the 1,000 to one mixture was applied to the skins of animals, pregnant goats and others, the animals aborted and lead was found in the bodies of the fetuses. He definitely says so.

CHAIRMAN: These are skin experiments? --- Yes; the skin and inhaling. He does the experiments independently. That is a piece of work carried out that is entitled to just as much credence as the other.

CHAIRMAN: Of course that report of Dr Flinn is before us.

PROF DIXON: I have another question to ask? --- There was a question that you asked before that I did not give sufficient answer to.

CHAIRMAN: It was this question: that although those men had been for two or three years in the neighbourhood of motors using this material they had discovered no cases of damage? --- And my answer was in regard to animals: that there was

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CHAIRMAN: It was this question: that although those men had been for two or three years in the neighbourhood of motors using this material they had discovered no cases of damage? --- And my answer was in regard to animals: that there was experimental evidence that it was dangerous in a short time. There was also a third point that you could not tell in two years.

PROF. DIXON: That was not quite my question. People who use ethyl petrol do not wash in it. Those goats that are refer

to were washed in the ethyl petrol? --- Well, I understand that it was applied to a part of their skin. You will have an opportunity of getting it in very great detail from other witnesses.

Q Then as to your experiments on your own skin: you have said that you could not get the lead away from your skin again by washing it with kerosene? --- That is so.

Q Do you think that that was because the lead was absorbed under the surface. I mean supposing you had scraped the skin a little: rubbed it hard with a hard brush. Did you try that? --- I tried it with kerosene.

CHAIRMAN: Just with a linen rag? --- Just a linen rag -- well rubbed with kerosene; and that was simply in conformity with what they did. They used soap as well.

PROF. DIXON: Supposing you used a solution of lead acetate and put that on the skin: we know perfectly well that lead acetate is not absorbed in the skin. That is an established fact? --- I think that is so.

Q If you were to put lead acetate on the skin in solution and leave it there a minute, would you be able to get it off by washing? --- I do not know.

Q No, you would not? --- I do not know.

Q You get some sort of compound: some form of lead acetate: do not you think something of the kind may happen with the lead? --- The question was put to me by the Chairman and I said then what I knew: that the material was fixed on the skin: but the evidence that it goes into the body is overwhelming.

Q Oh yes: you need not have said that. I am dealing with this particular experiment? --- And I say that kerosene is not

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Q Oh yes: you need not have said that. I am dealing with this particular experiment? --- And I say that kerosene is not efficient for the purpose.

Q You draw the conclusion therefore that the lead acetate is absorbed? --- Not from that experiment.

Sir ROBERT ROBERTSON: On the purely chemical side I would like to ask some questions. Referring to page 3, where you find one part of 10,000 of lead present. Do you know the process by which this was done? --- No, I do not.

Q You do not know the details of that? --- No.

Q Then on the next page do you know how the 0.005 milligrams was found? --- By a method of heating referred to in the addendum. 220 - 230 degrees.

Q So it would be above boiling point? --- Yes.

Q Is .005 milligrams correct, or is it .005 grams? --- It is .005 milligrams.

Q Then I want to ask some questions bearing on this method of determining the amount of lead by a method of difference. It is page 10. I think you said that you passed the C.O.2. through the oil? --- May I go back again.

Q You say you passed the C.O.2. through the solution? --- That with air across the surface -- bubbling.

Q Bubbling through the material at 220 degrees. Would it not have been a much more potent method if you had condensed from the C.O.2. any lead which was present, instead of merely taking that method of difference? --- Of course there is a limit to the amount of work I am expected to do.

Q Oh, yes. I was referring to the cogency of the experimental method. You could not interpret this difference so well as if you had absorbed the C.O.2., or whatever it was, in some exhaust, and determined the lead in that. One could drain the potash free from lead, then determine the amount of lead from the potash. It would be quite as easy as doing the lead in the residual oil, and very much more

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by which this was done? --- No, I do not.

Q You do not know the details of that? --- No.

Q Then on the next page do you know how the 0.005 milligrams was found? --- By a method of heating referred to in the addendum. 220 - 230 degrees.

Q So it would be above boiling point? --- Yes.

Q Is .005 milligrams correct, or is it .005 grams? --- It is .005 milligrams.

Q Then I want to ask some questions bearing on this method of determining the amount of lead by a method of difference. It is page 10. I think you said that you passed the C.O.2. through the oil? --- May I go back again.

Q You say you passed the C.O.2. through the solution? --- That with air across the surface -- bubbling.

Q Bubbling through the material at 220 degrees. Would it not have been a much more potent method if you had condensed from the C.O.2. any lead which was present, instead of merely taking that method of difference? --- Of course there is a limit to the amount of work I am expected to do.

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Here the method of difference seems to be not very cogent and certainly not diagnostic of the substance that you were after? --- I take it that it is volatile. Assuming it is so, there is one part that volatilises. I grant you that assuming you had the time and opportunity you could do a lot more.

Q My point is that it would not have taken any more time. Anyhow you agree that this is not very cogent to prove that it was lead tetra-ethyl that came off? --- I should not like to say. I do not know. That is comparing two methods.

Q On page 3 of your own experiment you give this table of evaporation. What was the actual spirit that you used. What was its boiling point -- the same boiling point? Was it high? --- Yes. Very high. The same boiling point is comparatively high. This experiment at 60 degrees Fahrenheit there is practically the same as 97 degrees Fahrenheit, the same result; but it takes a very long time. Then evaporation takes 10 days.

Q I daresay, but I wanted to know what petrol you used. Do you know its final boiling point? --- I should have to refer for that.

Q Was it the ordinary petrol that is used in England? --- Just the ordinary petrol. No. 1.

Q Are the methods of determination of the lead that you used in your own laboratory when you were experimenting on your arm described in this document? --- Yes; they are described in very great detail.

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Q Are the methods of determination of the lead that you used in your own laboratory when you were experimenting on your arm described in this document? --- Yes; they are described in very great detail.

CHAIRMAN: You have done a good deal of experimenting?

--- Yes; and it was a very difficult thing to do. It was all voluntary work.

Dr Coplans.

MR CHAPMAN: With regard to the skin experiment on yourself. Of course the method adopted was a little rough, and having regard to that you would not attach very much importance would you to the precise figure for absorption that you got? --- I am giving two places of decimals, as a rough calculation.

Q I will put it in another way. Do you think that experiment really gave you more ^{than} a sort of collective statement that there would be absorption? --- I would not like to say absorption: I say there is fixation.

Q We will say fixation if you like? --- Might I say also that the lead tetra-ethyl is not removed?

Q Would you mind looking at page 3 of your own experiments. They are experiments dealing with water? --- Yes.

Q If I understand this correctly, you had 15 cubic centimetres of ethyl petrol and an amount of water which must have been small in regard to the dimensions of the tube. It is on page 3? --- Experiment (a).

Q Yes. What I am saying is this: that you employed apparently in the experiment 15 cubic centimetres of ethyl petrol? --- Yes.

Q And I say the amount of water must have been small because that is limited by the dimensions of the tube? --- Yes.

Q Anyhow, you collected 33 cubic centimetres of water? --- Yes.

Q That is to say twice as much water as you took of ethyl petrol? --- Yes.

Q Then having done that you still found only 0.7 of a part

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Q Anyhow, you collected 33 cubic centimetres of water? --- Yes.

Q That is to say twice as much water as you took of ethyl petrol? --- Yes.

Q Then having done that you still found only 0.7 of a part per million of lead in that water? --- That is so.

Q 0.7 of a part per million is not really of the same order -- not enormously in excess of the amount which is sometimes regarded, I will not say as permissible, because I do not think anything is regarded as permissible, but as having no serious significance in potable water? --- Well, I should

suggest that the limit is one hundredth of a grain to the gallon -- 0.14.

Q Yes, but this is 0.7. It is not of the same order?

--- You will see an experiment later on.

Q I am coming to it in a moment? --- That was the initial experiment.

Q That is to say under favourable circumstances you only get 0.7 of a part per million, which is after all a very small amount? --- It is on the threshold of danger.

Q Yes, on the threshold if you like, but it is only a trace? --- It is sufficient in potable water to cause trouble.

Q I am not saying that it is not -- I am not an authority on that -- I am only asking whether it is more than a trace? --- I think the question was whether it was on the threshold of danger.

Q We will assume it is quite on the threshold, if you like. In your next experiment you had the same sort of conditions. The experiment was made in 15 cubic centimetres of ethyl and 100 cubic centimetres of water? --- Yes.

Q There you got 0.6 of a part per million? --- Yes.

Q Am I rightly understanding these experiments as showing that you do not even under circumstances of that sort, where the conditions are as I have described them -- extremely favourable to the taking up of lead -- get ~~the~~ enormous quantities? --- But I say they would be quite sufficient.

Q I am not saying that they would not be sufficient: I am dealing with absolute quantities. You do not get enormous quantities? --- But you do not require enormous quantities.

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Q Yes, but t_his is 0.7. It is not of the same order?

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Q I am not saying that they would not be sufficient: I am dealing with absolute quantities. You do not get enormous quantities? --- But you do not require enormous quantities.

Q I know you do not require any; but even when you have conditions which are very favourable to the solution of lead, you do not get great quantities? --- I think there is another interpretation for what you are saying -- which I will come to presently.

- Q Yes, if you like. Then you filter through sand. Sand does not take much out. It would not be so likely to abstract from the liquid as a great many others that were mentioned. If you fix a solution through sand you would not expect much of the absorbed substance to be taken out? --- I am afraid I do not quite follow your motive.
- Q I have no motive at all, except to arrive as far as I can at an understanding of these experiments. What I am saying is this: is it not a fact that the conditions therefore are not favourable to the removal of lead by anything through which you filter. In other words you have got sand in it; would you expect sand to remove much lead? --- I do not expect sand to remove lead at all.
- Q Very well: that is an answer to my question. Having regard to the very small amount of lead which you get under favourable circumstances, when you were trying to see what it will take out, do you really think that there is serious danger of contamination of large water supplies by such quantities of lead as would perhaps be scattered on the earth and be washed through strata, on sand and other things? --- I think in connection with wells and pools of shallow surface water there would be, because you might easily get a can of petrol which was in the neighbourhood of these places.
- Q You might of course get a can-full of sheep-dip? --- Yes, but not very often. There are not a million people using sheep-dip in England, but there are a million people using motorcars.

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Q You might of course get a can-full of sheep-dip? --- Yes, but not very often. There are not a million people using sheep-dip in England, but there are a million people using motorcars.

Q But one is an accident just as much as the other. If the well was a very shallow one and the earth was very porous round it, surely all kinds of dirt would filter in the well, and the presence of it there in relation to the other things would be negligible? --- I think there is sufficient there to pollute a shallow surface well. That is the answer.

Dr Coplans.

- Q Very well. In answer to the Chairman and in answer to Sir Charles Martin, I think you said that you did not know whether there would be any concentration of the ethyl petrol as compare with carbon monoxide. I mean in the case of the material coming from an exhaust in certain machines. You do not know from your experience whether there would be any tendency for the lead communicating with the air -- not the dust -- as compared with the carbon monoxide, at a given moment, I have no evidence, but my impression is that it would be the other way about.
- Q Assuming that there was no such concentration of lead and the amount of carbon monoxide present was predominating.. Do you think there is would be any reason for prohibiting the use of ethyl petrol? --- That the amount of carbon monoxide was what?
- Q That the amount of carbon monoxide present is such that its poisonous properties must predominate over the amount of the lead -- in other words that you would be poisoned by carbon monoxide long before you would be by the lead ethyl, again assuming that that can be shown to be the case, do you think there would be any reason for prohibiting the sale of the ethyl petrol? --- I cannot see any relation between the two problems.
- Q Well, there is an intimate relation is not there. Supposing the lead and the carbon monoxide were present in the exhaust? -- Yes.
- Q Assuming the carbon monoxide was there in an amount which if it were leaking, and was concentrated, would poison people in

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Q Well, there is an intimate relation is not there. Supposing the lead and the carbon monoxide were present in the exhaust? --- Yes.

Q Assuming the carbon monoxide was there in an amount which if it were leaking, and was concentrated, would poison people in a short time? --- Yes.

Q If there were no concentration of the lead, would you consider the lead problem was serious at all, or sufficient to justify any prohibition such as we are now dealing with? --- I cannot see any connection.

Q Well, supposing you have a given volume of carbon monoxide and a given volume of lead, and suppose the carbon monoxide tends to disappear: In that case there would be a danger after a certain time. But supposing there is no accumulation of lead and the carbon monoxide also tends to disappear, and its poisonous properties be diminished, then I ask you do you think there would be a justification for the prohibition of the lead ethyl? --- I think you are putting the question to me in this way: if there are two injuries going on at one time and one is a fatal injury and the other is only a slight injury, would you prohibit the slight injury?

Q Yes, if you like to put it that way? --- I say one is a very slight thing and the other is exceedingly fatal. I do not see that one has any relation to the other.

Q Very well, I take your answer? --- Carbon monoxide is so out of the way.

CHAIRMAN: You really mean that the other is negligible?

--- In the circumstances of the carbon monoxide, I would not consider lead at all in the presence of carbon monoxide.

Q That is my question? --- There is such an extraordinary difference between the two. It is obvious.

CHAIRMAN: That is exactly my question. I am glad to know that it is obvious.

SIR WILLIAM WILCOX: I think, Dr Coplans, that you have spent a good deal of your professional life in public health work?

--- Yes.

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SIR WILLIAM WILCOX: I think, Dr Copland, that you have spent a good deal of your professional life in public health work? --- Yes.

Q I gather that from your numerous degrees? --- I have not got numerous degrees.

Q You are an M.D.? --- Yes.

Q I think you are very interested in sanitary work? --- I was advisor in sanitary work to the Expeditionary Force. I was advising the sanitation of the Second Army.

- Q And your work was recognised by the honours that have been conferred upon you. You, I gather, have rather approached the subject from the public health aspect? --- Entirely.
- Q As a sanitarian? --- Quite so.
- Q And as such you take extreme care --- meticulous care in protecting the public health? --- As is customary.
- Q In regard to the toxic action of lead, the poisonous effect depends upon how much is absorbed into the system? --- Yes, I agree.
- Q And therefore as regards the inorganic salts of lead, for instance sugar of lead, or lead acetate, you agree with me that there have been cases where an ounce has been taken and death has not occurred? --- That is so.
- Q Because the poison has not been absorbed? --- That is true.
- Q You mentioned in your paper Professor Blair-Bell's work, in the use of lead in chemistry? --- Yes.
- Q Shall I quote what is the dose of lead, or do you recollect it? --- It is rather high.
- Q You will agree if I put it? --- I will accept what you say.
- Q In the colloidal lead ----- That is not this kind of lead at all.
- Q No. I mean the colloidal lead which is given ^{in cancer} ~~is~~ a half per cent solution? --- Yes.
- Q And an average dose is 10 cc. That would be 50 milligrams? --- It has unexpected fatal results at times? ---
- Q ^{Yes} ~~You~~ agree that in the treatment of cancer 50 milligrams of lead is given? --- Of colloidal lead?

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- Q ^{Yes} ~~You~~ agree that in the treatment of cancer 50 milligrams of lead is given? --- Of colloidal lead?
- Q Yes; and sometimes as you say, with toxic results? --- Yes.
- Q Would you regard lead as a cumulative poison? --- From one's industrial experience it is so. It is a self-evident proposition.
- Q Do you consider it as one of the best examples we know of?

--- As a slow cumulative poison?

Q Yes. A lead worker for instance has lead ~~save~~ stored in his system, and then becomes entirely free from excess of lead: how long would it be before the lead would be eliminated?

--- You might say it might be years after. It might go on for years.

Q And it was that aspect of lead which influenced you in your work? --- Quite.

Q With regard to carbon monoxide, supposing a person absorbs carbon monoxide from exhaust gases in a garage: as you know the carbon monoxide combines with the human blood. How long would it be before that carbon monoxide were eliminated, supposing the person went out into the open air? --- A question of minutes or hours.

Q Several hours. I mean eliminated from the blood? --- Anyhow I mean quickly -- a question of days as compared with years.

Q A question of a couple of days, two or three days? --- Yes, we will say that.

Q When the petrol ethyl spirit is used a certain amount of inorganic lead is produced? --- Yes.

Q Could you tell me what the compound of lead would be in the dust?

--- 50 per cent I should think would be bromide.

Q The point I want is this: is that compound of lead soluble or insoluble in water?

--- Soluble.

Q I take it that you would regard that compound of lead as being produced by the use of lead tetra ethyl.

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- Soluble.
- Q I take it that you would regard that compound of lead as being produced by the use of lead tetra-ethyl -- you would regard it as one of the chief risks of the contamination of water supply? --- Undoubtedly. One of the chief risks of ordinary dust, not of water.
- Q I was dealing with water supplies?

L8.

Dr Coplans.

--- Ah, I do not know.

Q The point was this: if you have lead bromide dust on the road? I do not see much danger in that. I did not consider that proposition at all.

Q You mentioned the pollution of shallow wells?

--- I was thinking of the pollution of shallow wells from petrol direct, and from oil being poured down.

You do not require any special experimental work to prove that lead bromide can be a source of water contamination, because it is known that lead is soluble in water, but what we do not know is what lead petrol will do provided it is allowed

to dry in the soil. That was the object of those

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to dry in the soil. That was the object of those

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doubt that even in three feet of sand it is not

removed or destroyed.

Q I was rather surprised that you did not bring out the point of the lead bromide dissolving in water and being conveyed by the underground water channels, and polluting shallow wells. --- From an experimental point of view I do not think I can establish anything other than what you can imagine for yourselves -knowing that lead bromide is fairly freely soluble in water.

Q Do you think that is a possible cause of pollution?

--- I should think so. I have never considered it at all. I am thinking more of accident ~~form~~ design in polluting the well.

Q In your experiments with sand you used, I think, oil containing lead ethyl? --- Yes. Nothing has been used in the experiments except material which was supplied to me by The Research Association.

Q Lead ethyl is easily soluble? --- Yes.

Q Therefore do you not think that it would stick to the oil rather than go elsewhere? --- The result proves that it goes into the water. I imagine what happens is some chemico-physical change in which you get a thin film of oil on the surface.

Q Some goes into the water? --- Some goes into the water; experiments prove that it is so.

Q As Mr Chapman pointed out, not all of it? --- If it went up to 1500 cc., it would take a long time.

Q You did not get all of it? --- I did not intend to.

Q I suggest that one explanation would be that a lot of the lead ethyl would remain in the oil which adheres to the surface of the sand? --- And that the bromide might have

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Q Yes. --- I quite agree.

Sir ROBERT ROBERTSON: Do you mean bromide?

Sir WILLIAM WILLCOX: I was talking of the oil. --- But the oil is the oil taken from the engine sump.

Dr Copland

Q And does the oil combine with lead bromide? --- I could not say. I think I have given you the exact analysis there.

Mr PYE: On page 5 of your experiments you say the lead compounds are soluble in water calculated as lead 0.097 per cent by weight. --- I am simply concerned with the lead soluble in water. We know to a mathematical nicety when cases of lead poisoning occur, and the percentage is 0.35 milligrams per gallon to 0.5.

Sir Wm WILLCOX: Would you, as a public official, regard the presence of Lead in detectable quantities in water as dangerous? --- I should think it was my duty to find out why it was there.

Q Would you regard it as undesirable? --- I should want to know why it was there.

Q Would you regard it as dangerous to the public health? --- No, it depends on the quantity again: I do not like it there and I should try to keep it down.

Q I said, if you found it in detectable quantities? --- Well, if one found it in detectable quantities, one ought to look round to find out why it was there.

Q What limit would you permit in water? --- I certainly should not like to permit as much as a third of a milligram.

Q I think you did quote some figures. --- One hundredth of a grain in a gallon: that is about half a milligram.

Q Would you regard that as negligible? --- Yes: I say you are on the threshold of danger then.

Q You know that London, Birmingham and other big cities do not

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Q You know that London, Birmingham and other big cities do not derive their water supplies from shallow wells? --- Quite so.

Q You rather had in mind country districts where the water is derived from wells, when you were talking about the danger of contamination? --- Yes. I was thinking of my own experience in the Army: we had a very large number of shallow wells, and we had to shut them up because of the contamination.

- Q Where was that? --- That was with the Second Army. We had a great many lorries drawing up near wells or water supplies, and depositing spirit.
- Q Would you regard the presence of lead in fish as of importance from the point of view of rivers? --- Fishing rivers? No, I do not: I do not care a rap about fish, and I do not think that is of the slightest importance; but when a whole family has to drink water from one spot and there is no other source, I do not think these people should be poisoned by a passing car or a passing lorry.
- Q You are aware that the London water supply comes from the Thames water, or a certain proportion of it? --- This is not a problem of river pollution.
- Q I was referring to the contamination of river water by lead. --- I am not prepared to discuss that at all.
- Q In your experience of the evaporation of the ethyl petrol, you found a concentration of over fourteen times? --- Yes.
- Q Did you do any skin experiments with those different strengths? --- Yes, I have done a lot.
- Q Have you shown that there is more lead ethyl absorbed with fourteen times the concentration? --- No. First of all, it is difficult to find volunteers. I do not care to ask a man to do something that I am not prepared to do myself. It is very difficult to get oil at all ----
- Q I was not criticising, I only wanted to know: You did the experiment on yourself with the ethyl petrol? --- Yes.
- Q Did you have your urine tested? --- No: I did not think there was any point in that, because we know what happens
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- Q I was not criticising, I only wanted to know: You did the experiment on yourself with the ethyl petrol? --- Yes.
- Q Did you have your urine tested? --- No: I did not think there was any point in that, because we know what happens in regard to animals. The whole question was: Would kerosene remove it from the skin?
- Q You rather gathered from the amount put on and the amount brought off that the difference would ----
--- would remain on me.

Q I am not criticising, but do not you think it would be fairly interesting if you could estimate the lead in the urine, and possibly in the faeces as well, and then you could get definite proof not only that it had been absorbed into the skin but had been absorbed into the body? --- Well, is it justifiable to do that on oneself, knowing there is overwhelming proof that it does occur in animals?

Q But you did the experiment on yourself? --- Yes, on the skin.

Q It would not have done you any great harm if you had had the analysis made? --- I do not know of any Americans who have done it, and I do not see why I should do it.

Q I do not suggest that you should; but if you had had the analysis of the excreta made, was what I was asking.

--- I only wanted to determine one point, which was whether it was removed by kerosene.

Q As you know, the tetra-ethyl is a rapidly soluble substance, and it is admitted that it is absorbed very rapidly when applied to the skin? --- Yes, very rapidly.

Q You have no evidence that the ethyl petrol is absorbed in a very rapid degree? --- Dr Flinn has done some work on the question in experiments with a dead monkey, and he has come to the conclusion that the lead ethyl has exactly the same action: there is no difference.

Q But you agree that the lead in ethyl petrol is absorbed at a very, very greatly less rate than lead tetra-ethyl?

--- Yes, with the addition of the petrol, it renders the absorption more difficult. I think when it is applied to the surface of the skin, it dries very rapidly, and in the

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--- Yes, with the addition of the petrol, it renders the absorption more difficult. I think when it is applied to the surface of the skin, it dries very rapidly, and in the action of drying I think there is concentration; ~~and I think there is concentration.~~

Dr BRIDGE: Do you say that kerosene will not remove the ethyl petrol from the skin? Can you suggest anything that would do it? Is it the fault of the kerosene, in other words? It is rather an important point. --- Yes. I find that the

Americans tried kerosene and soap. I did not do that because they proved themselves that it was useless to try anything else.

Q You think there is nothing else that will do it? --- It may be that olive oil will do it.

Q In your introduction you state this, in speaking of garage work: "With regard to the solid deposits there is no doubt that by reason of its physical characters and chemical composition, these substances would, if present in paint, come within the provisions of The Lead Paint Regulations 1927, and that workers who handle these substances require similar legislative protection." What is that view based on? --- It is based on the fact that there is more than five percent of solid *lead* in the deposits.

Q Then it depends on the quantity of deposit as to whether the contact is sufficient? --- quite so.

Q We have no definite evidence of the amount of deposit present. --- I think I have given some there, and it is given by The Research Association.

Q But it would not amount to anything very great? --- I say that the question of one car does not matter at all; but if you are going to have people handling it all day long, it is another matter.

Q But nobody in a garage would handle it all day long? --- I am not at all sure.

Q I think they are engaged on other things. --- I think they are engaged in connection with those deposits at all times.

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- Q You think there is nothing else that will do it? --- It may be that olive oil will do it.
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- Q But nobody in a garage would handle it all day long? --- I am not at all sure.
- Q I think they are engaged on other things. --- I think they are engaged in connection with those deposits at all times.
- Q But it is based on the assumption that there is going to be a considerably quantity of it in the garage? --- This is 3.5 per cent.
- Q Then it depends on the quantity of dust you find in the garage. I do not think you quite agree with Dr Kehoe as to the amount of lead he finds in the deposits? --- I accept his statement.

Dr Coplans.

- Q You quote from Dr Carl Vogel of St Luke's Hospital, New York, who says: "Only 3.4 per cent of all patients admitted had significant amounts of lead in stool". What do you mean by "significant amounts"? --- I was only quoting there. There had been a meeting of the Industrial Hygiene Association of the United States before I got there in which they discussed this.
- Q In New York it was 4 per cent? --- Yes; and outside it went to as far as 100 per cent.
- Q Do you think that is possible? --- If one finds it there, one accepts it.
- Q I am interested in those experiments on the garage workers. One of the men was not so exposed to the lead petrol, and yet they found more lead on his overall than they did on the mechanic who was exposed to it. You would expect it to be the other way round? --- I do not know.
- Q It looks rather as though it was a normal condition, the amount of lead that was found in the faeces. If you had examined 100 garage workers, you might have found fifty of them with that amount? --- quite so.
- Q Whether they had used lead petrol or not? --- Yes. That was brought out at the Essex Congress: that there was an enormous distribution of lead on the workers, to see what the risks of exposure were.
- Q At the bottom of your first page of experiments I think there is a mistake. You say: "Linen swab plus 2 cc. kerosene plus the reagents used for the estimation of the lead. 0.01 mgm of lead tetra-ethyl found. (2) Linen swab plus 2 cc. kerosene
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Q At the bottom of your first page of experiments I think there is a mistake. You say: "Linen swab plus 2 cc. kerosene plus the reagents used for the estimation of the lead. 0.01 mgm of lead tetra-ethyl found. (2) Linen swab plus 2 cc. kerosene plus 1 cc. of ethyl petrol. Corrected for the blank. 1.1 mgm lead tetra-ethyl found." I think that must be a mistake. --- Oh no, that is all right.

Dr BRIDGE: It seems a curious thing to find those words.

Sir Wm WILLCOX: I did not understand it. --- There is a certain amount of lead.

Dr Copland

Q Yes: I can understand it being "lead". --- Yes, I should have said "lead". It should be "lead", not "kerosene".

Dr BRIDGE: As to this question of lead as compared with acids: they do not contain only lead petrol acid? --- Quite so. The lead is more active on the skin.

Q You suggest that it should be scheduled as a poison? --- Yes

Q You would schedule white lead as well? --- No. If it is known that it produces abortion, and it is known -----

Q Of course it is very important? --- Yes:: if it is known that it will produce abortion.

Q Then you think it should be scheduled? --- Yes, because of that.

Q Do you think women rub it into their skin in order to produce abortion? --- I do not know what they will do.

Sir Wm WILLCOX: They schedule diaculum? --- Yes; and women take diaculum.

Dr BRIDGE: It is not the question of scheduling ethyl petrol, but the ethyl itself? --- Oh no: the lead ethyl itself. There is lead ethyl being sold by the D.D.H. in the last three years as an ordinary article.

Sir Wm WILLCOX: Lead et_hyl? --- Lead ethyl. There it is: they sell it concentrated as lead ethyl.

CHAIRMAN: Thank you.

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(The witness withdrew).

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CHAIRMAN: Thank you.

(The Witness withdrew).

(The Committee adjourned for lunch).

Mr H. S. ROWELL called and examined.

CHAIRMAN: I think you are the Director of the Research

Association of the Allied Motor Manufacturers? --- Yes.

Q You are the senior associate of the School of Mines, a Bachelor of Science and have various other distinctions. You have been concerned with those experiments that Dr Coplans has been telling us about this morning? --- Yes.

Q Many of them were done at your Research laboratory, I think? --- The engine tests were done there.

Q Would you tell the Committee briefly what you can tell them in regard to the health dangers of this ethyl gasoline. First of all, in regard to those two mechanics, were they your workmen? --- Yes.

Q Did you notice at all that they were ill? --- No, sir, they were not ill; and they were repeatedly questioned during the tests as to whether they felt any ill effects. Without exception they answered no.

Q You are familiar with the finding of lead in the excreta of one of the workmen? --- Yes.

Q Do you attach any consequence to that at all? --- No. In fact during the progress of the examination I was informed that lead had been found and^I therefore asked the mechanic to enquire of the specialist at the college as to whether the lead had any influence, so that he could take him off his work; but he was informed that the trace of lead was so minute and might easily be caused by soldering -- of which he did a good deal -- so that there was no danger apparent from that.

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- Q So you did not yourself think that the lead that was found in the excreta had necessarily come from the ethyl petrol? --- Well, I did not personally. At least for some time I did not because there was no lead found in the second man. On going into that to try and find the explanation of it I found

that mechanic A. had been working at the engine, whereas mechanic B. had not and mechanic A. was more exposed to the action of ethyl petrol -- if it has an action -- than any ordinary man in a garage or in a motorists depot could possibly be. He was constantly adjusting the carburettor, very often holding his hand over the inlet: his arms were frequently exposed, and in filling the overhead tank occasionally the ethyl petrol would trickle down his arms and in spite of warnings he did not take any precautions to wash it off; so I was not surprised to find lead storage: nor was I doubtful that it was from the ethyl petrol.

- Q You think some of it did come from that? --- Yes, I think so.
- Q These workmen were engaged I gather in scraping these engines? --- Yes. That was after the cars had done their mileage. They were brought there and opened out and various deposits were removed.
- Q Those two mechanics were engaged on that work? --- They were both engaged equally on the scraping: I did some myself: in fact I took part in removing every deposit in order to get an idea of the texture and hardness of it.

Dr LANDER: There are one or two very minor points I should like to ask you about. Could you describe just a little more at length the nature of the texture and hardness of the deposits you have just referred to. That is to say, to what extent is it conceivable that those deposits might make dust? --- Certainly. The nature of the deposits varies very widely indeed according to the conditions in which the engine has been running. For instance, on a small engine, running the thing cold and with plenty of oil you get a lead mass on the

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ordinary man in a garage or in a motorists depot could possible be. He was constantly adjusting the carburettor, very often holding his hand over the inlet: his arms were frequently exposed, and in filling the overhead tank occasionally the ethyl petrol would trickle down his arms and in spite of warnings he did not take any precautions to wash it off; so I was not surprised to find lead storage: nor was I doubtful that it was from the ethyl petrol.

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rich mixture and plenty of oil, you get a cake of carbon; and then you can surmise after that that the engine was run hot, and with the leaner mixture you get some of the old carbon burnt off and a drier carbon deposit. Then you get a fresh layer. Then sometimes in the exhaust pipes and exhaust valves you get a very hard redish deposit. It is hardly a scale, in fact it is hardly a deposit, it is more like some alloy on some iron. The variety of the deposit was so great that no attempt was made to analyse, beyond one or two outstanding features. In general I think it was found that the exhaust water contained more chloride and the carbon deposits more bromide, but I should not like to make them too definite.

- Q Would it be fair to summarise it by saying that the powdery material was more likely to come from the exhaust pipe; and the dust which has come off during de-carbonising, or something like that, is on the average, generally speaking, a softer material -- I am thinking more of the dust in the garage rather than the dust in the street? -- I find it very difficult to answer, because on the exhaust valves as a rule you get a dry thin layer of dust, but underneath you get a hard pink scale that flies up, and that is difficult to analyse. Then in some of the valves where one cylinder is over-oiled, for instances, you get the oil holding the carbon and the dust in a soft layer. I think the great dust danger, if there is one, lies in the silencer. But most silencers are seldom cleaned out, unless there is back-firing in the street, then you may get a cloud of black dust blown out through firing the silencer.

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Q That is perhaps likely to occur at long intervals with a car, but it is a fairly definite thing to happen, is not it. You might get storage in the exhaust pipe. Could not you say that with practically every car, perhaps once a week, you might clear quite a lot of stuff out of its silencer? -- By back-firing, yes you would.

Q So here it is a condition like that? --- Yes.

Q I am not quite sure whether this is a silly question. It occurred to me in connection with where you say it is seldom that a motorist needs to adjust his carburettor. I was wondering whether there was any tendency with the use of ethyl petrol for the carburettor to need adjusting more frequently: where the petrol had been standing, where some decomposition had taken place, and where there was a tendency for the jets to get stopped up more? --- Supposing a car is standing for a long time, in which case the word "seldom" applies -- in regard to stopping the jets we have not found that except where the acetylene lamps are used. But in regard to the carburettor, unless the engine was running very badly it is very unlikely that jets get blocked.

Q In the last paragraph, referring to your letter in Nature -- which I have not before me at the moment -- you say the maximum possible increase of energy obtained from ethyl petrol -- that I suppose is with the present concentration? --- That is so.

Dr LANDER: Thank you.

MAJOR GALWEY: Were these mechanics who were tested your own mechanics? --- Yes.

Q Were they volunteers or were they just detailed to the work? --- They were detailed. It was part of their work.

Q They did not seem to mind using this stuff at all? --- No.

Q Had they any apprehension? --- No: except ~~that~~ as regards any special tests that I had occasion to forbid, because it was not part of their work, but the testing of engines and

that a motorist needs to adjust his carburettor. I was wondering whether there was any tendency with the use of ethyl petrol for the carburettor to need adjusting more frequently: where the petrol had been standing, where some decomposition had taken place, and where there was a tendency for the jets to get stopped up more? --- Supposing a car is standing for a long time, in which case the word "seldom" applies -- in regard to stopping the jets we have not found that except where the acetylene lamps are used. But in regard to the carburettor, unless the engine was running very badly it is very unlikely that jets get blocked.

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Q Had they any apprehension? --- No: except ~~that~~ as regards any special tests that I had occasion to forbid, because it was not part of their work, but the testing of engines and experimenting with any sort of fuel is part of their work and they are expected to do it.

Q They did not seem to mind using this stuff? --- If they had they would have had to go.

Q And they still employ on this the same two men? --- Yes.

Q Have you noticed any detriment to their health at all? --- No.

Q As regards Dr Coplans finding about the overalls, have you as a matter of fact taken any steps as regards laundries since that time? --- No. Normally I insist that they shall have clean overalls once a week, but for the special purpose of this experiment the overalls were used continuously from the beginning to the end, and they were certainly very dirty.

Q So that those overalls would be abnormally dirty? --- Oh, very much so. Perhaps I might explain the preponderance of the material on the overall of mechanic B. by saying that he has a very bad habit of wiping his hands on his overalls.

Mr PYE: There is a figure which I think you are responsible for, which was quoted this morning, namely, 94 milligrams of lead per cubic metre of exhaust gas? --- Yes.

Q That seems to me rather an important figure, because certain calculations were based upon it, because the amount of lead per cubic metre of exhaust gas would depend upon the mixture's strength? --- Yes.

Q I thought it might be useful if you would tell us the basis of that calculation. Is that 94 milligrams on the assumption that just enough air was taken in to burn all the petrol ethyl? --- No. That is worked out on a .084 mixture, as 12 to 1; but if you take 16 to 1 then you get a greater volume of exhaust gas, and therefore a lower lead content per cubic metre. Then again 80 milligrams per cubic metre: that is 16 to 1.

Q In fact you were allowing in the 94 milligrams for a certain

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Q. In fact you were allowing in the 94 milligrams for a certain richness of mixture which would be normally existing in a motor car engine? --- It is a good average figure. You could go to a 10 to 1 mixture, in which case you would have to take 106 milligrams per cubic metre; so I think 94 is a very good average for running conditions.

Mr Rowell.

Q I wanted to be quite clear that you were not taking a lean mixture then? --- No. There is a point that I ought to mention I think: that is that 94 is calculated out on the assumption of $3\frac{1}{2}$ grams of metallic lead per gallon of petrol. The lead content in the lead petrol varies somewhat from perhaps 3.1 to 3.6: so that by assuming 3.5 we have not been weighting the evidence in favour of one side.

Q On page 3 of your memorandum in the first paragraph you say: "Moreover lead tetra-ethyl appears to decompose very rapidly in the open and the total quantities split are proportionately small". Have you done any experiments on that decomposition of tetra-ethyl lead? --- Yes: we have done quite a number of experiments ~~in~~ with pure tetra-ethyl in petrol, in various proportions, but the most striking experiment -- which I carried out personally -- was in connection with corrosion. I was interested to know whether engine cylinders or petrol tanks are not corroded with this new fuel, and I put various samples of metals in bottles with various fuels and found no corrosion. I found the ethyl petrol decomposed very rapidly, frequently under the action of very moderate heat. What the decomposition was I do not know, but there were deposits on the walls of the bottle -- grey deposits, and the fuel itself appeared to lose a little of its colour. I could not say very definitely on that.

Q Did you test the effect of the temperature on the decomposition at all? --- No, I should not call it a test. It was more observation. Any cold surface in the engine appears to retain more of the character of the original fuel, naturally, than a hot surface.

Q Would you say that decomposition is likely to be in oxidation

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- Q On page 3 of your memorandum in the first paragraph you say: "Moreover lead tetra-ethyl appears to decompose very rapidly in the open and the total quantities split are proportionately small". Have you done any experiments on that decomposition of tetra-ethyl lead? --- Yes: we have done quite a number experiments ~~in~~ with pure tetra-ethyl in petrol, in various proportions, but the most striking experiment -- which I carried out personally -- was in connection with corrosion I was interested to know whether engine cylinders or petrol tanks are not corroded with this new fuel, and I put various samples of metals in bottles with various fuels and found no corrosion. I found the ethyl petrol decomposed very rapidly, frequently under the action of very moderate heat. What the decomposition was I do not know, but there were deposits on the walls of the bottle -- gray deposits, and the fuel itself appeared to lose a little of its colour. I could not say very definitely on that.
- Q Did you test the effect of the temperature on the decomposition at all? --- No, I should not call it a test. It was more observation. Any cold surface in the engine appears to retain more of the character of the original fuel, naturally, than a hot surface.
- Q Would you say that decomposition is likely to be in oxidation? --- I do not know. I have read Mellor on Lead in connection with this work, and found that the conditions likely to occur both in the engines and the pipes are so complicated that it is very difficult to reach anything more than very general conclusions. In the engine cylinder, for instance, you have an atmosphere rich in C.O., where you get lead oxide being reduced, and very often the atmosphere is fluctuating a good deal also. I should have thought that the decomposition of the tetra-ethyl lead -- I am speaking not as a chemist but from general observation -- is rather a breaking down of the compound.

Mr Rowell

Q The point I was really moving towards was this: whether if there is any ~~danger~~ tetra-ethyl lead, that should go down into the crank case into the oil, it is likely to remain as lead tetra-ethyl seeing that the oil is certain to be well aerated, and that it is at a temperature of 50 degrees or so - whether that lead tetra-ethyl is not very likely to become decomposed or oxidised into some non-volatile form? --- That is my impression. In fact, apart from the starting conditions - starting in cold weather where you might get the liquid petrol coming down the cylinder walls into the crank case - I find it very difficult to imagine the tetra-ethyl lead ever reaches the crank case; and we found just recently only one example of obvious tetra-ethyl lead on the cylinder head, and that was due to the engine having stopped just after an induction stroke, so that the liquid petrol had been drawn in on to the surface before the next firing stroke began. There is that possibility of tetra-ethyl lead in the form of a petrol being either in the crank case or in the cylinder head; but the amount is extremely small.

PROF. DIXON: In view of what you say, would you think there would be any more danger in cleaning out the cylinder heads than in cleaning the oil tank? --- I should not like to say that. The risk depends so much on the care of the man, and whether he has small cuts on his hands; but I should say that in cleaning engines out, either in the cylinder heads or the crank cases, there is extremely little need for contact with the skin.

Q But even if there were contact with the skin, it is not

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lead tetra-ethyl seeing that the oil is certain to be fairly well aerated, and that it is at a temperature of 50 degrees or so - whether that lead tetra-ethyl is not very likely to become decomposed or oxidised into some non-volatile form? --- That is my impression. In fact, apart from the starting conditions - starting in cold weather where you might get the liquid petrol coming down the cylinder walls into the crank case - I find it very difficult to imagine the tetra-ethyl lead ever reaches the crank case; and we found just recently only one example of obvious tetra-ethyl lead on the cylinder head, and that was due to the engine having stopped just after an induction stroke, so that the liquid petrol had been drawn in on to the surface before the next firing stroke began. There is that possibility of tetra-ethyl lead in the form of a petrol being either in the crank case or in the cylinder head; but the amount is extremely small.

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Q. But even if there were contact with the skin, it is not absorbed into the system ordinarily? --- I suppose not; but that is not my province.

Q. I mean, contact with the skin would not matter unless there is lead ethyl? --- Even then we do not mind: we use cottonwool or mutton cloth, to wipe out the final traces.

Mr Rowell

Q It is quite an easy matter to clean out these deposits?

--- Oh yes.

Q And the danger is said to be due to the dust that is caused? --- Yes.

Q Take the case of dry paint, old paint, such as is used in these days, you use a wiper to wipe it down? --- Yes.

Q Surely that could be done in the same way in the cylinder head? --- Yes, I should think so. If it was dusty, there is no more difficulty in dusting it than in dusting the floor.

Q Quite. You could not give any figures as to the amount of lead in this deposit in comparison with the amount of lead in old scraped-off paint? --- I should have said less; but I cannot remember what the ^{com}position of paint is. I should say it is generally less on account of the carbon. The carbon forms a very large bulk; but it is less in the deposit.

Q Less in the cylinder? --- All through.

Q What becomes of the old paint that is scraped off our houses? --- I do not know; in fact I have only seen them scraped off by burning a blow lamp.

Q That is out of date; but what becomes of the old paint? --- I could not say.

Q Does it contaminate the workman? It might if it is discarded and is not carefully collected? --- I do not know whether it is burnt or how it is done.

SIR ROBERT ROBERTSON: Following up an answer that you gave to Mr Pye that you did not see why there should be any undecomposed lead tetra-ethyl in the crank case oil, we have had some evidence put before us from which it is

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- SIR ROBERT ROBERTSON: Following up an answer that you gave to Mr Pye that you did not see why there should be any undecomposed lead tetra-ethyl in the crank case oil, we have had some evidence put before us from which it is deduced that there is in the crank case oil a certain amount of lead tetra-ethyl; would you be surprised to hear that? --- I was.
- Q You do not know by any chance the chemical process that was

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used by the institution which examined that lead?

--- I understand it was the fixed analysis.

Q Was not that used simply for an affirmative test? --- No, I think not. I cannot say from personal knowledge, but I understand that the method that is now used in these examinations is to insert a minute fraction of lead and take a photograph.

Q Put it through the spectroscope? --- Yes; we tested it through photographs.

Q You think that was not used affirmatively? --- As far as I know.

Mr CHAPMAN: There is a statement here - I think it is quoted from some American publication - that at the peak hours of traffic a contamination of 0.8 parts of carbon monoxide per 10,000 parts of air exists". --- Is that on page 2?

Q I beg your pardon: it is on page 4 of your proof, the first paragraph. --- That is taken from an automobile journal, and I understand it has been based on a report to which the Chairman referred this morning.

Q I follow. Then in the next sentence you say: "Using this peak value as a measure of dilution, it ~~can~~ can be shown that the lead risk is negligible". That of course is merely deduction and is based, I suppose, on the assumption that lead would rise or fall pri passu with the carbon monoxide. Have you any views on the matter whether there would be any possibility of the lead increasing while the carbon monoxide diminished, or do you think they would tend to rise and fall together; or do you think there would be at any moment a

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discharged, and a very large amount would be absorbed perhaps in carbon particles afterwards, carried by water vapour, and I should say that the lead dust, as metallic dust, is probably a very small proportion.

Q Might not some of it be discharged as lead promide or chloride? — Yes, I suppose so.

Q I was wondering whether the lead pari passu would go down with the carbon monoxide or whether there would be a tendency for one to increase while the other was diminishing? — I may give an illustration: We have had an engine running now since January, and I have looked very carefully for any signs of lead and find no trace of lead or of anything which would suggest anything apart from the ordinary.

Q Of course in fact what happens as to the old paint is, I suppose, that there must be a good deal of lead dust about; and considerable quantities of lead, I take it, have at times, or over long periods, been added to the agricultural land with the super-phosphate manures and things of that sort; so that the soil must contain some lead; so that if the constant effect of the ethyl petrol were not to increase materially the amount of lead — which might conceivably come normally in the dust — then I suppose you would feel that the risk would be a negligible one? — I have reached this conclusion mostly on the examination, watching the two mechanics, and the difference between the two findings, as well as on general reading.

Mr CHAPMAN: Thank you.

Sir WILLIAM WILLCOX: If a car is running in a garage, do you see

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... that the lead dust, as metallic dust, is probably a very small proportion.

Q Might not some of it be discharged as lead bromide or chloride? — Yes, I suppose so.

Q I was wondering whether the lead pari passu would go down with the carbon monoxide or whether there would be a tendency for one to increase while the other was diminishing? — I may give an illustration: We have had an engine running now since January, and I have looked very carefully for any signs of lead and find no trace of lead or of anything which would suggest anything apart from the ordinary.

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Mr CHAPMAN: Thank you.

Sir WILLIAM WILLCOX: If a car is running in a garage, do you see any of the fumes from the lead: can you tell, if a car were running in a garage, whether ethyl spirit is being used or ordinary petrol? — I do not think so.

Q The fumes are not visible? — I do not think so.

Q The finely divided lead is not visible? — Oh no. We have watched the running very carefully and certainly there are

Mr Rowell

no signs of lead; that is quite clear.

Q With regard to lead in vegetation, is it the fact that lead stops the growth of plants and flowers? --- I have never heard of that.

Dr BRIDGE: You have said that the water was quite clear?---Yes.

Q Did it remain very long? --- Yes: it remained ^{as} a minute quantity of lead chloride.

Q Not much ~~chloride~~?--- Oh, a fair amount.

Q In an engine running slowly there is generally a trip? ---Yes, if it was cold.

Q That would contain most of the ~~lead~~ petrol or lead bromide? --- As far as my experience goes it would contain lead bromide.

Q A good deal? --- Yes. Another difficulty arises in this way: that you have got this aqueous vapour coming down the exhaust pipe, passing through the system, which is slowly charged with the lead, and it is accumulating. You cannot make definite statements as to what might happen.

Sir Wm WILBOCK: When you say lead chloride, you mean lead scheelite

--- No, we found very little coming off.

Dr BRIDGE: In the engine as well as the exhaust pipe itself?

--- Yes.

Q There were large accumulations there?---Yes; but that is not ordinarily removed; in the ordinary way you do not take it away; so that all that really would happen in an ordinary garage would be the scrapings of the cylinder head and the crank case oil; except that the inside of the silencer may become coated.

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steps the growth of bacteria and moulds: --- I have never heard of that.

Dr BRIDGE: You have said that the water was quite clear?---Yes.

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Q But that would be the main source in this case: cleaning out the exhaust pipe? --- I do not say that would be the main source of risk: I think the ventilation would be the main point.

Q I mean, from the point of view of lead.

--- The cleaning?

Q Yes. --- Then the crank case oil or the deposits on the outside of the crank case, if there was a leaking joint and if the man were careless or had a cut hand - I think that remains.

Q Why? --- That is more or less admitted.

Q The dust, you mean? --- No, I am speaking of the actual ethyl petrol: as to the silencer dust and so on, I do not think there would be a risk at all.

Q That is fine dust? --- Yes, but it is in flakes.

Q There would not be very much dust. I am thinking of risk where there would be dust purely. I am leaving out the question of lead - purely dust. --- Well, as far as my memory serves me, in taking down one silencer which had 219 grams deposit, that was rather dusty in parts, but the bulk of it was heavy flakes, heavy oil.

Q It was not near to you? --- No, but there would be just slight risk when you took the thing down; that might arise by the attempt to get the silencer open.

Q That is an unusual thing? --- Yes.

CHAIRMAN: Thank you.

(The witness withdrew).